

**Mastery, mobility, and mathematics: A
case study on service children and the
NCETM's five big ideas**

**A Thesis Submitted for the
Degree of Doctor of Philosophy**

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2024

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Abstract

This case-based research study examines the implementation of Teaching for Mastery (TfM) in mathematics using the NCETM's Five Big Ideas – Coherence, Representation and Structure, Variation, Mathematical Thinking, and Fluency. The study considers the opportunities and challenges associated with applying TfM pedagogy when teaching mathematics to a diverse pupil group, particularly Service (Army) children.

The study uses the concept of policy enactment to explore how teachers interpret and apply these principles within their classrooms. Drawing on classroom observations, teacher interviews, field notes, and work samples, the research investigates the successes and challenges of applying TfM, with particular attention to the needs of Service children who often experience educational disruptions due to family mobility.

Teachers working with Service children face additional challenges in maintaining coherence and continuity in learning despite frequent school transitions. This research examines how the structured, deep-learning approach of TfM, underpinned by the Five Big Ideas, can address these challenges while fostering a cohesive and inclusive learning environment.

Findings indicate that while the Five Big Ideas promote mathematical understanding and engagement, their enactment is shaped by teachers' professional beliefs. Teachers are more likely to embed the aspects of TfM that they perceive to have, or are likely to have, a positive impact. Importantly, the analysis also identified two further principles – Community and Context – as essential to effective mastery teaching in this setting. Together with the NCETM's Five Big Ideas, these form a proposed framework of Seven Big Ideas that reflect both established principles and the lived realities of diverse classrooms.

The study highlights the central role of professional development – particularly in strengthening subject knowledge – in enabling teachers to adapt mastery pedagogy effectively for diverse pupil populations. Implications for policy include the need to design TfM support with sensitivity to contextual factors, such as the unique needs of transient military communities. The study concludes with recommendations for further research, including longitudinal studies on the sustained impact of the Seven Big Ideas – especially Community, Context, and Coherence – for Service children, and continued investigation into targeted professional development for mastery teaching.

List of Abbreviations

CPD - Continuing professional development
DfE - Department for Education DfES - Department for Education and Skills DV - Diagrams and Visual Problems
EAL - English as an Additional Language ECT - Early Career Teacher EYFS - Early Years Foundation Stage
HA - Higher attaining HT - Head teacher
ITT - Initial teacher training
LA- Lower Attaining
MA - Middle Attaining MTE - Mathematics Teacher Exchange MM - Maths Mastery
NCETM - National Centre for Excellence in the Teaching of Mathematics NRP - Non-routine problem NRPs - Non-routine problems (plural) NQT - Newly Qualified Teacher
OECD - Organisation for Economic Co-operation and Development
PISA - Programme for International Student Assessment
SDP - School Development Plan SEN - Special Educational Needs SS - Shanghai, Singapore
TfM - Teaching for Mastery TIMSS - Trends in International Mathematics and Science Study

Statement of Original Authorship

The copyright of this thesis rests with the author. No quotation from it should be published without the author's prior written consent and information derived from it should be acknowledged.

Acknowledgements

First and foremost, I owe endless gratitude to my supervisors, Dr Gwen Ineson and Professor Mike Watts. Thank you for your guidance, insights, and extraordinary ability to keep your facial expressions neutral whenever I proposed yet another 'ground breaking' idea. Your dedication to feedback has taught me resilience, humility, and the impressive word count possible with the words 'not quite.' You have been more than supervisors; you've been relentless editors, cheerleaders, and, on many occasions, therapists. Thank you for everything.

To my participants, your contributions are, quite literally, the foundation of this thesis. To all who endured endless video recordings, obscure questions, and the occasional existential query on my behalf: thank you.

A massive thank you goes out to my incredible family. Your support has been unwavering. To my two brothers, Kal and Morad (mainly Kal), I am grateful for your encouragement, your pride, and your bewildering ability to listen to me explaining my research and nod enthusiastically even though none of us really know what it's about.

To my friends, especially Naomi: thank you for listening to my endless thesis rants, only pretending to understand half of it, and forgiving me for my constant thesis-induced delirium. Special thanks to Nikki who took the time to proof-read, any lingering typos are solely on you.

Thank you all for supporting me through this bewildering, exhausting, yet strangely satisfying journey. Here's to never having to read this thesis again.

1 Chapter 1: Background

In this chapter the landscape in which this study resides and the research field are established. The three key themes of Maths Mastery, Service children and diverse pupils are introduced within the context of a specific primary school drawing on case-based research.

This thesis focuses on the implementation of maths mastery or teaching for mastery (TfM) approach according to the National Centre for Excellence in the Teaching of Mathematics (NCETM) definition, using the 'Five Big Ideas'. The context of the school is integral to considering how policy is enacted as well as the impact of specific pupil groups. The school's high in-take of Service pupils and its military parent population is also considered.

1.1 Introduction

This study investigates how the National Centre for Excellence in the Teaching of Mathematics' (NCETM) 'Teaching for Mastery' (TfM) framework- particularly its Five Big Ideas- is enacted within a primary school serving a predominantly military-connected population. Service children, defined as those with one or both parents serving in the armed forces, face unique educational challenges that extend beyond the classroom. Frequent relocations, transitions across educational systems, and parental deployments can lead to discontinuities in learning, emotional strain, and reduced academic progress. Despite the scale and complexity of these challenges, the educational experiences of Service children remain under-researched, particularly in the context of mathematics.

My interest in this area stems from two decades of teaching and leadership in schools serving vulnerable communities. As a child of migrant parents, I developed an enduring belief in education as a driver of equity. My Master's research into the mathematical learning of Traveller heritage children revealed systemic blind spots- children whose transience and socio-cultural contexts often placed them outside the scope of policy and pedagogy. This realisation formed the basis for my current inquiry.

Upon joining Alexander First School- situated within a Ministry of Defence estate, I was struck by the volatility of our pupil population. Children arrived mid-year, from diverse national and international contexts, often carrying emotional burdens related to separation, trauma, and instability. As Assistant Headteacher and subsequently Headteacher, I introduced the TfM model not simply as a pedagogical tool, but as a mechanism for stability, inclusion, and continuity.

This thesis is therefore situated at the intersection of research and professional practice. It explores how a mastery approach in mathematics can be adapted to meet the needs of a highly mobile, emotionally complex pupil group—offering a nuanced, practice-informed contribution to the fields of educational leadership, curriculum policy, and Service child education.

1.2 Researcher Positioning

My dual role as Headteacher and Maths Coordinator within the research school offered me a unique position from which to examine the implementation of the NCETM's Five Big Ideas. As an insider researcher, I had direct access to participants, school data, and pedagogical processes, which facilitated trust and ease of entry into the research site. However, this positionality also demanded a rigorous and

reflexive approach to minimise the influence of professional bias and to safeguard participant autonomy, particularly given my leadership status.

The school's adoption of a Teaching for Mastery approach was a change initiative I had personally introduced, informed by the distinctive context of our school population, which includes a high proportion of Service children and pupils with disrupted prior educational experiences. As such, I was professionally invested in the success of this pedagogical shift. I recognised that this could pose risks to the neutrality of the study, both in terms of how participants might respond to me and how I might interpret the data. For example, staff might feel compelled to support the initiative or may perceive the study as evaluative in nature. To mitigate this, I established clear boundaries between my leadership and research roles, reiterating that participation was voluntary and that the purpose of the study was to explore pupil experiences of maths mastery, rather than to assess teacher performance (see section 5.13.1).

Throughout the research process, I remained attentive to how my insider status shaped interactions and data collection. I employed strategies such as reflexive journaling, semi-structured interviews that allowed participants to guide the narrative, and peer debriefing to help monitor my own interpretations (see section 5.14). This reflexive stance was especially important given that my proximity to the implementation of mastery could lead to unconscious bias or assumptions. By positioning myself as a researcher rather than a Headteacher during fieldwork, I worked to foreground the voices of pupils and reduce the hierarchical dynamics that might otherwise have constrained responses.

This positioning did not detract from the quality of the data; rather, it provided a deeper understanding of the school's ethos and the rationale behind the adoption of mastery. However, it also required vigilance and critical self-awareness to ensure that the research remained credible, ethical, and transparent. The implications of this dual role are explored further in Chapters 5.13 and 5.14, where I discuss the ethical management of power, consent, and identity, and reflect on the methodological choices informed by my role.

1.3 Mathematics Context

The landscape of primary mathematics teaching and learning in England has been shaped by various educational reforms, pedagogical trends, and societal needs. The current climate of mathematics is one in which there is an emphasis on deeper understanding of mathematical concepts, a mastery approach, and the development of critical thinking and problem-solving skills (Ball, 1994). Below is an overview of key aspects that define the current landscape of primary mathematics education.

1.4 Mastery

Inspired by successful models from East Asian countries like Singapore and Shanghai, the mastery approach has become increasingly popular in primary mathematics education least owing to significant financial and political intervention (Boylan, 2020). This approach focuses on ensuring that students gain a deep and thorough understanding of mathematical concepts before moving on to new topics (NCETM, 2017). Whilst this may seem an obvious pedagogical undertaking, historically there has been an emphasis on rapid mathematical curriculum coverage, with more able pupils encouraged to undertake content beyond their academic year, irrespective of whether or not their actions were understood (Morony, 2023).

Referring to the way mathematics is taught in East Asia, the term ‘mastery’ entered into use in England relatively recently (Clapham and Vickers, 2018) and the term was then taken up by the National Centre for Excellence in Teaching Mathematics (NCETM) in 2014 with the formulation of ‘Teaching for Mastery’ (TfM), essentially an inter-changeable term used to describe maths mastery. This thesis focuses on the model of maths mastery outlined by the NCETM and in particular, their mastery framework described as the ‘Five Big Ideas’ (NCETM, 2017).

The NCETM's ‘Five Big Ideas’ in mathematics mastery provides a comprehensive framework for teaching and learning mathematics in a way that fosters deep understanding, reasoning, and problem-solving abilities, by emphasising:

- Coherence
- Representation and Structure
- Mathematical Thinking
- Fluency
- Variation

This approach seeks to ensure pupils not only learn mathematical procedures but also develop a thorough and flexible understanding of mathematical concepts (Cai et al., 2013). In doing so, the NCETM suggest this mastery approach prepares pupils for future mathematical challenges and promotes a lifelong appreciation of the subject.

1.4.1.1 Whole-Class Teaching

Traditional approaches to mathematics teaching and learning have often relied upon grouping or setting pupils according to their prior attainment in order to ‘teach to their ability’ (English, 1997). This would invariably mean lower attaining pupils would be taught together, separately from higher attaining pupils. However, the current mathematical climate advocates for all pupils to be taught the same mathematical concept at the same time, with the belief that everyone can achieve a high-level of understanding.

Differentiation occurs through the level of support provided rather than through different tasks (Jerrim and Vignoles, 2015). This means teachers use scaffolding, questioning, and additional practice to support students who may struggle, while extending the learning those who grasp concepts quickly.

1.4.1.2 Use of Concrete-Pictorial-Abstract (CPA) Approach

The Concrete-Pictorial-Abstract (CPA) approach has gained widespread popularity in mathematics education, especially in primary settings. This teaching method, which moves students through a sequence of concrete experiences, pictorial representations, and abstract symbols, is effective in helping students develop a deep understanding of mathematical concepts. This method helps pupils understand mathematical concepts by first using concrete objects, then visual representations (pictorial), and finally moving to abstract symbols and numbers. Jacques (2018) argues this progression helps students build a strong foundation in understanding mathematical principles. Whilst Kling and Bay-Williams (2015) argue mathematical resources and materials have long been used in primary mathematics, the formulaic approach is something of a shift in educational practice and closely associated with TfM training and development.

1.4.2 Curriculum and Assessment

1.4.2.1 National Curriculum

Currently, the National Curriculum in England reflects ongoing efforts to improve mathematics teaching and learning in response to international benchmarks, educational research, and societal needs (Lewis et al., 2022). The current programme of study for mathematics is designed to be more rigorous than its predecessors, aiming to raise standards and ensure that students are competitive globally. It has evolved to include greater opportunities and emphasis on developing fluency in key concepts, reasoning mathematically, and problem-solving. Blausten (2020) suggests there is a strong emphasis on fundamental topics such as number sense, fractions, and arithmetic in the early years, which are viewed as essential for developing a solid mathematical foundation. Consequently, there appears to be greater focus on mapping out a mathematical educational experience which is sequential and interconnected. Again, this can be regarded as something of a shift from previous approaches to curriculum design which often relied upon revisiting topics in instances where understanding had not been securely grasped (Almond, 2020).

1.4.2.2 Assessment Practices

‘The term ‘assessment’ in Mathematics refers to the identification and appraisal of students’ knowledge, insight, understanding, skills, achievement, performance, and capacity in Mathematics’ (Niss, 1998, p.228). Niss (1998) suggesting assessment in primary education in England is shaped by a combination of standardised testing, formative assessments, and a focus on the individual. However, according to An et al. (2011) standardised assessments, such as SATs (Standard Assessment Tests), continue to be used to evaluate pupils’ mathematical ability. Harris and Jones (2019) argues that this is counterintuitive to the principles of TfM. For example, they argue that SATs assessments often stress procedural fluency - the ability to carry out calculations - over and above conceptual understanding. Consequently, pupils may be confident in performing operations correctly, but lack a deeper understanding of how or why these operations work. Contrary to this, TfM seeks to emphasis a deep understanding and connections across mathematical concepts which does not align well with the procedural focus of SATs assessments (Hyde, and Jain, 2020).

In 2020 and 2021, the SATs were cancelled due to the COVID-19 pandemic. This disruption led to a temporary pause in standardised assessments and gave rise to concerns about the long-term impact on student learning and progression. According to Lewis (2022), the cancellation prompted discussions about the role and necessity of high-stakes testing in primary education. They argue that given that SATs assessment scores are aggregated, published and often appear in local and national comparative league tables, they create pressure on schools and teachers to focus on test preparation, often leading to a narrowing of the curriculum. This is a view supported by Morony (2023) who suggests, teachers are more likely to prioritise teaching content that is likely to appear in assessments or, ‘teaching to the test’, rather than instilling a broader, deeper understanding of mathematics. Subsequently, this may diminish motivation or opportunity to use probing tasks that encourage reasoning, problem-solving, and discussion, which are central to a mastery approach.

However, since September 2023, it is no longer statutory for schools to administer Key Stage 1 SATs assessments as the Reception Baseline Assessment (RBA) was designed to replace this. The RBA is taken by all pupils when they first start school in Reception class. Its introduction was cited as an assessment opportunity to ensure early intervention and address gaps in understanding (Shimizu and Vithal, 2023).

1.4.3 Problem-Solving and Reasoning

1.4.3.1 Emphasis on Problem-Solving

The current climate of mathematical problem-solving in primary education stresses deep understanding, real-world application, and the development of critical thinking skills (Adams and McLeod, 1989). With the integration of the mastery approach, the use of the CPA model, ongoing teacher development, and the inclusion of problem-solving in assessments, there appears to be a strong desire to equip pupils with the skills needed to navigate complex mathematical challenges. However, challenges remain, such as teacher confidence and time constraints and fostering a problem-solving mindset. Consequently, these challenges are likely to impact future curriculum development, teaching practices, and assessment methods.

1.4.3.2 Mathematical Reasoning

Mathematical reasoning remains a cornerstone of primary education, with an increased emphasis on developing pupils' ability to think logically, justify their answers, and understand the underlying principles of mathematical concepts (Peng et al., 2020). This reflects the distinct desire to promote a deep understanding of mathematics. TfM or maths mastery, prioritises depth of understanding over the pace of progression through the curriculum. This approach naturally incorporates reasoning as it encourages pupils to think deeply about mathematical concepts, explain their thought processes, and make connections between different areas of mathematics. According to Wong (2017), teachers using a TfM approach often employ variation theory to present problems in different ways, encouraging students to see patterns and reason about the relationships between numbers and operations. This technique supports pupils develop flexible thinking and strengthens their reasoning skills.

The 2014 revision of the national curriculum in England placed a strong emphasis on reasoning as one of the three key aims of mathematics education, alongside fluency and problem-solving. This change reflects a shift towards valuing pupils' ability to reason mathematically and use logical arguments to justify their answers. Furthermore, the curriculum specifies objectives related to reasoning, such as explaining why a mathematical statement is true or false, justifying choices and decisions in mathematical problems, and using mathematical language to explain reasoning processes (You and Morris, 2016). Wong (2017) suggests these objectives encourage teachers to incorporate reasoning activities into daily lessons.

1.4.4 Use of Resources

1.4.4.1 High-Quality Textbooks

Blausten et al.'s (2020) research on supporting mathematics teaching for mastery in England suggests that in recent years many schools have adopted high-quality textbooks that align with the mastery approach. Inspired by those of Shanghai and Singapore (which emphasises visual learning, problem-solving, and a strong conceptual understanding), these textbooks are carefully organised to build understanding and provide a variety of practice problems that cater to different levels of ability (Boaler et al., 2015). The NCETM's 'Five Big Ideas' of mathematical mastery (Coherence, Representation and Structure, Variation, Fluency, and Mathematical Thinking), are often embedded within these textbooks. This ensures that teaching materials promote a consistent approach to developing mathematical understanding (Clapham, and Vickers, 2018). Additionally, manipulatives, such as number lines, counters, and base-ten blocks, are also commonly used to help students visualise mathematical concepts.

The UK government has supported initiatives to encourage the employment of high-quality textbooks via the funding of both Maths Hubs (led by the NCETM) and grants to support the cost of purchasing materials

(Boylan, 2020). The Maths Hubs have facilitated the introduction and distribution of mastery-based textbooks, particularly those developed in collaboration with international partners. However, caution must be paid to the fact not all teachers are familiar with the use of specific high-quality textbooks and may need training and support to ensure teachers are confident in using textbooks effectively. Additionally, there has recently been a growing debate regarding the need to shift towards digital learning platforms, making textbooks available online and with increased interactive resources.

1.4.5 Professional Development and Teacher Support

1.4.5.1 Ongoing Professional Development

Crozier and Gerrard's (2016) work on procedural variation with mastery specialist teachers suggests ongoing professional development (PD) for primary mathematics teachers has become a critical area of focus to enhance teaching quality, improve student outcomes, and align with contemporary educational standards and methodologies. The increasing emphasis on mastery-based learning, mathematical reasoning, and problem-solving requires teachers to continuously update their knowledge and skills. In England, the Maths Hubs program (led by the NCETM) have played an essential role in supporting ongoing professional development. Via collaborative networks, Maths Hubs brought together schools and professional development providers to share best practices and resources. The Hubs have offered workshops, training sessions, and collaborative projects aimed at improving TfM. Government funding has been provided to support schools in accessing Hub provisions and therefore increase accessibility and volume of school participation (Crozier and Gerrard, 2016). This level of 'buy-in' has been particularly crucial in implementing changes aligned with the 2014 national curriculum, which emphasises mathematical fluency, reasoning, and problem-solving.

1.4.5.2 Collaboration and Lesson Study

According to Fernandez et al. (2003), the current climate of collaboration and lesson study in primary mathematics is characterised by a growing recognition of their importance for effective teaching and learning. Supported by initiatives like Maths Hubs and NCETM, these practices promote professional growth, reflective practice, and a focus on pupil learning.

The lesson study model has gained popularity in primary mathematics education in the UK owing to its focus on collective learning and evidence-based practice. The repeated nature of lesson study allows for continuous refinement and improvement of teaching strategies. The Maths Hubs have been instrumental in spreading the lesson study model across the country as they have facilitated partnerships among schools, allowing teachers to share best practices and learn from one another (Drury, 2018). Furthermore, the Hubs have provided resources, training, and support for schools to implement lesson study. However, there remains several challenges related to collaboration and lesson study. One of the main challenges of collaboration and lesson study is finding time within the school schedule. Teachers often have demanding workloads, and dedicating time to plan, observe, and analyse lessons can be difficult. Schools need to allocate sufficient time for collaborative activities to ensure their effectiveness. Moreover, teachers' engagement in collaboration and lesson study can vary depending on their experience, confidence, and commitment to professional development (Ball et al., 2011). Encouraging all teachers to participate actively and valuing their contributions is important for building a collaborative culture (Boylan, 2020).

1.4.6 Inclusion and Differentiation

1.4.6.1 Meeting Diverse Needs

Simpson and Wang (2022) suggest, whilst primary mathematics education aims to be inclusive, as classrooms become more diverse in terms of cultural backgrounds, language proficiency, learning abilities, and socio-economic status, educators are challenged in providing inclusive and effective mathematics instruction that meets the needs of all students. TfM or maths mastery, stresses that all pupils can achieve a deep understanding of mathematical concepts given the right support and time. Given this, there is currently an increased focus on providing timely support and intervention for pupils who need more time or help (Goldin and Shteingold, 2001). TfM involves the use of scaffolding techniques to support such pupils. The use of manipulatives, visual aids, and structured frameworks to build understanding, are but a few of the current strategies employed to meet diverse needs. Such provisions facilitate a step-by-step approach that gradually moves pupils from concrete to abstract thinking.

1.4.6.2 Support for Special Educational Needs (SEN)

TfM aims for all pupils to gain a deep and secure understanding of mathematical concepts (Boylan et al., 2018). Consequently, it is an approach that is arguably more inclusive as teaching strategies, materials, and assessments are adapted to ensure all pupils can engage with and understand the content. Under the guidance of the NCETM, Maths Hubs have provided specific training on how to tailor interventions, such as one-on-one support and small group work to meet the learning needs of pupils with SEN.

Following the examples of Shanghai and Singapore, scaffolding techniques are widely used to support SEN pupils. Teachers are encouraged to break down complex concepts into smaller, manageable steps and provide guidance and support at each stage. According to Harris and Jones 2019, this is a cultural shift from previous habits of providing SEN pupils with ‘watered down’ tasks dissimilar to that undertaken by their peers.

1.5 Service Children’s Academic Research to Date

The Service Children’s Progression (SCiP) Alliance (2024, <https://www.scipalliance.org/>) is a partnership of organisations focused on improving outcomes for children from Armed Forces families. They define a Service child as ‘a person whose parent, or carer, serves in the regular armed forces, or as a reservist, or has done at any point during the first 25 years of that person’s life.’ According to Cozza and Lerner (2013) researchers who study and collect data on military families and children typically define Service families as the spouse/partner and dependent children of men and women on active duty or a reservist. This is the definition I have used in describing Service children and their families.

Cozza and Lerner (2013, p.5) argue that to-date, research on the development of Service children has largely focused on the quality or function of their family systems and on the potential risks of a parent’s deployment to their wellbeing. They argue:

‘Existing research offers only a rudimentary depiction of military children and their families across their respective life courses and certainly not a representative one. The children of military families deserve to have policies and programs designed to fit their developmental needs. Given the extraordinary sacrifices that military personnel make, and their invaluable service that they provide, our lack of a thorough understanding of their children’s development is not appropriate.’

Pedro et al. (2011, p.566) supports this in stating, 'at present, there is a knowledge gap in educational research regarding military-connected schools and students.' Esqueda et al. (2012, p.65) echo this in arguing, 'education researchers often overlook the educational experiences and needs of military children attending civilian-operated schools.' Additionally, Cozza and Lerner (2013, p.7) suggest, 'without precise knowledge of military children's strengths and their opportunities for positive development, conjecture and overgeneralisation will inappropriately frame decisions about meeting their needs and supporting their health.'

Bradshaw et al. (2010); De Pedro et al. (2011); and Mmari et al. (2009) all argue that whilst recent education research has shown that external stressors such as mobility, deployments and changes negatively affect the academic functioning and behavioural outcomes of military children, 'research identifying evidence-based practices in schools with students from military families is rare' (Esqueda et al., 2012, p.68).

Service children have long been overlooked in education research literature and the effects of this oversight is only now beginning to 'enter into the field's stream of consciousness' (Esqueda et al., 2012, p.69). Given that this publication is more than a decade old now, it goes some way to illustrate the lack of current research findings.

1.6 School Transitions

According to Esqueda et al. (2012, p.66) Service children change schools approximately every 2.9 years. This includes changes across local authorities, school structures (varying from primary models to first schools to middle school structures). Consequently, a Service child may begin their academic year in one school and finish that year in another school and with this, experience a disjointed curriculum. That is to say, whilst there is a National Curriculum, how subject topics are mapped out and scheduled across the academic year is at the discretion of schools. As a result, depending when a Service child relocates, they may miss a unit of study in its entirety or face repeating it. For example, in Alexander First School, Electricity is covered in Year 3 in Spring Term 1. Depending when a Service child joins the school, they may have already covered this unit or miss it completely. Additionally, Service children are expected to adapt between different schemes of learning and pedagogical approaches. For instance, one school may deliver their phonics programme using one scheme of learning with ascribed teacher and pupil interaction, and then join a school with a different scheme and different learning requirements. Consequently, Esqueda et al. (2012) argue differing curriculum designs and provisions appear to be hindering the educational progress of Service children.

1.7 Parental Deployments

Long periods of absence from a parent at any age is difficult for a child, but separation combined with the heightened danger of military service is uniquely attributed to Service children. Yet Engel et al. (2008, p.73) argue, the impact of such work-related absence and its effects on children is 'relatively scarce.'

Military deployment is the movement of armed forces. Deployment includes any movement from a military Service member's routine posting to somewhere outside the UK and its territories. One example would be when a unit based in the UK is deployed to another country to enter into a combat zone. However, deployment is not restricted to combat; units can be deployed for other reasons such as humanitarian aid, evacuation of UK citizens, restoration of peace, or increased security. Given this wide-ranging definition of 'deployment', Service children experience frequent, often unpredictable parental

deployments. As a result, parental deployments and its association with war, trauma, disability and/or death are among the Service-specific psychological stressors to negatively influence the academic, psychological, and socioeconomical outcomes of Service children (Engel et al., 2010; Lyle, 2006; Mmari et al., 2009).

Research findings show children of deployed parents are more likely to demonstrate internalising and externalising symptoms, such as anxiety, depression, and aggression (Aranda et al., 2011; Chartrand et al., 2008; Lester et al., Lincoln and Sweeten, 2011; Chandra et al., 2010; 2011). Furthermore, 'children of deployed military parents are also at greater risk of experiencing psychosocial difficulties, including attention problems' (Tanielian et al., 2014, p.7).

Additionally, Groman et al.'s (2010) study of Service children found between 2005 and 2006 the number of behavioural and mental health visits, behavioural disorders, and stress disorders reported for military children increased by 11%, 19% and 18% respectively while a parent was deployed. Similarly, Watanabe (1996) found that parental deployments were positively associated with a greater incidence of juvenile depression among younger military children. Yet despite these findings, Mmari et al. (2009) argue civilian schools in particular are unlikely to be able to support Service children appropriately. Consequently, research available suggests a school's climate - that of the social relationships, sense of community, feeling safe - all moderate the potential effects of behaviours known to adversely impact academic ability (Astor et al., 2009; Cohen et al., 2009).

de Burgh (2008) suggests military deployments likely impact Service children owing to the dramatic changes which arise in family functioning. Although spouses of Service persons are not deployed themselves, their lives prior to, during and post-deployments are routinely affected (Tanielian et al., 2014). Whilst the Service person is absent, the nondeployed spouse must assume additional responsibilities for the household and parenting duties. This is a view supported by Engel et al. (2008) who suggest Service children's academic success may be negatively affected by deployments as the amount of time available to support and engage with a child's learning is reduced to that of one parent who may need to support multiple children during this time. Consequently, Gibbs et al. (2008) states children with a deployed parent are likely to experience neglect or maltreatment.

1.8 Mathematics Learning, Service Children and Deployment

According to Engel et al. (2010, p.78), deployments and its impact on Service children's mathematics scores is 'statistically significant'. Parental deployments during the current school year lowers a child's math NCE (Normal Curve Equivalent) score by 0.76% points, nearly twice the effect on the total NCE score. Furthermore, the longer the deployment (be that a combative or non-combative deployment) the greater the impact with Engel et al. (2010, p.78) stating the deployment 'lowers a child's math score by 1.50% points compared with 0.90 for the total NCE (Normal Curve Equivalent) score.'

According to Engel et al. (2010, p.80) under closer scrutiny, deployments during the months of standardised testing presented a 'significant' negative effect in mathematics results for Service children. 'A child whose parent is deployed during the month of the exam experiences a 0.92%-point reduction in his or her math score relative to a child whose parent is not deployed during that time.' (Engel et al. 2010, p.80). Significantly, they report that when a deployed parent returns well ahead of an examination period, Service children score 'about the same as a child whose parent does not deploy at all that year.' However,

in contrast they report that when a deployed parent returns later beyond the examination period, Service children typically score '0.79%-points lower in maths than a child whose parent does not deploy that year.'

Consequently, Engel et al. (2010, p.80) provide two interpretations, the first being the 'disruption' effect and the second being the 'catching up' effect. The 'disruption' effect suggests that a parental deployment disrupts a Service child's academic performance, 'particularly if the absence occurs during the month in which the child is tested.' Engel et al.'s (2010) explanation of the 'catching up' effect describes the instance in which a Service child whose parent returns earlier in the academic year has time to 'catch up' before formal assessments take place. To conclude, they state: 'we observe a statistically significant negative effect, indicating that these [Service] children experience a decline in academic achievement that results from deployments from as far back as 5 years.' These statistical findings clearly demonstrate the punitive impact of military-life on Service children's educational achievement. However, what is also clearly apparent is that negative effects tend to dissipate after a parent's return. This underscores the need for schools, especially those serving pupils prone to parental absence, to consider systems and approaches to support parental engagement post-deployment and to support Service children's educational continuity during periods of separation. Alexander First School is a prime example of a school with a Service child population which benefits from such active research.

1.9 Frequent Relocations and Transitions

One of the most significant challenges Alexander First School faces is the high turnover of pupils owing to the frequent relocation of Service families. During the academic year 2023-2024, 24% of pupils were new to the school and 15% of pupils who had been at the school the previous academic year left during this period. This demonstrates the significant level of transition both in and out of the school throughout the academic year. There is no particular sequence nor period in which moves/arrivals occur and so consequently, pupil mobility is described as trickling in and out, often without prior notice. The obvious impact of this is that pupils arrive at various points during curriculum coverage. Consequently, very few pupils benefit from the school's curriculum over a longer period of time. Teachers must account for a Service child arriving at any point within a topic of study with either some or no prior learning experience.

1.10 Social, Emotional and Mental Health (SEMH) Needs

Added to this are the emotional complexities which accompany such significant change. A newly arrived Service child must contend with establishing a sense of belonging/community and making new friends where being the 'new' pupil can lead to feelings of isolation, anxiety, and stress. Additionally, Service pupils are expected to attune to the systems and structures of the schools they join. For example, they must adapt to meet new and often different expectations for routines, policies, reward and sanction systems, all on top of attempting to contend with new learning material. Whilst these may seem trivial notions, each small, different and new school-context requirement places significant emotional and cognitive demands on Service pupils.

The school often find that Service pupils require time to make these adjustments and do well academically once their emotional needs have been met. Unfortunately, given that most pupils will leave the school after roughly two years, the school often does not have the time to yield the academic gains before pupils then move on. This is often captured in the school's published data which, in KS1 SATs achievement is often below national and local expectations for writing and mathematics (reading scores are generally in-line with those of national and local expectations).

1.11 Staff Recruitment and Retention

Given the combination of academic and emotional challenges, teacher retention has been challenging, particularly in Early Years (Nursery and Reception) where pupils typically join at their most vulnerable development point, academically, socially and emotionally. Teachers typically stay at the school for between one to three years, however, there are a number of teachers who have been at the school for eight years or more, including those who began as Newly Qualified Teachers (NQTs). Added to this is the change of teaching assistants. Most of the school's teaching assistants are military spouses/partners and move alongside their serving partner typically after two years. Consequently, the school has taken a particular interest in identifying teaching and learning strategies which offer the maximum learning capacity when time is constrained.

1.12 Organisation/Structure

This thesis begins with an extensive review of the research literature, which explores the existing evidence base surrounding maths mastery and TfM. Following this, the methods utilised to gather qualitative data are described, and justification for the use of such methods is provided. The results chapters are structured to present the findings of each of the 'Five Big Ideas' of TfM, after which a discussion of the key findings in relation to each of these Ideas is presented, and the discussion chapter concludes by outlining the key implications for future research.

1.13 Conceptual Framework

Whilst maths mastery or Teaching for Mastery (TfM) is increasingly used as an underpinning approach in primary mathematics classrooms (Marks, Barclay & Barnes, 2023), research studies exploring the effect of TfM on mathematical achievement have reported mixed results, with large-scale studies yielding only small effects (for Key Stage 1 pupils only) and it is unclear which particular aspects of TfM are most effective at improving mathematical outcomes (Boylan et al., 2018). The limited research evidence available is presented in the literature review of this thesis.

Service children are defined as those who have one or both parents serving in the armed forces. Despite there being some 80,000 Service children in England, to date, no research studies (that this author is aware of) have examined maths mastery or the TfM approach within the context of a school with a high proportion of Service children. This unique demographic often faces challenges that can affect their educational experiences, including frequent relocations, parental deployments, and the stress associated with military life. However, there remains limited research specifically focusing on the educational experiences of service children, particularly in the area of mathematics. Most existing studies on military children are broader in scope, addressing general educational outcomes, mental health, or social-emotional well-being rather than specific academic subjects like mathematics. This gap poses an opportunity to explore a TfM-aligned mathematics programme within the context of a school with both a diverse and Service pupil population. Additionally, this thesis provides an insight into the enactment of policy from practitioners with a differing range of experience in policy change and introduction. These two aspects combined offer an insight into the aspects of TfM that benefit a nuanced pupil group and school community.

Besides the lack of research focused on Service children within a TfM approach, there is also minimal documented research to date that explores teachers' perspectives about opportunities for Service children within the TfM approach. Teachers and school leaders provide the means by which to enact

significant educational reform and change (Harries & Jones, 2019); therefore, it is crucial teacher voice is not overlooked when evaluating the effectiveness of large-scale changes and policy reform.

Figure 1 below illustrates the key themes of this thesis.

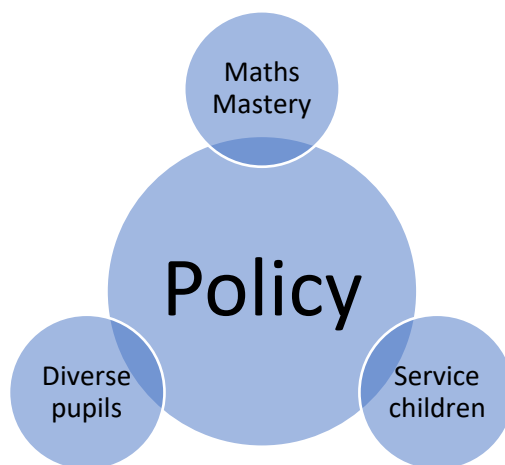


Figure 1: Provides a visual representation of the inter-related themes of this thesis.

1.14 The Structure of this Study

This chapter has established that the thesis details the narrative surrounding the NCETM's definition of Maths mastery using their 'Five Big Ideas' concept. This provides the groundwork to then consider the learning responses of practitioners, Service children and diverse pupils.

Chapter 3, the literature review, begins with discussion surrounding the National Curriculum and the politicisation of the maths curriculum and links this to the recent focus on Far Eastern approaches to teaching and learning mathematics. Having considered the increased focus on such approach, discussion then moves to the theoretical underpinning for these Far Eastern methods.

The literature considered is wide ranging and an emerging appreciation of a learning community shifts focus from just content and delivery, to asking the reader to consider the wider implications of policy borrowing and the application of definitions of maths teaching and learning for such a community.

In chapter 4 the theoretical framework for the study is discussed, including debate surrounding the tension between policy and action.

Chapter 5 introduces the research interpretive paradigm and the case-based research approach undertaken. Considerations related to insider research, ethical considerations and insider bias are all debated before focus then shifts to a more analytical description of the research methods. Links to the overarching research questions and the gathering of learner data is also considered. The chapter concludes with examination of data collection tools and the coding process.

Chapter 6 analyses the data via each 'Big Idea' as outlined within each theoretical framework. Data across each collection method is considered and how this contributes towards better understanding the context of the school and their delivery of maths mastery via the NCETM's TFM approach.

Chapter 7 reviews to what extent the study has met its criteria and answered the research questions as stated by reviewing each 'Big Idea'. Particular consideration is paid to the context of the school and how this affects the delivery and potential of TfM. Areas that may benefit from further research are identified and an overall summary concludes the thesis.

Summary

Having established the mathematics context in which this research study has risen, the interchangeable terms 'maths mastery' and 'Teaching for Mastery' (TfM) provide a description of the pedagogical approaches, curriculum design and cultural practices as defined by extensive literature and research. However, mastery is proposed as having more than a single definition, although central to this theory is the requirement that no learner is left behind and therefore necessitating individualised responses and intervention. This ties with Bloom's (1968) model of learning which appears to have significantly shaped instructional design related to TfM here in the UK and in the Far East.

The nuances of Service children's education are identified and the absence of up-to-date research data explored. The consequence of this is a significant gap in knowledge and the associated recommendations on bringing about improvements to this community of learners.

The school setting is outlined thereby providing a clear context for the research methodology, case-based research which is discussed in chapter 4. Personal motivations reveal the desire to attune policy, actions and practices in order to provide the best educational experience for a community often experiencing educational injustice and inopportunity. Finally, the structure and outline of this thesis has been described for the reader.

2 Chapter 2: The Case - Alexander First School

This chapter explores the national and local policy context in which this research is situated, the development and enactment of curriculum policy in mathematics, and the leadership strategies employed to support change. While this chapter outlines the broader context influencing decision-making at the school level, readers are also referred to Chapter 4, where the school's unique Service setting and the lived experiences of its pupils and staff are discussed in greater depth through data collected during the study.

Within this chapter I also offer insight into the context of Alexander First School as maths coordinator and Headteacher. The school's relationship to its Service community is explored including the way in which curriculum design and provisions have been selected to meet this community's needs.

The employment of Service spouses and partners brings numerous benefits, including enhanced understanding of military family dynamics, improved community connections, and increased staff commitment. However, the challenges are also explored and how these have the potential to impact pupils' mathematical understanding.

Further discussion is also offered relating to how the school environment seeks to support pupils' social, emotional and mental health needs and how this enhances mathematical attainment.

2.1 Alexander First School

This thesis applies a case-based approach to its research methodology. Alexander First School is unique in that whilst being a maintained, local authority school, it serves a considerably large Service (Army) pupil in-take. Teaching in a school that serves a Service community comes with unique challenges and opportunities. Military children, often referred to as Service children, face specific circumstances that can impact their educational experiences and outcomes. Educators working in these communities must navigate a range of factors to provide consistent, supportive, and high-quality education. The school context will now be discussed in more detail.

Alexander First School is located on the Ministry of Defence (MoD) housing estate in Windsor. Although a local authority, maintained school, given its location Alexander First serves a pupil population which comprises of roughly 75%-85% army Service children. This is formed predominantly of Service personnel attached to the Coldstream and Welsh Guards Regiments. However, as Windsor sits on what is referred to as the 'Guards Corridor', Service parents/carers also work between areas such as Knightsbridge, Woolwich, Aldershot and Pirbright. This creates a more nuanced Service school as movements across the 'Guards Corridor' are more frequent than typical garrison schools. Within this, pupils move between not only school settings, but differing school systems as Windsor operates a three-tiered school system (First, Middle and Upper) compared to the more widely operating Primary and Secondary model.

2.2 Rates of Service Pupil Mobility and Transition

Typically, Service parents/carers at Alexander First School are mandated to spend regular periods of time either training, on exercises or deployed overseas. This means frequent periods of separation between parent and child. This period of separation can vary from days to months, including periods as long as seven months. These intervals are not always anticipated and can result in the sudden and unexpected

departure of a parent/carer. Equally, return dates can be modified and so reunification can often be undetermined.

During the deployment period, the absence of a caregiver can lead to separation anxiety in children, especially younger pupils. Alexander First staff often find this presents as increased anxiety and difficulty maintaining concentrating. Additionally, the uncertainty about a parent's safety, well-being and return date results in considerable distress which can lead to lower rates of school attendance or periods of school refusal.

Service pupil mobility describes the frequency with which children from military families move between schools due to their parents' deployment or relocation. Depending upon the job role, location and promotional opportunity this mobility can vary, however, Alexander First School find most Service families typically move every 2-3 years. The school also have 'boomerang' pupils, those who join the school, leave owing to a parent's military assignment, and then re-join the school.

Service children move not only within the UK, but between countries as military personnel are posted both domestically and internationally. Consequently, Service children can arrive at Alexander First School having not only attended several schools, but having attended several schools in different education systems within a short span of time, further complicating the continuity of their education. Additionally, the school proudly serves a large and diverse Commonwealth community, mainly comprising of a thriving Fijian and Gambian background. Consequently, many of the school's Service children are newly arrived to the UK reuniting with parents having spent their formative years separately from their Serving parent(s). For these pupils, there is a greater adjustment beyond adapting to a new curriculum, rather one which requires adjusting to a new language, cultural context, friendships and re-establishing attachments to a primary care-giver.

Figure 2.0 below illustrates rates of pupil mobility at Alexander First School over successive years.

Year Group	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021		2021-2022	
	Pupils joined (Sept 2016 to July 2017)	Pupils left (Sept 2016 to July 2017)	Pupils joined (Sept 2017 to July 2018)	Pupils left (Sept 2017 to July 2018)	Pupils joined (Sept 2018 to July 2019)	Pupils left (Sept 2018 to July 2019)	Pupils joined (Sept 2019 to July 2020)	Pupils left (Sept 2019 to July 2020)	Pupils joined (Sept 2020 to July 2021)	Pupils left (Sept 2020 to July 2021)	Pupils joined (Sept 2021 to July 2022)	Pupils left (Sept 2021 to July 2022)
Nursery	20	8	11	14	10	10	6	7	13	4	18	5
Reception (*GLD)	2	3	4	3	4	4	9	6	4	4	5	2
Year 1 (*Phonics screening)	6	3	7	7	10	4	13	6	2	2	3	11
Year 2 (*SATs)	3	3	10	4	6	6	14	3	2	8	2	5
Year 3	4	2	4	1	5	7	10	5	1	5	3	1
Year 4 (*Times table test)	27	3	14	3	7	5	12	2	1	6	2	4
Total												
Service pupils/ total pupils	62/123	22/123	50/116	32/116	42/101	36/101	64/120	29/120	23/98	29/98	33/95	28/95
Impact	50% of the school's population were new	18% of school's population left over the course	43% of the school's population were new	28% of school's population left over the course	42% of the school's population were new	36% of school's population left over the course	53% of the school's population were new	24% of school's population left over the course	23% of the school's population were new	30% of school's population left over the course	35% of the school's population were new	29% of school's population left over the

	pupils over the course of the academic year.	of the academic year.	pupils over the course of the academic year.	of the academic year.	pupils over the course of the academic year.	of the academic year.	pupils over the course of the academic year.	of the academic year.	pupils over the course of the academic year.	of the academic year.	pupils over the course of the academic year.	course of the academic year.
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** indicates statutory assessment*

Figure 2: Demonstrates the rates of Service pupils joining and leaving Alexander First School year-on-year.

Unlike typical school transitions, which usually occur at the start of the academic year (September), Service children move throughout the school year. The high rates of in-year transitions create further challenges for Alexander First School in terms of supporting pupils to not only adapt to a new curriculum, but to foster social connections when repeated changes occur. This is complicated further by the often short-notice, making their transition more abrupt and potentially more disruptive to their learning and emotional well-being. In an effort to mitigate this where possible, Alexander First School provide transitional support to pupils in preparing them for their next educational setting. Support includes 1-2-1 tuition for academic assistance, small group work with other Service children due to relocate, or therapeutic sessions.

Whilst England has a National Curriculum outlining core knowledge to be developed in pupils, its sequencing, delivery and pedagogical approach are all at the behest of individual schools. For Service children this means having to contend with differing curriculum provisions.

An additional complicating factor arises as many pupils at the school have been taught in Welsh following a Welsh national curriculum. According to Maisuria (2024), the Welsh curriculum focuses on developing general skills, while the English curriculum focuses on specific knowledge. Furthermore, the Welsh curriculum has fewer formal assessments during the infant and junior years, instead opting to focus more on coursework and class projects.

Given this and the fact pupils are transitioning from schools domestic and overseas, pupils arriving at Alexander First School may either inadvertently repeat units/topics of study, or miss them in their entirety. Alexander First School attempt to lessen the impact of this through daily pre-teaching and post-teaching interventions.

2.3 Rationale for Change

2.3.1 A Need for Systemic Transformation

At the time of my appointment to a leadership position at Alexander First School, it was clear that significant transformation was needed to improve both the consistency and quality of mathematics education across the school. Serving a predominantly military population, the school faced several contextual challenges—chief among them, high pupil mobility, inconsistent curriculum access due to frequent transitions, and fluctuating staff capacity. These factors combined to produce variable mathematics attainment and left some pupils, particularly those from Service families, feeling under-confident and unsupported in their learning journey.

From a leadership perspective, it became evident that isolated interventions or surface-level adjustments would not be sufficient. What was required was a deep, structural change—a pedagogical and organisational approach that could provide a consistent curriculum experience for all pupils, regardless of when they entered the school or how long they stayed. The solution needed to be scalable, sustainable, and responsive to the specific demographic and emotional needs of the pupil body.

2.3.2 Why Teaching for Mastery?

In exploring possible models for change, I considered a wide range of commercial and publisher-led mathematics schemes. While many offered standardised lesson sequences and assessment frameworks, few provided the conceptual depth, curricular flexibility, or embedded professional development necessary to enact meaningful long-term change. Many were limited to fixed schemes of work with minimal room for adaptation or interpretation. What set the NCETM's Teaching for Mastery (TfM) framework apart was its balance of structure and philosophy. It was not a scheme in the commercial sense, but a comprehensive pedagogical approach informed by both national research and international best practice, particularly from high-performing jurisdictions such as Shanghai and Singapore.

The TfM framework is grounded in the principle that all pupils can achieve in mathematics, given sufficient time and appropriate support. Its Five Big Ideas—coherence, representation and structure, mathematical thinking, fluency, and variation—provide a conceptual foundation for lesson design and delivery that prioritises deep understanding over surface-level coverage. For a setting like Alexander First School, where pupils frequently join partway through the academic year and often experience curriculum misalignment, this emphasis on small steps, reasoning, and whole-class progression offered exactly the kind of pedagogical model we needed.

2.3.3 Professional Development and the Role of the Maths Hubs

Equally influential in our decision was the support network offered through the national Maths Hub programme. Unlike traditional one-off training events, Maths Hubs facilitate sustained professional development through collaborative inquiry, peer coaching, and access to mastery specialists. Teachers are not only trained in the TfM approach but are also supported over time to embed the principles within their own classrooms and school systems.

The Maths Hub Work Groups provided structured opportunities for our staff to engage in lesson studies, plan collaboratively, and participate in cross-school learning networks. These experiences allowed teachers at Alexander First School to see mastery teaching in action, discuss challenges with peers, and reflect critically on their own practice. Importantly, the Hub's emphasis on teacher development as a long-term, career-enhancing process aligned with our goals to stabilise staffing and build professional capital across the school.

Through this partnership, our staff were empowered not only to understand the TfM philosophy but to adapt it meaningfully to our school context. This included tailoring resources, pacing, and representations to support pupils arriving mid-topic or mid-year, many of whom had gaps in foundational knowledge or had experienced inconsistent teaching approaches in previous schools.

2.3.4 Embedding Structural Support: Pre-Teaching and Re-Teaching

One of the most significant innovations introduced under the TfM model at Alexander First School was the formalisation of pre-teaching and re-teaching strategies. These were developed specifically to address the needs of transient pupils—particularly newly arrived Service children—who may have missed core curriculum content or lacked confidence due to interrupted schooling.

Pre-teaching sessions were implemented before daily maths lessons. These 15-minute sessions allowed staff to identify pupils with gaps in prior knowledge and provide them with targeted exposure to the day's learning content. The approach not only introduced key vocabulary and core concepts but offered a psychologically safe space for pupils to ask questions, rehearse language, and build early familiarity

with the material. For many Service children, this helped to alleviate the anxiety of entering a lesson feeling behind or unfamiliar with the topic. Pupils reported feeling more confident and engaged, and teachers observed increased participation and resilience in the main lesson.

In contrast, re-teaching (sometimes referred to as post-teaching or immediate intervention) focused on reinforcing learning after the main teaching input. These sessions were delivered to small groups of pupils identified through in-lesson assessment as having misunderstood or partially grasped the content. Re-teaching allowed concepts to be revisited in a targeted and differentiated manner, helping pupils to consolidate their understanding before misconceptions took root. For Service pupils arriving mid-unit, this provided a valuable opportunity to "catch up" and develop fluency at a manageable pace.

Both pre- and re-teaching approaches proved particularly effective in supporting pupils with English as an Additional Language (EAL)—a significant group within the school's diverse Commonwealth intake. Vocabulary was prioritised in both sessions, and pupils were encouraged to use and apply mathematical language in a meaningful, scaffolded way.

2.3.5 The Impact of Focused, Deep Instruction

A further structural adaptation involved reconfiguring the length and design of daily mathematics lessons. Based on pupil needs and observed attention spans—particularly among those experiencing separation anxiety or stress—we implemented 40-minute focused input sessions, followed by a 20-minute feedback and consolidation period. The 40-minute structure provided sufficient time to explore concepts in depth while avoiding cognitive overload, particularly important for emotionally vulnerable children.

Lesson design was closely aligned with TfM principles, beginning with concrete resources, progressing to pictorial representations, and concluding with abstract thinking. This structured progression allowed all pupils to engage with the material at an accessible level and ensured that those with gaps in foundational understanding were not left behind.

Staff were trained to make the most of these focused sessions, integrating key elements such as "Review Not New" routines to reinforce previously taught content and support memory retention. By identifying and addressing misconceptions during the main teaching input, teachers were able to better personalise their support in the feedback block that followed.

2.3.6 The Role of Immediate Feedback

The 20-minute immediate feedback window was used to great effect. Teachers identified pupils needing further support based on in-lesson questioning, observations, and formative assessment. These pupils were brought together for short, targeted discussions where feedback was given verbally and interactively. Misconceptions were addressed immediately, and correct methods reinforced. The aim was not just correction but understanding and empowerment—helping pupils to reflect on their learning, gain clarity, and develop a growth mindset.

For Service pupils in particular, this approach helped reduce the stigma of "getting it wrong" and promoted a culture of continuous learning. Feedback was often embedded in collaborative discussion, with opportunities for peer support and shared reasoning. For EAL learners, this also provided further exposure to mathematical language in context.

2.3.7 Emotional Safety and Inclusion

A major strength of the changes we introduced was the creation of emotionally safe, inclusive learning environments. For children dealing with the uncertainty of frequent relocations, parental deployments, or cultural transitions, consistency in classroom structure and expectations became a source of emotional reassurance. Teachers at Alexander First School reported a noticeable reduction in behavioural incidents during maths sessions and an increase in pupil engagement and perseverance.

This emotional safety extended to the way learning groups were formed. Unlike traditional intervention groups—which often inadvertently label and segregate "low-attaining" pupils—our pre- and re-teaching sessions were responsive, dynamic, and focused on need rather than attainment labels. Pupils moved in and out of support groups fluidly, depending on their understanding of the specific concept taught that day. This approach reduced the risk of stigmatisation and helped foster a growth mindset across the pupil body.

2.3.8 Adapting for Transient and Diverse Pupils

The school's demographic complexity required a pedagogy that could adapt to wide-ranging prior experiences. At Alexander First School, a third of pupils spoke English as an additional language, and many arrived from overseas postings with very different curriculum exposure. The mastery approach—particularly its emphasis on concrete-pictorial-abstract (CPA) progression and consistent vocabulary—was especially powerful in creating a shared learning language across the school.

The use of stem sentences, carefully modelled teacher language, and structured talk during mathematical discussions helped scaffold understanding for all learners and was critical for EAL learners and recently relocated pupils alike. In this way, TfM was not simply a means of improving outcomes—it became a unifying pedagogy that enhanced inclusion, clarity, and confidence across a highly mobile pupil population.

2.3.9 Sustaining Change Through Professional Culture

Ultimately, the success of these reforms depended on more than new lesson formats or classroom strategies. What enabled lasting impact was the creation of a professional culture of inquiry, reflection, and collaboration. Staff were not just expected to implement mastery techniques—they were supported to understand the underlying principles, adapt them meaningfully, and engage in collective problem-solving. Regular coaching, collaborative planning, and reflection cycles were embedded into weekly routines, drawing heavily on Maths Hub resources and structures.

Leadership played a critical role in modelling this culture. Senior leaders, including myself, participated in Work Groups, led CPD sessions, and engaged in lesson observations with a focus on growth and learning, not compliance. This helped staff to feel ownership of the process and reduced resistance to change.

The decision to implement Teaching for Mastery at Alexander First School was not taken lightly. It was driven by a clear understanding of the school's unique challenges—particularly the educational risks faced by Service children—and a desire to embed a model of teaching that was consistent, inclusive, and resilient to change. The NCETM's framework and the national Maths Hub programme offered a powerful combination of pedagogical coherence and embedded professional development that no commercial scheme could match.

The result was a whole-school approach that improved teacher expertise, pupil engagement, and curriculum continuity. For Service pupils, it offered stability in the midst of disruption, clarity amid confusion, and—perhaps most importantly—a renewed belief in their ability to succeed in mathematics.

2.4 Staff Employment and Turnover

Alexander First School makes a concerted effort to employ Service spouses/partners throughout the school in various capacities. Nearly all the teaching assistants (TAs) in the school are Service spouses/partners but other roles such as the school cook, office administrator, dance coach and Special Needs support teacher have all be undertaken by Service spouses/partners.

Service spouses/partners have a profound understanding of the unique challenges faced by military families, such as frequent relocations, deployments, and separation. Their lived-experience provides an empathetic grounding offering emotional support rooted in a shared experience. Having experienced similar challenges as the pupils they serve, Service spouses/partners are well-equipped to address and respond to the specific social, emotional, and academic needs of Service children. This understanding fosters a supportive school environment tailored to the well-being of military families.

However, Alexander First School is often the first educational work setting for Service spouses/partners, with many beginning their career for the first time at the school. Consequently, this requires a high level of investment in training and development. Training needs to cover everything from statutory aspects such as safeguarding, first aid and health and safety, to school's curriculum specific training such as phonics, mathematics and behaviour management. Each new member of staff must receive this training, often from an accredited provider at a cost to the school. However, frequent and sometimes unpredictable moves can interrupt the professional development of Service spouses/partners. They often miss out on long-term training opportunities, which can make it harder for the school to support them in advancing in their careers and for staff to contribute consistently to school improvement initiatives. Additionally, as each new Service spouse joins the school, training and development begins again. This can impact the overall quality of teaching and support services, especially if multiple staff members leave before training is complete. The short-term nature of many of these positions means the return on this investment is often limited as the school finds Service staff move soon after joining the school with the typical duration of time at the school being between 1 to 3 years.

Given that Service children already experience instability owing to parental deployments and/or relocations, many form close bonds and attachments with staff members who recognise and understand their situation. However, where a high rate of staff turnover exists, this can add an additional emotional disruption to pupils who already experience loss and separation.

2.5 The Classroom Environment

Alexander First School believes not only does teaching and learning require continual reflection and development, but so too does the environment in which this takes place. The school draws on Kaplan's (1988) theory of Attention Restoration Theory (ART). Kaplan proposes that particular environments help restore cognitive focus and reduce mental fatigue. In classroom settings, softer lighting such as lamps significantly contribute to a more restorative learning environment, helping children focus better. ART stresses the importance of environments that do not overload pupils' attention, and harsh fluorescent lights may contribute to cognitive fatigue. Additionally, Kaplan (1988) suggests pupils, especially those with sensory processing challenges (common in neurodivergent pupils, such as those with autism or

ADHD), are more affected by harsh fluorescent lights, which can cause discomfort or sensory overload. Alexander First School often finds Service pupils arrive exhibiting neurodivergent traits but are yet to be diagnosed, given the frequent rate of their mobility. This coupled with high rates of pupil anxiety, have prompted the school (Nursery to Year 4) to use floor lamps instead of standard fluorescent lighting to create a more tranquil and welcoming atmosphere, whilst table lamps are used to create a more balanced feel. Alexander First School finds the use of lamps offer a softer, more diffused light which can help create an environment that reduces sensory stress, thereby promoting better engagement and reducing distractions.

The inclusion of plants in the classroom offers multiple benefits, especially for Service children who contend with a range of challenges nuanced to military life. By reducing stress, enhancing focus, improving emotional well-being, and fostering a positive learning environment, plants can support the holistic development of pupils, helping them succeed academically and emotionally.

According to Pitts (2018) the natural presence of plants has been shown to reduce stress and anxiety levels in pupils. Service children, who may be grappling with separation anxiety or uncertainty due to family circumstances, can benefit from the calming atmosphere that plants create. This can lead to improved emotional well-being, helping them feel more settled in school and in doing so, support pupils' capacity to engage in their learning. Additionally, as previously discussed, Service children at Alexander First are at a higher risk of developing Emotionally Related School Avoidance (ERSA). Persistent absenteeism significantly affects the learning capability of pupils as it creates gaps in their curriculum coverage. Therefore, creating an environment which feels safe, welcoming and entices pupils into school is essential to their academic achievement. If pupils do not attend school, no matter how effective the curriculum design or provision, their learning and progress will not improve. Plants have been associated with mood improvement and positive emotional responses (Pitts, 2018). Pupils, including those from Service families, can benefit from the psychological uplift that plants provide. The presence of greenery can help them feel more calm, happy, and emotionally balanced. Furthermore, Service accommodation can vary from posting to posting. Alexander First School finds some Service children arrive having not had easy access to green spaces. By bringing plants into the classroom, staff believe there is a connection to nature, which has a grounding effect and promotes relaxation.

An additional consideration in employing Service spouses/partners arises in the challenge to support them in balancing work and homelife. Military spouses often have to respond to last-minute changes in their partner's military commitments. As a two-person household become one-person, childcare responsibilities fall to one person. This unpredictability can lead to difficulties in attending staff meetings, or completing school-related tasks on time.

2.6 Scheme of Learning

Alexander First School uses White Rose maths mastery scheme of learning which is designed to promote deep understanding and fluency in mathematical concepts. White Rose follows a mastery approach based on the principles of small, coherent steps and is structured to build mathematical fluency, reasoning, and problem-solving. It provides a systematic, step-by-step curriculum that encourages uniformity in teaching across all year groups. Given the rates of staff turnover, ensuring stability and consistency in delivering provision is essential. The scheme cultivates a coherent learning journey, making transitions between year groups smoother for pupils and teachers alike. Furthermore, the White Rose Maths scheme is widely used across many UK schools, and this provides the opportunity to

enhance continuity in Service children's learning as they transition from one school to another. The scheme follows clearly structured and progressive learning objectives, making it easier for pupils to re-join lessons and learning at the same point at which they left in their previous school. This is crucial to ensuring Service children's mathematical curriculum provision is not fragmented.

Alexander First School elected to use White Rose Maths as it focuses on developing a deep understanding of mathematical concepts rather than rote memorisation. This approach benefits Service children, who may have reduced ability to memorise owing to stress and trauma. Additionally, the focus on depth of understanding leads to stronger foundational knowledge which eases reintegration into lessons after absences or school changes.

Prior to the school using the White Rose scheme of learning, staff at Alexander First School (as captured in teacher interviews) felt the pace of learning was often too hurried. The scheme stresses the importance of staying on a topic until a child has mastered it. This is of immense benefit to Service children, who the school finds, frequently endure gaps in key concepts due to moves or low attendance. The mastery approach ensures gaps are addressed which combats the disjointed learning experience. Fluency is developed through applying knowledge in a range of contexts with pupils supported in explaining their thinking and mathematical reasoning. Concepts are segmented into smaller, manageable steps, which reduces cognitive overload for pupils and ensures that each concept is fully understood before moving forward.

White Rose Maths scheme offers guidance on how to support learners at differing stages of their understanding. Teachers are able to employ support resources and materials tailored to the needs of pupils regardless of their background to receive appropriate challenge and help. This is of great benefit to teachers and support staff who have to contend with pupils of contrasting abilities arriving sporadically and meeting their learning needs. The whole-class, approach targeted approach ensures pupils are supported without being overwhelmed by the enormity of the undertaking.

A key aspect of TfM is the employment of problem-solving and reasoning skills. The White Rose scheme utilises these skills to encourage pupils to become independent thinkers. Alexander First School finds developing these skills help children adapt to new learning environments, encourage resilience and self-sufficiency. These proficiencies are transferable across different subjects and life situations, which benefits all pupils but especially Service children.

During teacher interviews, staff shared their perspectives on pupils' mathematical confidence and self-image related to the subject. Staff noted improvements in these areas following the introduction of the White Rose scheme of learning. According to staff this stemmed from the fact all pupils experienced the same learning provision and opportunities. That is to say, pupils previously identified as 'lower attainers' would have typically been taught away from their higher attaining friends and received limited or a watered-down provision. In contrast, White Rose Maths scheme provides a structured, clear approach which is undertaken by all pupils holistically. This has the capacity to change pupils' self-perception as they see how their mathematical competence grows and develops. Furthermore, through collaborative tasks and group problem-solving, pupils begin to recognise the value of their contribution, thoughts and knowledge.

Consequently, Alexander First School regards White Rose as a trojan horse through which TfM can be achieved as well as supporting the vast Service community.

Summary

This chapter provides a detailed contextual overview of Alexander First School, the setting for this case study. Situated on a Ministry of Defence estate, the school serves a highly mobile and culturally diverse population, with approximately 75–85% of its pupils from Service families. These children face significant challenges, including frequent relocations, parental deployments, separation anxiety, disrupted curriculum continuity, and emotional instability. The chapter explores how these dynamics uniquely shape teaching, learning, and the operational landscape of the school.

Key to addressing these challenges was the strategic adoption of the Teaching for Mastery (TfM) approach, supported through White Rose Maths and the national Maths Hub programme. TfM's structured yet flexible pedagogy provided the consistency and depth required to support transient pupils. Significant innovations such as pre-teaching, re-teaching, and immediate feedback were implemented to reduce gaps in understanding, especially for those arriving mid-year or mid-topic. These were complemented by adaptations to lesson timing, emotional safety practices, inclusive classroom environments, and scaffolded support for EAL learners.

The school's staffing model—largely composed of Service spouses—also shaped its culture, requiring ongoing training cycles due to frequent staff turnover. This added another layer of complexity to school improvement efforts but also enriched the pastoral ethos of the school through lived experience.

Incorporating Attention Restoration Theory (ART), the school designed calming, sensory-conscious learning environments that reduce pupil anxiety and increase engagement, especially among neurodivergent and emotionally vulnerable children.

Overall, Alexander First School exemplifies how a mastery-based model can be adapted to a complex educational setting. The case highlights the importance of community, consistency, and pedagogical coherence in achieving equity for Service children. The innovations discussed lay a foundation for understanding the school's rationale for change and its journey toward embedding a sustainable and inclusive mastery approach.

3 Chapter 3: Literature Review

This chapter begins by exploring the increasing politicisation of mathematics education. Noyes et al. (2013) highlight the disjunction between the swift cycles of educational policymaking and the slower, more nuanced processes through which meaningful mathematical change is enacted in schools. Lemke's (2000, p. 5) concept of 'scales of time' is also drawn upon to illustrate how mathematics education reform operates on multiple temporal levels—from the macro timescales of global trends to the micro timescales of classroom enactment.

The chapter then turns to the origins and evolution of the National Curriculum for Mathematics in England, with particular attention to the shifts in terminology, assessment mechanisms, and the increasing visibility of attainment data. International comparative assessments, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), are reviewed to explore their impact on UK mathematics policy. These comparisons often serve as levers for policy shifts, reinforcing the desirability of Far Eastern pedagogical models in pursuit of improved international rankings.

It is within this context that the adoption of Teaching for Mastery (TfM) in England can be understood. Rooted in Bloom's (1968) theoretical model of mastery learning—though not originally subject-specific—TfM has gained significant traction in shaping instructional design and formative assessment practices. This model provides a conceptual foundation for the NCETM's approach, which adapts East Asian principles while embedding them within the structure of the English curriculum.

Recent literature provides an increasingly critical lens on these developments. Studies such as Shearman (2021), Pratt and Alderton (2023), and Coles and Helme (2022) reveal the complex and sometimes contradictory ways in which TfM is interpreted, mediated, and enacted within policy and practice. These analyses are especially pertinent for schools serving high-mobility populations, where stability, continuity, and access to conceptual understanding are central concerns.

Following this policy and conceptual grounding, the chapter turns to the NCETM's Five Big Ideas—Coherence, Representation and Structure, Mathematical Thinking, Fluency, and Variation—which are examined in depth. Drawing from both foundational and contemporary sources, the review interrogates the theoretical underpinnings of each idea and considers how they are translated into classroom practices. New studies, particularly those published between 2019 and 2024, have added further empirical and critical depth to the field. These are incorporated throughout the chapter to enrich understanding and reflect the evolving landscape of TfM research. By integrating these insights, the chapter not only outlines the theoretical and practical framework of TfM but also provides a basis for interpreting its enactment in Alexander First School, thereby supporting the analysis presented in the Results Chapter.

3.1 Introduction

The concept of mastery in mathematics education has undergone substantial evolution. While originally associated with deep conceptual understanding (Brown et al., 2011), mastery has since been formalised into a state-backed pedagogical model (Boylan et al., 2018). The NCETM, drawing on practices from high-performing East Asian jurisdictions, positioned mastery as a means to promote inclusive, deep learning for all. This shift was intended to address concerns about superficial coverage, uneven attainment, and a

tendency to accelerate learners through content without ensuring secure understanding (Askew et al., 2010).

However, despite its widespread promotion, mastery remains a contested concept. Shearman (2021) identifies a spectrum of meanings attached to mastery through a Q-methodological study, revealing underlying tensions in how educators, policymakers, and researchers conceptualise the term. Shearman found that some educators associate mastery with depth and reasoning, while others see it as tied to curriculum fidelity and standardisation. Mastery emerges as a polysemic construct—fluid, multifaceted, and contextually bound. This multiplicity presents challenges for policy enactment, as schools may interpret the same term in divergent ways, leading to inconsistencies in implementation.

Adding a critical policy perspective, Pratt and Alderton (2023) argue that TfM operates within broader neoliberal and neoconservative education reforms. They suggest that mastery serves as a disciplinary mechanism aligned with marketised schooling, performativity, and a tightly regulated curriculum. Their analysis of curriculum policy and teacher interviews indicates that while the rhetoric surrounding mastery promotes equity and inclusion, its implementation is often dominated by assessment targets, datafication, and curriculum control. In such contexts, teachers may experience tension between pedagogical integrity and policy compliance. Pratt and Alderton's findings are particularly resonant in schools serving vulnerable or mobile populations, where high-stakes accountability can constrain responsive, inclusive teaching.

Boylan et al. (2018) similarly emphasise the importance of considering mastery not as a fixed template but as a dynamic and situated practice. Drawing on policy sociology and practitioner accounts, they note that TfM is shaped by a complex interplay of top-down reform and bottom-up negotiation. While teachers may adopt the language of mastery, its practical meaning is often shaped by local values, resources, and professional cultures. This is consistent with Ball et al.'s (2012) theory of policy enactment, which highlights the mediating role of school contexts in shaping how reforms are interpreted and performed.

In light of these perspectives, it becomes clear that any discussion of TfM must attend not only to its pedagogical principles but also to its ideological framing and systemic constraints. This is particularly pertinent in the context of schools like Alexander First School, where teaching must address high pupil mobility, diverse prior experiences, and the need for both conceptual continuity and emotional security. TfM, when viewed through this lens, is not merely a set of strategies but a politically situated and ethically charged approach to teaching.

3.2 Maths Education and Political Intervention

Mathematics education has long been a key arena for political intervention. As education systems have become more data-driven and policy-led, mathematics has been placed under especially intense scrutiny. Noyes et al. (2013) argue that mathematics is distinctively political for three reasons. First, its perceived cultural neutrality makes it an attractive tool for comparing national education systems. Second, mathematics is foundational to the STEM (Science, Technology, Engineering and Mathematics) agenda, which is framed as critical to economic competitiveness. Finally, mathematics commands interest from a range of influential stakeholders—including school leaders, parents, inspectors, and policymakers—partly because of the visibility of attainment data.

In their critique of policy timelines, Noyes et al. (2013) also draw on Lemke's (2000) concept of 'scales of time'. Lemke suggests that in complex systems like education, meaningful change must be understood

across different temporal layers: rapid policy decisions, medium-term shifts in classroom practice, and long-term cultural attitudes. Applying this, Noyes et al. argue that policymakers often seek quick reforms with little regard for the slower pace of educational change or the deeply embedded cultural dispositions around mathematics learning. They caution that policy actions can have unpredictable, heterochronic consequences—where small changes accumulate into “avalanches” that reshape classroom life over time.

Shearman (2021) supports this complexity by highlighting that the term “mastery” itself is polysemous in policy discourse. It is used to invoke both cognitive depth and performative proficiency, revealing the tensions between educational, political, and ideological meanings. Shearman’s Q-methodological study of teacher perspectives found that mastery is simultaneously seen as empowerment and control, illustrating how political language can obscure rather than clarify reform goals.

Pratt and Alderton (2023) offer a sharp critique of how mathematics mastery reform is shaped by neoliberal and neoconservative imperatives. Neoliberalism manifests through accountability pressures, performativity, and international benchmarking. Neoconservatism is visible in the turn to “traditional” pedagogy and teacher-directed instruction. Together, these ideological forces have shaped mathematics mastery in England as a form of state-driven curriculum governance that privileges conformity and compliance over critical pedagogical innovation.

3.2.1 The Mathematics National Curriculum

The 1988 National Curriculum introduced statutory control over curriculum content in England, with mathematics designated a core subject. A dedicated daily mathematics lesson has since become the norm in most primary schools, shaped further by the National Numeracy Strategy (DfEE, 1999), which mandated a structured “numeracy hour”. Brown et al. (1998) note the technocratic framing of numeracy as a “value-free” skillset focused on calculation and recall, reflecting a remedial agenda to tackle perceived societal innumeracy.

By 2006, the Primary National Strategy marked a shift in terminology and aspiration—from numeracy to mathematics—aligning more closely with constructivist ambitions around reasoning, problem-solving, and conceptual understanding (Millett & Johnson, 2011). This pivot also reflected broader political shifts towards a more holistic and internationally competitive education system. Eacott and Holmes (2010) argue that the core status of mathematics has raised its profile both in schooling and in national accountability, with Ofsted monitoring performance data via the Inspection Data Summary Report (IDSR). As a result, underperformance can trigger interventions, making mathematics a high-stakes subject for school leaders.

The NCETM’s Teaching for Mastery (TfM) programme, developed from 2014 onwards, emerged amid this politically charged landscape. Substantially funded by government, the NCETM’s interpretation of mastery has gained quasi-policy status, particularly through the establishment of regional Maths Hubs (DfE, 2014a). These hubs promote a uniform vision of TfM centred on the Five Big Ideas and influenced by East Asian pedagogies. Boylan et al. (2019) identify these hubs as key vehicles for reform diffusion, shaping regional practices in line with national priorities.

Coles and Helme (2022) critique this pipeline from research to policy to practice. They argue that the translation of research on mastery into national policy has been selective and shaped by political expediency. For instance, while the original Singaporean and Shanghai models emphasised depth over

speed, policy in England has often reduced mastery to a list of "expected" outcomes. This misalignment creates implementation challenges and limits the potential for genuinely transformative pedagogies.

Al-Murani et al. (2019) offer a nuanced look at how variation theory—a conceptual cornerstone of mastery—is used in practice. Their study of classroom examples reveals that while teachers often apply structured variation to develop procedural fluency, opportunities for deeper conceptual learning vary widely. This disparity underscores the tension between a centralised vision of mastery and its practical, situated enactments.

Oliver (2024) focuses on a related gap: the lack of attention to non-routine problem-solving within mastery-oriented classrooms. Her doctoral research suggests that while TfM has improved conceptual clarity and fluency, it often leaves limited space for uncertainty, creativity, or divergent thinking—skills essential for long-term mathematical resilience.

Finally, the Education Endowment Foundation (EEF) (2023) provides a comprehensive review of evidence on KS2 and KS3 mathematics. Its guidance advocates for mastery approaches, including the use of manipulatives, structured discussion, and problem-solving. However, the EEF emphasises the importance of high-quality teacher development and contextual adaptation—cautioning against "one-size-fits-all" implementation. The review reinforces the importance of a research-informed, flexible approach rather than rigid adherence to a single doctrine of mastery.

3.3 What is “Maths Mastery”?

3.3.1 *Introduction to Maths Mastery*

International comparative studies such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) have played a central role in shaping mathematics education policy across the globe. PISA, coordinated by the OECD, assesses the competencies of 15-year-olds in reading, mathematics, and science, and is widely used to draw comparisons between national education systems (OECD, 2009a). As Pons (2011) argues, the publication of PISA data has become a powerful catalyst for global educational debate, often defining systems as “good” or “bad” based on their ranking.

Countries in East Asia—such as Shanghai, Singapore, South Korea, and Taiwan—have consistently ranked at the top of PISA and TIMSS mathematics assessments. The OECD (2012) estimated that the mathematical performance of students in Shanghai was equivalent to approximately three additional years of schooling compared to their English counterparts. In 2014, the OECD (2014b) reported that 21% of England’s 15-year-olds were classified as low-attainers, in contrast to under 4% in Shanghai.

TIMSS data similarly show England performing moderately well but behind high-achieving countries like Singapore and Japan (Greany et al., 2016). More concerning are persistent socioeconomic disparities in mathematics achievement. Richardson et al. (2020) highlight that students eligible for free school meals (FSM) perform significantly below their peers, revealing structural inequalities in access to high-quality mathematics education. Cosgrove and Creaven (2013) link this performance gap to a lack of depth in teaching methods and variability in teacher training. Unlike East Asian countries, which often deploy specialist mathematics teachers at the primary level, England has historically relied on generalist teachers with inconsistent access to professional development (Keys, 1999).

A further challenge relates to pupils' confidence and engagement. Richardson et al. (2020) found that confidence in mathematics is positively associated with achievement, yet this confidence tends to decline with age. Comparative data from Boe et al. (1999) showed a higher percentage of East Asian students reporting enjoyment of mathematics than their English peers.

These disparities in outcomes, teaching approaches, and attitudes fuelled policy interest in adapting East Asian pedagogies—particularly those of Singapore and Shanghai—as a means of reforming mathematics education in England. This movement gave rise to what became known as “maths mastery”, with policy borrowing aimed at replicating the perceived success of East Asian education systems (You & Morris, 2016; Clapham & Vickers, 2018). By 2016, the Department for Education had committed £41 million to support mastery approaches (DfE, 2016b), and Ofsted made mastery implementation a point of inspection focus (Maths Hubs, n.d.). Although the 2014 National Curriculum does not explicitly mention mastery, its principles are embedded in the expectation for pupils to progress at broadly the same pace, with greater depth prioritised over acceleration (DfE, 2013).

Boylan et al. (2018) describe this as the most ambitious system-wide adoption of external educational practices ever undertaken in English mathematics policy. However, as Pratt and Alderton (2023) argue, the policy is shaped as much by ideological forces—neoliberal performativity and neoconservative traditionalism—as it is by pedagogy.

3.3.2 *Origins of “Mastery”*

Although frequently associated with East Asian systems, the concept of mastery learning originates in the work of Benjamin Bloom (1968). Bloom believed that variations in pupil achievement were not due to innate ability but to differences in instructional quality and time allowed for learning. His model emphasised two central principles:

- Feedback, corrective and enrichment processes
- Instructional alignment

Through frequent formative assessment, learners receive targeted feedback. Those struggling receive corrective instruction tailored to their needs, while high-achieving pupils engage in enrichment activities (Bloom, 1968; Guskey & Jung, 2011). Instructional alignment involves designing teaching around clear learning outcomes, ensuring consistency between goals, instruction, and assessment (Cohen, 1987).

Importantly, Bloom's mastery model was not limited to basic skills. Guskey (2007) argues that Bloom also advocated for higher-order thinking, problem-solving, and the application of knowledge to unfamiliar contexts—an element sometimes neglected in contemporary implementations.

The Education Endowment Foundation (EEF, 2021) has found mastery approaches, when implemented over a short duration (less than 12 weeks), to have a moderate positive effect—especially for lower-attaining students—offering an average of five months' additional progress. This supports Bloom's assertion that time and support can significantly reduce achievement gaps.

While Bloom's principles underpin mastery theory, Boylan et al. (2018) argue that the version of mastery now promoted in England is more aligned with the structured pedagogies of Shanghai and Singapore—often referred to as Teaching for Mastery (TfM). Though these systems share characteristics with Bloom's model, they also carry cultural and structural specificities that are not easily replicable. These

include lesson study, extensive professional development, and specialist teaching—all largely absent in the English implementation (Boylan, 2020).

3.3.3 Interpreting ‘Maths Mastery’ in the English Context

The term ‘maths mastery’ lacks a universally agreed definition and is applied in diverse ways across policy, research, and practice (Boylan et al., 2018; Shearman, 2021). It is used to describe both pedagogical processes and attainment standards, often interchangeably. Drury (2014, p.9) defines it as ‘the capacity to apply mathematical knowledge in both routine and novel situations and to communicate mathematically.’ However, early curriculum guidance equated mastery with attainment ‘beyond’ expectations, before replacing the term with ‘greater depth’—highlighting the conceptual vagueness at the heart of policy discourse (DfE, 2014).

Rather than a single, unified model, maths mastery comprises a constellation of pedagogical strategies. Jerrim and Vignoles (2015a) suggest it represents a collection of interlinked practices rather than a fixed approach. These include use of concrete-pictorial-abstract representations, structured variation, teacher-directed instruction, and a focus on procedural fluency alongside conceptual understanding.

The NCETM’s Five Big Ideas—Coherence, Representation and Structure, Mathematical Thinking, Fluency, and Variation—serve as the most widely accepted framework for operationalising mastery in England. Coles and Helme (2022) highlight that this framework has allowed for some professional clarity and shared vocabulary, though implementation continues to vary widely. Similarly, Al-Murani et al. (2019) found that while variation theory provides a powerful tool for supporting conceptual understanding, its application in English classrooms remains inconsistent.

Oliver (2024) raises an important concern: that in striving for structure and consistency, mastery approaches may underplay opportunities for non-routine problem-solving—an essential component of mathematical resilience and creativity. This highlights a broader tension in TfM between depth and flexibility, particularly in classrooms with diverse or transient intakes.

Boylan (2020) also points to a disconnect between policy aspiration and systemic support. While English reforms promote the classroom practices of Shanghai, they have not replicated the enabling conditions—such as reduced teaching loads, specialist training, or embedded lesson study. This raises critical questions about the feasibility and fidelity of importing such a pedagogically complex model into a different system.

3.3.4 Historical Background to Mastery

Although often described as a contemporary trend, mastery-based teaching has deep roots in educational history. Early advocates such as Washburne (n.d.) and Carroll (1963) challenged deterministic notions of aptitude, suggesting instead that learning rate—not capacity—distinguished pupils. Carroll’s (1963) Model for School Learning highlighted perseverance, opportunity, and quality of instruction as key determinants of success. These principles strongly influenced Bloom’s own model, which emphasised mastery through time, support, and feedback (Bloom, 1973).

McCourt (2019) contextualises this lineage further, noting that early mastery models assumed all learners could achieve a high standard if given sufficient opportunity. Washburne’s approach, for example, involved frequent formative assessment and tailored feedback, concepts now embedded in the NCETM’s Five Big Ideas.

Today's TfM model reflects this philosophical heritage but also reveals how policy shapes pedagogy. While its roots are in equity and personalisation, mastery in the English system increasingly serves as a mechanism for curriculum control and accountability (Pratt & Alderton, 2023; Blausten et al., 2020).

3.3.5 Research Questions and Teaching for Mastery

In light of the complex and evolving nature of maths mastery, this research seeks to explore how the NCETM's Five Big Ideas are enacted in practice, particularly in relation to schools with transient pupil populations. The following main research question guides this study:

- What are the challenges and opportunities for teachers when using the NCETM's Five Big Ideas as an approach to mathematics teaching?

This is further developed through two sub-questions:

- How do teachers attempt to support transient pupils in their mathematics teaching, and how does this relate to the Five Big Ideas?
- What are the challenges and opportunities for pupils, particularly transient pupils, when 'Teaching for Mastery' is the guiding approach to their mathematics lessons?

These questions aim to illuminate the lived realities of implementing mastery in dynamic school contexts, focusing not only on pedagogical strategies but also on the structural and relational challenges faced by teachers and pupils alike.

3.3.6 What is Teaching for Mastery?

The concept of Teaching for Mastery (TfM) has become central to mathematics education reform in England, particularly through the work of the National Centre for Excellence in the Teaching of Mathematics (NCETM). Simpson and Wang (2022) note that TfM draws significantly from Bloom's mastery learning model (1968), wherein all pupils are expected to demonstrate competence before moving forward, supported by differentiated inputs, such as scaffolding and representational tools.

The NCETM defines mastery not simply as achieving a fixed level of attainment but as acquiring deep, adaptable mathematical understanding. Central to this approach is the idea that the majority of pupils progress through content at a similar pace, with differentiation occurring through depth rather than acceleration (NCETM, 2014; Mullis et al., 2020). Pupils who grasp concepts rapidly are encouraged to deepen their understanding through problem-solving and reasoning rather than moving on to new material.

To operationalise this philosophy, the NCETM (2019; 2023) promotes a coherent pedagogical model based on the 'Five Big Ideas' of Teaching for Mastery:

- Coherence
- Representation and Structure
- Mathematical Thinking
- Fluency
- Variation

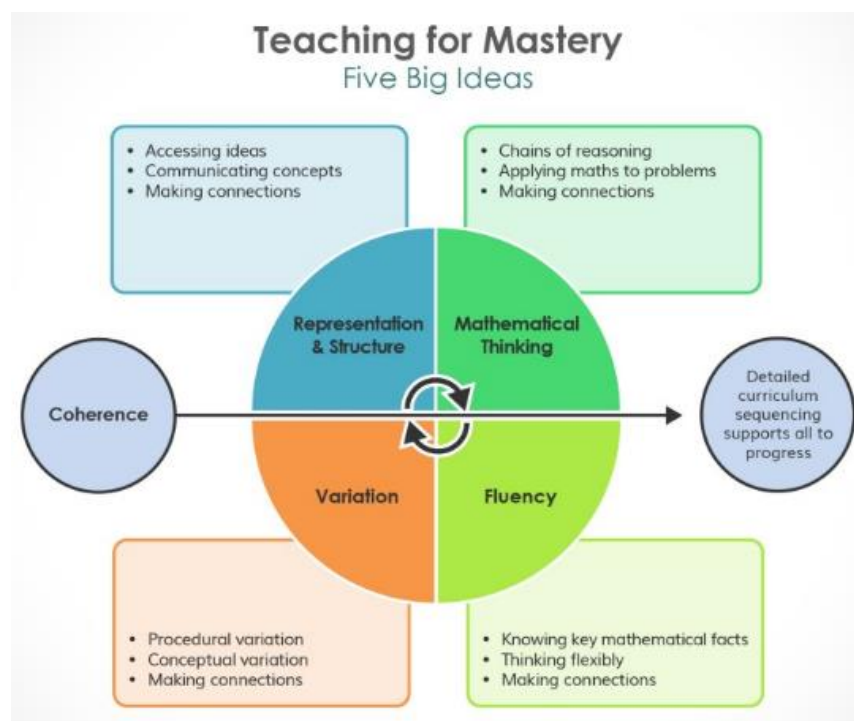


Figure 3.0: The NCETM (2023) provides a visual representation to demonstrate how the ‘Five Big Ideas’ are inter-related

3.3.7 Coherence

3.3.7.1 Theoretical Grounding to Coherence

Coherence in mathematics education refers to the logical sequencing of concepts and the establishment of meaningful connections across learning episodes. Hiebert and Grouws (2007) define it as a feature of instruction that ensures continuity, allowing students to integrate new knowledge with prior understanding. Morony (2023) differentiates between internal coherence—how well components of the curriculum fit together—and external coherence—how mathematics connects to wider contexts and learner needs.

Coherence also aligns with Vygotsky’s (1978) Zone of Proximal Development (ZPD), where knowledge is scaffolded in manageable steps. In this model, the teacher’s role is to mediate learning by introducing concepts at the right moment and in the right sequence, ensuring that all learners can access and build understanding cumulatively.

3.3.7.2 NCETM Description and Links to Theory of Coherence

The NCETM (2023) defines coherence as the careful design of lessons to introduce concepts in small, connected steps, ensuring every pupil is able to access the mathematics. Teaching sequences are intended to minimise cognitive overload while maximising understanding. Teachers are encouraged to revisit and reinforce key concepts regularly, thus aligning practice with the theoretical focus on ZPD and concept continuity.

Recent findings by Coles and Helme (2022) suggest that while teachers value coherence, it is often interpreted in procedural terms—focusing on lesson sequencing—rather than as conceptual or structural

coherence. Similarly, Pratt and Alderton (2023) argue that the policy framing of mastery can lead to oversimplified enactments, reducing coherence to coverage and pacing rather than promoting depth of conceptual interconnection.

Coherence is essential to the integrity of the TfM model, allowing learning to build sequentially and conceptually. While NCETM's interpretation aligns with theory, research highlights tensions between intended and enacted coherence, particularly where pressures of accountability influence classroom pacing.

3.3.8 Representation and Structure

3.3.8.1 Theoretical Grounding to Representation and Structure

Representations in mathematics serve as tools for externalising and manipulating abstract ideas. Goldin and Shteingold (2001) distinguish between internal (mental) and external (symbolic or visual) representations, which together facilitate deeper conceptual understanding. The Concrete–Pictorial–Abstract (CPA) progression, grounded in Bruner's theories and influenced by Dienes' work on perceptual and mathematical variability, underlines the pedagogical importance of multiple modes of representation to secure learner understanding.

Skemp's (1976) distinction between relational and instrumental understanding also reinforces the importance of representations that show structure rather than simply illustrate procedures. Structured representations allow learners to discern patterns, make generalisations, and transfer learning across contexts. When students engage with representations that foreground mathematical relationships, they are more likely to develop schema that support long-term learning.

3.3.8.2 NCETM Description and Links to Theory of Representation and Structure

The NCETM (2023) encourages the use of carefully selected and consistent representations that expose mathematical structure. These are not only intended to scaffold weaker learners but to serve as shared tools that help all learners access and express mathematical concepts. Examples include number lines, tens frames, bar models, and place value charts, each designed to help pupils 'see' the mathematics and connect different ideas.

Research by Al-Murani et al. (2019) identifies that while representations are frequently used in TfM classrooms, their conceptual potential is not always realised. Some teachers use visual tools in procedural or surface-level ways, missing opportunities to make structural features explicit. Similarly, Shearman (2021) finds that teachers' views of mastery differ considerably: while some focus on conceptual clarity through structured representation, others view resources as simply classroom aids rather than epistemic tools.

Furthermore, Coles and Helme (2022) observe that translating theoretical understandings of representation into classroom practice can be problematic without deep content knowledge. Their study emphasises the need for professional development that enables teachers to understand both the purpose of representations and the mathematical structures they reveal.

Representation and structure are essential to making abstract ideas accessible and meaningful. The NCETM's emphasis aligns well with theory, but successful implementation depends on teachers' understanding of the function of representations, not just their form. To fully realise the benefits, professional learning must address the conceptual intent behind these tools, not just their application.

3.3.9 Mathematical Thinking

3.3.9.1 Theoretical Grounding to Mathematical Thinking

Mathematical thinking encompasses a set of habits and practices central to engaging meaningfully with mathematical content. Isoda and Katagiri (2012) define mathematical thinking as the ability to organise knowledge logically, use abstraction and generalisation, and reflect critically on one's reasoning. It involves moving beyond the procedural to explore patterns, form conjectures, evaluate arguments, and make justifiable generalisations.

This conception aligns with the work of Mason et al. (1982), who characterise mathematical thinking as a recursive process of noticing, wondering, and reasoning. Similarly, Schoenfeld (1992) frames mathematics as a sense-making activity in which learners explore multiple methods, critique solutions, and justify their approaches. These theoretical models shift the focus from answer-getting to the development of reasoning, reflection, and strategic thinking.

Mathematical thinking also intersects with metacognition and self-regulation. Learners must monitor their strategies, adjust approaches when stuck, and remain persistent—skills that support both mathematical success and lifelong learning dispositions.

3.3.9.2 NCETM Description and Links to Theory of Mathematical Thinking

According to the NCETM (2023), mathematical thinking is “central to learning mathematics,” encompassing reasoning, questioning, conjecturing, and generalising. In a mastery context, all pupils are expected to engage in mathematical thinking throughout lessons, rather than reserving it for high attainers. Teachers are encouraged to use questioning, discussion, and whole-class dialogue to make thinking visible and to promote mathematical talk.

However, Oliver (2024) finds that opportunities for non-routine problem-solving—essential to developing mathematical thinking—are often underused, particularly in classrooms focused heavily on fluency and curriculum pacing. Shearman (2021) supports this view, noting a tendency in some mastery classrooms to prioritise procedural competence over exploratory reasoning. Teachers' varied understandings of mastery result in unequal emphasis on open-ended thinking versus structured skill development.

Moreover, the Education Endowment Foundation (EEF, 2021) emphasises that problem-solving and reasoning should be taught explicitly and integrated into everyday mathematics instruction. Their guidance cautions against treating mathematical thinking as a separate component, instead encouraging its integration into all aspects of learning and assessment.

Mathematical thinking is the engine of understanding and application. While the NCETM foregrounds its importance within mastery, realising this ambition requires deliberate classroom strategies that go beyond correct answers. For mastery to be truly transformative, learners must be given consistent and meaningful opportunities to engage in reasoning, conjecture, and structured exploration.

3.3.10 Fluency

3.3.10.1 Theoretical Grounding to Fluency

Fluency in mathematics is commonly misunderstood as speed or memorisation, but theoretical perspectives define it more broadly. Russell (2000) argues that fluency involves efficiency, accuracy, and flexibility in using and applying mathematical procedures. Kilpatrick et al. (2001) include procedural

fluency as one of five interrelated strands of mathematical proficiency, highlighting its connection to conceptual understanding, strategic competence, and adaptive reasoning.

Skemp's (1976) distinction between instrumental and relational understanding reinforces the importance of fluency built on meaning rather than rote repetition. Learners should not only know how to carry out procedures but also understand when and why they work. Fluency grounded in this relational understanding supports transfer and problem-solving, whereas instrumental fluency may limit learners when confronted with unfamiliar problems.

The notion of fluency is also underpinned by constructivist and cognitive theories. For example, schema theory suggests that fluent recall and flexible application emerge from well-organised knowledge structures built through rich and varied experiences (Bruner, 1960). These experiences help learners develop efficient strategies and adapt to new contexts without over-relying on memorisation.

3.3.10.2 NCETM Description and Links to Theory of Fluency

The NCETM (2023) defines fluency as more than the recall of facts or procedures; it includes the ability to apply mathematics flexibly and accurately across a range of contexts. Teachers are encouraged to ensure that fluency is developed in tandem with conceptual understanding and reasoning. Classroom practices often include deliberate practice, retrieval routines, and opportunities to rehearse calculation methods in meaningful contexts.

Foster (2013, 2017) and Watson and De Geest (2014) caution that fluency can become narrowed in practice to repetitive drills. Their research highlights a tension between systemic expectations for rapid, measurable success and the broader conception of fluency as embedded in reasoning and representation. Similarly, Blausten et al. (2020) observe that some schools interpret fluency narrowly due to assessment pressures, reducing it to answer accuracy and mental maths speed rather than flexible, strategic thinking.

The Education Endowment Foundation (EEF, 2021) supports the NCETM's multidimensional view, noting that fluent learners demonstrate automaticity while maintaining flexibility. Their guidance advocates for embedding fluency tasks in reasoning and problem-solving contexts, rather than treating fluency as a stand-alone skill.

Fluency, when grounded in conceptual understanding, supports flexible and efficient problem-solving. The NCETM's definition aligns with robust theoretical models, but enactment in schools can sometimes reduce fluency to speed or recall. Professional development and assessment design play key roles in ensuring fluency remains conceptually rich and meaningfully integrated into the wider mastery framework.

3.3.11 Variation

3.3.11.1 Theoretical Grounding to Variation

Variation theory, rooted in the work of Marton and Booth (1997), posits that learning occurs when learners discern critical features of a concept by experiencing variation against a background of sameness. It is through structured contrast and comparison that learners come to understand what remains invariant and what can change. Key to this theory is the identification of "dimensions of variation" and "critical aspects" that the teacher intends to draw attention to during instruction.

Gu et al. (2004) and Watson and Mason (2006) highlight the significance of carefully designed sets of examples, known as example spaces, that facilitate conceptual generalisation and deep understanding.

Rather than presenting random collections of problems, variation-based sequences are structured to highlight relationships and promote mathematical reasoning.

The distinction between conceptual variation (changing the representation of a concept to deepen understanding) and procedural variation (altering the structure of tasks to highlight a process) is central. Both forms are powerful tools in supporting learners to see patterns, test conjectures, and deepen their grasp of mathematical structures.

3.3.11.2 NCETM Description and Links to Theory of Variation

The NCETM (2023) defines variation as a key design principle for teaching, with tasks carefully crafted to expose the structure of mathematics. Teachers are encouraged to design sequences of questions or examples that vary systematically to support both concept formation and procedural fluency. The aim is to help all learners notice patterns, relationships, and generalities.

Kullberg et al. (2024) emphasise that variation is most powerful when teachers explicitly identify and present the critical features they want students to notice. However, they also note that some teachers may use variation in a mechanical way, without clarity on its conceptual goals. Their study reveals that in practice, variation is often underutilised or inconsistently applied across classrooms.

Al-Murani et al. (2019) likewise observed a mismatch between the theoretical potential of variation and its classroom enactment. While some teachers harnessed variation to support conceptual shifts, others relied heavily on visual or superficial variation, limiting opportunities for students to engage in deeper reasoning. Professional development is identified as critical for helping teachers distinguish between arbitrary and purposeful variation.

Boylan (2020) and Coles and Helme (2022) add that the full value of variation is realised only when teachers possess strong subject knowledge and are supported in planning lessons that build coherent and conceptually rich trajectories. Without this, the transformative potential of variation may be lost amid curriculum pressures and standardised pacing.

Variation supports deep learning by drawing learners' attention to important mathematical structures and relationships. The NCETM's framing is theoretically robust, but its implementation depends on teacher expertise in crafting and orchestrating example sequences. Developing this expertise requires targeted support, particularly in contexts where mastery is interpreted narrowly or implemented under external pressure.

3.3.12 Far Eastern Teaching Practices

Far Eastern education systems, particularly those of Shanghai and Singapore, have consistently been among the highest-performing jurisdictions in international mathematics assessments such as PISA and TIMSS (OECD, 2019; Mullis et al., 2020). The success of these systems has influenced the development of Teaching for Mastery (TfM) in England, particularly as structured by the NCETM's Five Big Ideas. However, to fully appreciate the rationale for policy borrowing, it is necessary to examine the detailed pedagogical practices underpinning mathematical achievement in East Asian classrooms.

While surface-level similarities between TfM and East Asian practices have been acknowledged (Boylan et al., 2019), deeper structural differences in curriculum design, lesson planning, teacher preparation, and cultural attitudes to learning are equally critical to understand. This section identifies and analyses the

pedagogical strategies most commonly associated with Far Eastern mastery teaching, and compares these to pre-TfM English practice, using contemporary literature to examine the implications.

3.3.12.1 Small Steps and ‘Success for All’

The principle of ‘teaching for depth before acceleration’ is foundational in East Asian systems and has become a cornerstone of TfM. Rather than rushing through content to cater to high-attainers, Shanghai and Singapore prioritise whole-class progression, allowing all students to master foundational content before moving forward (Baker, 2022; Sun et al., 2023). This approach contrasts sharply with prior English practices where differentiation by task often meant pupils within the same class learned entirely different content depending on perceived ability (Jerrim & Vignoles, 2015; Barmby et al., 2014).

Recent research by Huang & Leung (2022) reiterates that in Shanghai classrooms, advanced learners deepen their understanding through enrichment tasks that remain focused on the current unit of study—thus reinforcing the collective coherence of learning and avoiding premature curriculum advancement. Such strategies are grounded in the belief that all pupils are capable of high achievement, given appropriate support and time (Zhou et al., 2023).

The NCETM’s interpretation of mastery teaching borrows this ethos: rather than allowing some pupils to move ahead, higher attainers engage in rich tasks that broaden understanding within the same conceptual domain (NCETM, 2023). This approach aims to reduce attainment gaps and minimise the need for re-teaching.

3.3.13 Variation in East Asian Pedagogy

Variation theory, with its roots in phenomenography and the work of Marton and Tsui (2004), is a dominant pedagogical principle in Shanghai and Singapore. It is used to support pupils in discerning key mathematical structures through carefully sequenced examples. This principle is present throughout East Asian textbook design and classroom practice (Gu et al., 2004; Kullberg et al., 2024).

Zhang et al. (2017) describe how variation is implemented both procedurally—through systematic changes in problem types—and conceptually—through multiple representations that reveal different aspects of a concept. For instance, in teaching place value, Chinese teachers frequently present a sequence of examples where only one digit changes position, allowing pupils to perceive the structural role of each digit (Pang et al., 2017). These are not incidental changes but carefully planned to draw attention to invariant and variant features of the mathematics being taught.

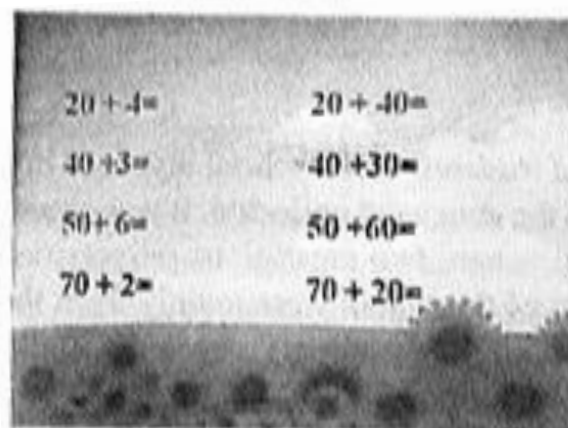


Figure 4.0: An example of an addition task taken from a Shanghai lesson on 3-digit addition (Pang et al., 2017, p.50).

Procedural variation, such as that exemplified in Pang et al.'s (2017) Shanghai study, builds fluency while encouraging pupils to identify underlying rules and relationships. Tasks often begin with an anchoring example, followed by carefully modified problems that support inductive reasoning (Jacques, 2018). The structure guides learners from the familiar to the unfamiliar while maintaining cognitive continuity.

Recent studies (Coles & Helme, 2022; Al-Murani et al., 2019) suggest that the power of variation lies not in variety for its own sake, but in purposeful contrasts that help learners focus on the critical features of a concept. This is particularly effective when teachers explicitly verbalise these features and scaffold the noticing process.

3.3.13.1 Textbook Design and Curriculum Alignment

Unlike the historical use of textbooks in England, where they were viewed as optional repositories of exercises, East Asian textbooks are considered central instructional tools. In Shanghai, textbooks are aligned closely with the national curriculum and embody variation theory in both structure and pedagogy (Fan et al., 2023; Wang & Fan, 2021).

Recent comparative research by Ding et al. (2022) indicates that Chinese textbooks incorporate progressive variation sequences, problem-solving contexts, and multiple representations that align with curriculum goals. This structure allows pupils to build connected knowledge and supports the teacher in lesson sequencing.

By contrast, English textbooks have historically focused more on procedural competence and offered fewer opportunities for pupils to generalise, represent, and discuss their reasoning (Boylan, 2020). Even with the advent of mastery textbooks in England, the NCETM (2023) acknowledges a continued need to develop the design of resources that reflect variation principles more authentically.

3.3.14 Conceptual Understanding and Making Connections

The emphasis on conceptual understanding is a defining feature of mastery-oriented systems such as Shanghai's. Central to this is the notion of relational understanding, where pupils grasp both the how and the why behind mathematical processes. This stands in contrast to instrumental understanding, characterised by rote learning and procedural application without deeper comprehension (Skemp, 1976).

Far Eastern teaching traditions have long prioritised relational understanding, with teachers consistently drawing connections between concepts, operations, and representations (Cai et al., 2013; Boylan et al., 2019). Ding and Li (2020) report that Chinese teachers are trained to identify and highlight these relationships explicitly through lesson design and classroom dialogue.

Recent studies emphasise the use of multiple representations—both concrete and abstract—as tools for deepening conceptual understanding (Liu et al., 2021; Hough et al., 2023). For example, number lines, arrays, bar models, and area models are commonly used not only for initial concept introduction but also as bridges to formal symbolic representations. This aligns with Bruner's (1966) modes of representation: enactive, iconic, and symbolic. East Asian teaching sequences often follow this trajectory explicitly, helping pupils transition from hands-on experiences to generalised reasoning.

Moreover, contemporary cognitive science supports these pedagogical practices. Research by Siegler and Lortie-Forgues (2015) highlights that deep conceptual knowledge enables more flexible problem-solving and transfer of learning. These findings lend support to TfM's insistence on 'staying with the concept' rather than prematurely introducing new content.

3.3.14.1 Mathematical Communication and Precision

Mathematical communication in Far Eastern classrooms is both frequent and precise. Teachers structure talk to promote reasoning, justification, and the use of formal vocabulary (Xu & Clarke, 2019). This includes practices such as full-sentence responses, choral repetition of accurate terminology, and scaffolded opportunities to explain reasoning.

Axbey (2020) observes that in Shanghai classrooms, teachers often guide pupils toward the precise articulation of mathematical relationships—such as naming properties, comparing strategies, and expressing generalisations. These discursive moves help embed conceptual understanding while also nurturing pupils' confidence and agency in mathematical conversations.

Peng and Li (2020), in their comparative study of Chinese and Canadian classrooms, noted that although Chinese classrooms tend to be more teacher-directed, pupil engagement remains high due to the interactive and structured nature of questioning. Teachers regularly prompt for clarification, request justifications, and orchestrate class discussions with the goal of surfacing mathematical structures.

This mirrors the NCETM's emphasis on 'thinking mathematically' and using precise language as a way to deepen understanding (NCETM, 2023). While communication in Far Eastern classrooms may appear more formal, the intent is to support metacognitive reflection and public reasoning—both of which are associated with improved mathematical performance (Webb et al., 2014; Hiebert & Grouws, 2007).

3.3.15 Problem-Solving in Far Eastern Mathematics Classrooms

Problem-solving is central to East Asian mathematics teaching but differs significantly in both purpose and placement compared to traditional practices in England. Rather than being a consolidation activity, problem-solving in Chinese and Singaporean classrooms often forms the starting point for conceptual learning (Lopez-Real et al., 2004; Chan et al., 2018; Zhang & Siegler, 2022).

Chinese curricula frequently employ non-routine problems to stimulate curiosity and promote deeper cognitive engagement. These are tasks without obvious solution paths, designed to develop adaptive reasoning and mathematical creativity (Miao et al., 2015; Ding et al., 2022). While pupils often solve problems procedurally, there is a deliberate attempt to develop strategy selection, flexibility, and reflection post-solution (Sun, 2011; Fan & Zhu, 2020).

However, researchers caution against overgeneralisation. Zhou et al. (2023) found that, in practice, some Chinese lessons reduced cognitive demand through extensive scaffolding, which may limit pupils' autonomy in true problem-solving. Similarly, Zhu and Fan (2006) noted a tendency for puzzle-like or logic-based problems to dominate textbooks, often at the expense of real-life, context-rich applications.

In contrast, England's traditional curriculum has often presented problem-solving as a peripheral element, addressed after content delivery rather than integrated within it (Barmby et al., 2014). Despite recent reforms and the aspirations of the NCETM, problem-solving remains underemphasised in official materials. The NCETM's (2019) own progress report on TfM made only a single direct reference to

problem-solving across its entire document—a significant omission given its foundational role in Far Eastern mastery pedagogy.

Nonetheless, ongoing work by UK-based researchers (e.g., Al-Murani, 2022; Mason et al., 2021) points to the importance of repositioning problem-solving as central to learning, not as an extension. When combined with effective questioning, representations, and structured variation, problem-solving can drive understanding rather than simply assess it.

3.3.15.1 Reflections on Transferability and Implementation

It is crucial to recognise that East Asian classroom successes are not merely due to specific teaching techniques, but also to systemic and cultural factors. These include well-resourced curricula, structured teacher professional development, subject-specific coaching, and cultural expectations of effort and discipline (Boylan et al., 2019; You & Morris, 2016; Zhao, 2022).

As such, simply adopting surface-level features of Far Eastern pedagogy—such as slower pacing or textbook formats—does not automatically lead to improved outcomes in England. The NCETM’s (2023) ‘Five Big Ideas’ represent an attempt to theorise and adapt these practices into a coherent model suited to the English context, accounting for local pedagogical traditions and institutional constraints.

The next section now turns to these Five Big Ideas, outlining their theoretical underpinnings and pedagogical relevance. In doing so, it explores how far they reflect the aspirations of mastery as seen in East Asia and how they might be realistically enacted in English primary classrooms.

3.4 Research Questions

Building upon the preceding analysis of Far Eastern pedagogical practices and the theoretical foundations of Teaching for Mastery (TfM), this study seeks to explore how the NCETM’s Five Big Ideas are interpreted and implemented in practice, particularly within the unique educational landscape of a Service school setting. In doing so, the research considers both the intended pedagogical rationale behind TfM and the contextual realities of its enactment in English primary classrooms.

This study’s main aim is to investigate:

- What are the challenges and opportunities for teachers when using the NCETM’s Five Big Ideas as an approach to mathematics teaching?

This central research question reflects the shifting policy landscape in England, in which mastery approaches—originally drawn from East Asian systems—have been adapted and promoted by the NCETM to improve equity and depth in mathematical learning. However, as the previous section discussed, TfM’s success depends not only on the quality of imported pedagogical strategies but also on how these are interpreted by practitioners working in diverse and dynamic classroom contexts.

In particular, the study explores how TfM affects curriculum delivery, teacher agency, and learner outcomes, with attention to how the Five Big Ideas influence classroom culture and curriculum sequencing.

3.4.1.1 Contextual Lens: Service Children and Transient Pupils

A key dimension of this study is its focus on Alexander First School, a primary school serving a high proportion of transient pupils from military families. Service children are frequently impacted by school

mobility, disjointed curricular experiences, and inconsistent pedagogical approaches. These challenges amplify the importance of coherent, inclusive, and responsive teaching frameworks such as TfM.

Recognising that the term ‘maths mastery’ has varied interpretations, this study foregrounds the NCETM’s Five Big Ideas as both a conceptual framework and practical pedagogy, investigating how these ideas support or hinder effective mathematics teaching in a setting with high learner mobility.

3.4.1.2 Research Questions and Theoretical Positioning

This table details the research questions the study sets out to answer:

Research Question	What This Question Seeks to Explore
Main Research Question What are the challenges and opportunities for teachers when using the NCETM’s Five Big Ideas as an approach to mathematics teaching?	Explores the pedagogical, emotional, and structural effects of TfM implementation on classroom practice. Drawing on Vygotskian notions of mediated learning and Bloom’s model of mastery, this question seeks to understand how TfM changes the relationship between teacher, learner, and curriculum. Interviews and video data indicate improved learner engagement and sense of mathematical success.
Sub-Question 1 How do teachers attempt to support transient pupils in their mathematics teaching, and how does this relate to the Five Big Ideas?	This question draws on both Bloom’s theory of feedback and correction, and the work of Ma (2010) on longitudinal coherence. It investigates how TfM—when informed by variation, representation, and structured coherence—offers both support and challenge for pupils with fragmented educational histories.
Sub-Question 2 What are the challenges and opportunities for pupils, particularly transient pupils, when ‘Teaching for Mastery’ is the guiding approach to their mathematics lessons?	Seeks to understand the learner experience through the lens of pupil mobility, confidence, and conceptual development. Teachers in the study noted improvements in pupil confidence and understanding but also acknowledged concerns regarding the rigid sequencing and time investment required. These findings are analysed in relation to Skemp’s (1976) relational/instrumental dichotomy and Bruner’s representational framework.

3.4.2 Conclusion and Transition to Methodology

Together, these research questions serve to connect the theoretical constructs of mastery learning with the practical experiences of teachers and pupils. They reflect a dual commitment: to evaluate TfM as a policy initiative and to examine its lived enactment in a highly mobile, diverse learning environment.

The following section outlines the methodology adopted to investigate these questions, describing the qualitative tools used to capture classroom dynamics, teacher perspectives, and pupil experiences. This includes semi-structured interviews, classroom video analysis, and reflective field notes—each chosen to capture the complex and situated nature of teaching for mastery in action.

Summary

This chapter began by asserting that mathematics education cannot be understood in a culturally neutral vacuum. Rather, it is embedded within—and shaped by—distinct cultural, social, and historical contexts. Although mathematical principles are universal in abstraction, the ways mathematics is taught, learned, and valued differ across international systems. Within this complexity, international comparators such as PISA and TIMSS emerge not merely as attainment assessments, but as powerful policy influencers prompting educational borrowing and reform.

The conceptual ambiguity surrounding ‘maths mastery’ was explored, tracing its theoretical lineage from early educational philosophers to Benjamin Bloom’s (1968) model of mastery learning. Bloom’s emphasis on instructional alignment, feedback, and the belief that all pupils can succeed with appropriate time and support laid the foundation for later policy developments. Although mastery approaches have been widely associated with the Far Eastern systems of Shanghai and Singapore, the chapter also highlighted their theoretical roots in Western educational research.

The chapter then examined the National Centre for Excellence in the Teaching of Mathematics’ (NCETM) *Five Big Ideas*, presenting them as a pedagogical framework guiding the enactment of Teaching for Mastery (TfM) in English schools. Each idea was explored in relation to its theoretical origin:

- **Coherence** was viewed through Ma’s (2010) *Profound Understanding of Fundamental Mathematics*, emphasising connectedness, longitudinal planning, and structural integrity of knowledge.
- **Representation and Structure** were examined via Bruner’s (1966) enactive-iconic-symbolic model, highlighting the progression from action to abstraction and the role of multiple representations in flexible thinking.
- **Fluency**, often misinterpreted as speed, was clarified through Schoenfeld’s (1985, 1992) emphasis on purposeful, strategic, and adaptable problem-solving.
- **Variation** was presented using Marton and Tsui’s (2006) theory, illustrating how varying non-essential features allows learners to discern mathematical structure and deepen understanding.
- **Mathematical Thinking** was analysed through Schoenfeld’s framework, promoting reasoning, pattern recognition, and strategic engagement with problems.

Far Eastern practices from Shanghai and Singapore were shown to align with the Five Big Ideas—not just in surface features like lesson design or textbook use, but in deeper pedagogical commitments to coherence, challenge, and inclusion. Practices such as structured variation, mathematical talk, and non-routine problem-solving further reinforced the theoretical underpinnings of TfM.

In synthesising theory, international practice, and national policy, this chapter establishes the conceptual and pedagogical landscape from which TfM emerged. It clarifies the constructs against which classroom practice will be evaluated. The next chapter turns to the theor, detailing how the research investigates the Five Big Ideas in the context of a mobile Service school environment.

4 Chapter 4: Policy, Practice, and School Context

This chapter begins with a discussion that seeks to highlight why educational policies—especially those related to mathematics teaching—are enacted differently across school contexts. While national frameworks such as the NCETM’s Teaching for Mastery (TfM) programme are designed to provide coherence and structure, their local interpretation and implementation can vary significantly. This variability is shaped by school-specific factors such as community demographics, pupil mobility, staff capacity, and school ethos. In light of this, the chapter considers how local conditions—such as staffing structures, curriculum priorities, or leadership styles—impact the ways in which policies are put into practice, leading to differentiated policy outcomes even when the policy itself is uniformly mandated.

Building on this, the chapter explores the role of teacher and school leader agency in the policy enactment process. Policies are not simply imposed from above, but are actively interpreted, negotiated, and adapted by those responsible for delivering them. Teachers and leaders draw upon their own values, beliefs, and knowledge as they make sense of policy expectations and embed them into their practices. Attention is given to the dynamics of professional discretion, institutional constraints, and external accountability, all of which influence how the TfM policy is taken up—or resisted—in practice.

The chapter also sheds light on the uneven power dynamics at play in the policy process. While senior leaders typically hold greater influence over the interpretation and prioritisation of national frameworks, classroom teachers often carry the weight of implementation without necessarily shaping the direction of enactment. In this way, the chapter recognises that policy work is situated within complex professional hierarchies and is shaped by relational as well as structural factors.

Finally, the chapter introduces the context of Alexander First School, the primary research site for this study. A detailed account is provided of the school’s demographic profile, the characteristics of its Service pupil population, and the institutional strategies used to support mathematics learning within a high-mobility environment. This context is essential for understanding how TfM is enacted at a local level, how the Five Big Ideas are taken up in day-to-day mathematics teaching, and how the school’s specific circumstances shape the challenges and opportunities involved in implementing mastery-oriented pedagogy.

4.1 Introduction

As Ball (1994) asserts, education policies are not designed to instruct practitioners verbatim, but rather provide a narrowed range of approaches and methods aimed at achieving specific outcomes. Many such policies, including those related to mathematics education, often arise from well-intentioned efforts to address perceived national issues or improve educational standards. In the case of maths mastery, government ambitions focused on raising both national and international performance levels, particularly through the adoption of practices shown to be effective in high-performing jurisdictions. However, how these intentions are interpreted and implemented by individual schools varies significantly and is shaped by a range of contextual factors. Braun, Maguire, and Ball (2010) argue that schools interpret and reshape policy guidance according to their own contexts, histories, and cultures, placing their own "spin" on policy enactment.

The ideas underpinning the maths mastery approach—such as Bruner’s modes of representation, Piaget’s cognitive development theory, Skemp’s relational understanding, and broader constructivist philosophies—are conceptually rich and demand deep understanding. This is further complicated by the inherent complexity of mathematical subject knowledge and how it is structured and developed in learners. For schools to implement mastery meaningfully, leaders and practitioners must engage in significant interpretation and adaptation. In practice, many schools have therefore re-contextualised the guidance on mastery into forms that are manageable within their unique constraints (Braun et al., 2011). Riseborough (1992) refers to this as the process of making minor adjustments that help policy align with the existing school culture—preserving core policy intentions while modifying application.

Each school community is distinct, and so are the ways in which policies are enacted within them. Ball (1994) terms this process ‘creative non-implementation’ or ‘fabrication’, whereby schools selectively engage with aspects of a policy to suit local conditions. With respect to maths mastery, barriers such as limited time, insecure subject knowledge, or professional anxieties have sometimes resulted in selective adoption—prioritising certain mastery elements over others.

A central feature of maths mastery is Variation Theory, which requires teachers to structure learning so that pupils can identify the critical aspects of mathematical concepts by varying the non-critical features. Yet Ma’s (1999) comparative study of Chinese and U.S. mathematics teachers reveals that many Western practitioners struggle to apply variation theory effectively. This undermines the fidelity of mastery implementation in some settings. Discussions with school leaders and maths coordinators also indicate a degree of scepticism about the longevity of maths mastery as a national strategy, particularly among veteran educators. This echoes Ball (2001) and Maguire (2007), who note that policy initiatives are often viewed with caution due to the transient nature of education reforms.

While policy directives seek standardisation and coherence across schools, they often overlook the significant diversity of local contexts. Factors such as pupil demographics, socio-economic background, staff turnover, and institutional histories are rarely accounted for. Thrupp and Lupton (2006, p. 309) argue that these “nuances of local context [can] cumulatively make a considerable difference to school processes and student achievement.” Similarly, Dilley (1999) and Lupton (2004) advocate for policy approaches that take local context more seriously. Importantly, this includes not only demographic considerations but also the pedagogical strengths and leadership capacity within schools, as well as practical limitations such as resources and infrastructure. Without attention to these contextual dimensions, centrally designed policies may clash with the reality of school life, creating tension between intended goals and lived experience.

Malen and Knapp’s (1997) research provides a useful framework for understanding how schools respond to policy. They propose five perspectives—rational, organisational, political, symbolic, and normative—that illuminate the diverse ways in which schools navigate policy enactment. These perspectives highlight how the expected or “ideal” response to policy from central government can be contested, adapted, or resisted at school level. It is often not the goals of the policy that are challenged, but the singularity of the methods prescribed. As education remains a highly politicised domain, schools operate under ongoing pressure from national mandates, inspection regimes, and shifting ministerial priorities. Malen and Knapp (1997, p. 430) argue that education policy ‘sends signals and creates symbols that serve important functions’ within political discourse, underscoring its performative and symbolic nature.

4.2 Policy

Educators are not passive recipients of education policy. Instead, they are required to interpret, mediate, and adapt policies within the realities of their local settings. This process of enactment is neither uniform nor predictable. As Ball et al. (2011, p.611) argue, teachers occupy a range of “positions” in relation to policy, shaped by their professional identities, experiences, beliefs, and school contexts.

McHoul and Grace (1993, p.34) describe this interpretive process as one driven by the “socially productive imagination.” That is, teachers’ engagement with policy is filtered through their own sense-making processes, informed by the cultural and social contexts in which they work. Thus, responses to the same policy can differ widely across settings—not simply because of differing material conditions, but because of the dynamic interplay between autonomy, values, and the structures of accountability.

This highlights the tension between individual agency and centralised control. While policies may be designed to produce consistency across the system, educators bring varied histories, pedagogical philosophies, and contextual knowledge to bear in the enactment process. Harker and May (1993) suggest that this inherent diversity often sits uneasily with the coherence and standardisation that national policy seeks to impose.

Ball et al. (2011) explore this dynamic further by presenting a series of propositions that illustrate the disjunctures and negotiations involved in policy enactment. These propositions move beyond the assumption that policies are simply implemented. Instead, they frame policy as a contested and creative space, in which educators must navigate multiple demands, often under considerable pressure.

Each proposition highlights a different facet of how policy is lived out in schools: the nature of the policy text itself, the time and emotional labour required to engage with it, the diversity of actors involved in the process, and the ever-present influence of context. Together, these insights challenge linear models of policy implementation and draw attention to the textured and situated realities of professional practice.

In sum, policies are not merely documents or directives—they are social and political instruments that intersect with human agency. Their enactment depends on far more than compliance: it requires interpretation, adaptation, and, at times, resistance. This sets the stage for a deeper examination of the specific propositions identified by Ball et al. (2011), through which the nature of policy engagement in the context of mathematics mastery can be more clearly understood.

4.2.1.1 *‘Proposition 1: Not all policies are the same!’ Ball et al. (2011, p.612)*

Ball et al. (2011) assert that not all education policies operate with equal weight or impact; instead, they produce different kinds of policy subjects, each shaped by the specific language, demands, and expectations of the policy in question. These differences are particularly pronounced in the contrast between what Ball et al. term imperative and exhortative policies.

Imperative policies, according to Ball et al., are designed to address perceived deficits in educational performance — often driven by national or international comparisons — and therefore tend to prescribe specific forms of action. In these cases, educators are positioned as largely passive recipients of externally defined goals. For example, the UK Government's investment in maths mastery was motivated by concerns about falling standards and a desire to replicate the perceived success of high-performing jurisdictions such as Singapore or Shanghai. As a result, implementation efforts focused on driving up pupil

performance through prescriptive pedagogies, supported by external funding, training, and structural guidance.

In this scenario, educators are expected to comply with policy demands, often reducing their autonomy. MacBeath (2008) notes that this instrumentalisation of teaching shifts attention towards performativity, where raising attainment becomes the key measure of success. As Jeffrey (2002) observes, this can lead to the marginalisation of more holistic educational goals such as creativity, emotional well-being, and social development. This raises pertinent questions:

- Is the mastery approach being used primarily to ‘teach to the test’?
- Are improved test scores the ultimate objective, eclipsing deeper learning?
- Does the perceived success of mastery hinge solely on measurable data?
- Can educators point to enhanced pupil engagement or increased mathematical confidence as outcomes?
- Has uptake of mathematics in further and higher education increased as a result?

These questions highlight the tension between compliance and conviction. Teachers may disagree with certain elements of a policy — such as mixed-ability grouping or same-day intervention — but feel compelled to adopt them due to the pressures of accountability. As Ball et al. (2011, p.612) note, ‘teachers are put under pressure to submit to the disciplines of necessity; although these necessities bear differently upon different parts of the school’. This underscores how school context — including leadership structures, teacher expertise, and pupil demographics — mediates the enactment of any given policy.

This pressure to conform often results in top-down leadership responses, where senior leaders focus narrowly on policy compliance at the expense of professional autonomy. Barber (1997) critiques this shift, arguing that performance metrics override professional discretion. Similarly, Mahony, Menter, and Hextall (2004, p.439) lament the irony of ‘teachers at the peak of their professional expertise’ having little say in how they work. Kelchtermans (2003, p.955) adds that this undermines teachers’ sense of identity, since ‘emotions reflect the fact that deeply held beliefs on good education are part of teachers’ self-understanding’.

By contrast, exhortative policies operate as softer, more suggestive frameworks. Rather than prescribing fixed actions, they invite educators to interpret, adapt, and make meaning of the guidance provided. These policies assume that teachers are capable professionals who will navigate the ideas with care, nuance, and judgement. In the case of maths mastery, exhortative elements include the emphasis on mathematical language, collaborative problem-solving, and variation theory — elements that require pedagogical reasoning rather than scripted delivery. Professional development plays a key role here, with Continuing Professional Development (CPD) initiatives encouraging teachers to internalise mastery principles and reflect on their own practice.

Exhortative policies, however, are more susceptible to ‘creative interpretation’. As Ball et al. (2011, p.615) observe, these can be ‘ignored, or underplayed or side-lined’ and become spaces for ‘creative repackaging’. Teachers may cherry-pick elements of a policy that align with their existing beliefs or are more manageable within their constraints, resulting in an uneven adoption of intended practices. However, Ball et al. (2011) caution against viewing this as a failure. Rather, they argue that this flexibility is essential in a field as complex and fluid as education. Learning is not a fixed event but a dynamic process

that requires space for experimentation and adaptation. The open-ended nature of exhortative policies fosters a deeper, more meaningful engagement with pedagogy, and in turn, leads to greater buy-in from educators.

Ultimately, this proposition illustrates the diversity of policy forms and the differential ways they are received and enacted by teachers. It points to the need for policymakers to consider how the form, tone, and intent of a policy affect not only compliance but also its sustainability and impact in practice.

4.2.1.2 'Proposition 2: Time and tired, how teachers move unreflexively between contrasting subject positions' Ball et al. (2011, p.616)

The work of Ball et al. (2011, p616) demonstrates the ease at which practitioners move between these policy types. 'This is indicative perhaps of contemporary teaching as 'a liminal state of being' - that is a state of being on the 'threshold' of or between two different existential planes, being an essentially incoherent subject, both rational and passionate, compliant and inventive.' Many would argue the time-restricted and frequently overworked nature of teachers mean they are unable to adequately scrutinise or contest the often-contradictory nature of the policies placed upon them. In response, teachers and school leaders respond by muddle through and surviving the torrent of policies and directives. As Ball et al. (2011, p616) suggest, 'a lot of the time teachers do not 'do policy,' policy 'does them.' This opposes the ideals of policymakers, in which a homogeneous response is anticipated.

The volume and often contradictory nature of policies, work against the routine demands of the teaching profession. Subsequently, practitioners concentrate on their primary function- teaching. Hoyle (1974) goes further in arguing the loss of professional integrity as practitioners are unable to draw upon both professional experience *and* theoretical practice.

In a mastery approach, same day intervention ensures struggling pupils keep up with their peers and avoids growing gaps between pupils. This is based on the theoretical work of Piaget's cognitive learning theory, in which he argues that it is not sufficient to just assimilate ideas but also to accommodate ideas learned through drill, practice, and reflection. However, putting this theory into practice requires compromise and bargaining. In a British context, in which the demands of other curriculum areas and statutory requirements (e.g. P.E. and R.E.) need to be met, practitioners may revert back to a focus on teaching, or in the case of Alexander First School, omitting policy theory.

Policy enactment in this way results in differing forms of teaching and learning, once again, calling into question the principles of education. Furthermore, 'problems' which elicited the policy in first place remain unchallenged or are forgotten. However, Ball et al. (2011, p616) argues against this in stating, the simple 'impossibilities of the job' (enacting the policy), eliminates the problem. On the other hand, as mathematics is a core subject of the national curriculum, policy directives related to this subject are both inescapable and inevitable. A view challenged by Goodson (1983) who argues, the complex structure and culture of schools with its phase leaders, subject coordinators, senior leaders etc. means policies will evoke different responses from different individuals. Once again, referring to the effect context has on policy enactment.

Almond (2020) suggests maths mastery or TfM has been endorsed by Ofsted, providing greater incentives for schools to adopt a TfM approach as endorsed by the NCETM. Changes to mandatory government documents and encouragement from influential stakeholders such as Ofsted yield the ability to bring about the systematic changes.

4.2.1.3 *Proposition 3: Concern and critique are reduced to discomforts and murmurings Ball et al. (2011, p.617)*

As outlined in the previous sections, policy enactment often relies on the compliance of practitioners. However, such compliance does not always signal agreement. Instead, there exists what Ball et al. (2011, p.617) term a 'quiet moral disquiet about the interests and purposes which animate these different policies'. This unease arises from the belief that, in some instances, the enactment of policy serves institutional goals or political imperatives at the expense of the needs of pupils. Educators may conform outwardly while harbouring inward reservations, leading to a form of passive resistance manifested through silence, hesitation, or withdrawal.

Such disquiet is rarely loud or overt. It surfaces as a collection of murmured concerns—expressed in informal conversations, staffroom exchanges, or reflective moments—rather than formal protest or critique. These murmurs reflect a deeper ethical tension between the values educators uphold and the demands imposed upon them. The requirement to implement a policy, particularly when it contradicts professional instincts or situational awareness, can generate internal conflict and professional fatigue.

Bottery (2000) offers a contrasting perspective, suggesting that teachers and school leaders often do share the broad concerns and aspirations articulated in education policy. However, the disconnect arises not in the ideals themselves, but in the interpretation and translation of those ideals into practice. The intentions of the policy author may diverge significantly from how the policy is understood and experienced by those enacting it. Thus, policy words take on different meanings depending on context, audience, and lived experience.

Dyson, Gallannaugh, and Millward (2003) reinforce this point, arguing that most educators acknowledge the necessity of policies and accept their place within the infrastructure of education. Many policies contain statements aligned with the principles of social justice, equality, and quality teaching—principles that resonate with those who enter the teaching profession. In their absence, such issues may be left unaddressed or inconsistently tackled across settings.

Yet, the noble aspirations of a policy can be overshadowed by the operational demands it creates. Teachers and school leaders are tasked with meeting performance targets, evidencing compliance, and aligning practice to centralised expectations. When these demands conflict with contextual needs—such as the emotional wellbeing of transient or trauma-affected pupils, as seen at Alexander First School—concern may emerge in the form of muted resistance. The gap between a policy's stated aims and its enacted effects fosters a climate of quiet discomfort rather than overt defiance.

Nonetheless, it would be inaccurate to suggest that educators do not care. On the contrary, it is often because they care deeply—about pupils, about learning, and about fairness—that they feel unsettled by policy directives that seem ill-fitting or reductive. Policies are, as Ball et al. (2011) suggest, performative mechanisms that shape the professional conduct of educators. But when these mechanisms constrain rather than enable, they provoke not protest, but murmurings—a subtle yet significant form of resistance.

4.2.1.4 *Proposition 4: Policy enactment involves different sorts of policy actors in the work of interpretation (decoding) and translation (recoding) of policy Ball et al. (2011, p.619)*

This stage of policy enactment signals a shift—from dialogue and reflection to meaning-making and, ultimately, action. It is here that policies become not just texts or directives, but lived practices within schools. Fullan (2001) regards this stage as the most difficult, as constructing meaning is inherently

complex. Supovitz (2008) supports this view, emphasising that meaning-making is the essential foundation on which analysis, synthesis, and subsequent action are built.

Ball et al. (2011, p.619) describe this process as involving both interpretation and translation, linked through what they term 'meaning work'. Interpretation refers to the act of deciphering the policy's intent, while translation is the process of operationalising that understanding within practice. These two facets, while distinct, are deeply interconnected.

Interpretations are never neutral or uniform; they are situated—shaped by the school's internal context, including staff expertise, student demographics, parental expectations, leadership structures, and available resources. Within schools, this meaning-making is continually negotiated and re-negotiated. Staff meetings, leadership team briefings, and coordinator planning sessions become key arenas where interpretation is shaped, shared, and repackaged—often with a performative edge to secure buy-in from the wider staff. There is, in this sense, a subtle politics to meaning-making: policies must be sold before they are enacted.

Ball et al. (2011, p.619) draw a clear distinction between interpretation as being 'mainly rationalistic', and translation as 'more realistic'. Translation is less about theoretical alignment and more about practical realisation. It is, by nature, a recursive and adaptive process, often drawing on external influences such as neighbouring schools, online resources, NCETM materials, or government guidance. In this way, schools give shape and value to policies by enacting them through shared language, examples, and rituals of practice. Buckles (2010, p.18) describes this process as 'recoding', while Hardy and Lingard (2008, p.66) refer to it as the 'logics of practice'—both capturing how translation reinterprets intent through the lens of practicality.

Translation happens in both imperative and exhortative policy contexts, but its texture and impact differ depending on the pressures and freedoms allowed. If interpretation is strategic—framing the 'why'—then translation is tactical—crafting the 'how'. In practice, translation often occurs during lesson planning, book scrutinies, moderation exercises, or lesson observations. Increasingly, lesson observations have become a key site of policy translation, acting as both accountability mechanisms and instruments of modelling and dissemination.

Ball et al. (2011) noted in their research that lesson observations gave school leaders a tangible, visible means of assessing policy enactment. They also provided teachers with opportunities to learn from each other and refine practice. However, Ball et al. also highlight the power dynamics embedded in this practice: classroom teachers may feel compelled to conform to leadership expectations, even when these differ from their professional judgement or contextual knowledge. The performative nature of translation, particularly under observation, risks narrowing pedagogy to meet anticipated standards rather than responding flexibly to pupil need.

This concern is echoed by Elmore (1996), who argues that classroom practices must remain responsive to the evolving needs of learners—no two cohorts are ever the same. The more prescriptive a policy, the less space there is for the nuances of classroom life. Policy, in such cases, risks overshadowing pedagogy.

Nevertheless, while interpretation and translation are analytically distinct, in practice they are deeply entangled. Both are shaped by school culture, policy pressures, and teacher agency. It is in their

intersection that the true enactment of policy occurs—not simply as a matter of compliance or resistance, but as a dynamic negotiation of meaning, purpose, and pedagogy.

4.3 Why Context Matters

As previously outlined, policies do not operate in isolation—they are enacted within a matrix of overlapping circumstances, shaped by the specific needs, norms, and histories of individual schools. While policies are often framed at the national level as universal solutions to pressing issues—such as raising attainment or narrowing gaps in achievement—their translation into practice is always local, contingent, and highly variable.

Policy enactment, therefore, cannot be understood without attending to the contextual factors that influence how, and to what extent, policies are implemented. This includes both tangible and intangible elements—ranging from infrastructure and staffing levels, to the professional beliefs, priorities, and histories of those enacting the policy.

Braun et al. (2011, p.588) provide a useful framework for understanding these contextual factors. They propose that context can be conceptualised through four interrelated dimensions: situated, professional, material, and external.

- Situated Contexts

These include the school's geographical and social locale, its historical reputation, the nature of its pupil intake, and the broader community it serves. For example, schools with high pupil mobility, significant numbers of children with English as an additional language, or serving areas of social deprivation may have different priorities and capacities when implementing a policy such as Teaching for Mastery (TfM). These situated realities frame what is possible, what is prioritised, and what is ultimately enacted.

- Professional Contexts

This refers to the values, beliefs, and pedagogical commitments of staff, alongside how leadership manages and interprets policy within the school. As Braun et al. (2011) note, schools are not ideologically neutral spaces. Teachers bring their own histories, experiences, and assumptions to their practice. For instance, a school with a long-standing culture of ability grouping may resist or adapt TfM's emphasis on mixed-ability teaching. Moreover, the leadership's stance towards professional development and policy management can significantly influence whether policies are embraced, adapted, or resisted.

- Material Contexts

Material resources—such as funding, staffing levels, access to CPD, physical environment, and availability of high-quality teaching resources—have a direct impact on the extent to which policy can be realised. For example, a school with limited teaching assistants may find it more difficult to implement same-day intervention or provide differentiated support as encouraged in mastery approaches. Similarly, outdated ICT infrastructure or overcrowded classrooms can hinder the enactment of interactive, representation-rich teaching.

- External Contexts

These refer to the broader policy ecosystem in which schools operate, including pressures from Ofsted, league tables, exam results, and national or local government directives. For instance, a school placed in 'requires improvement' may feel compelled to adopt a policy such as TfM more as a compliance measure than a pedagogical choice. Conversely, schools rated 'outstanding' may enjoy more autonomy and be able to adopt and adapt policies with greater freedom.

Braun et al.'s (2011) framework provides a powerful lens for interpreting how schools navigate the tensions between top-down directives and the messiness of real-world contexts. Importantly, it reveals that policy enactment is neither linear nor uniform—it is mediated through a complex interplay of values, constraints, priorities, and interpretations.

This nuanced understanding of context is crucial when examining how a policy like TfM is enacted at Alexander First School. It allows for a richer exploration of the school's particular response, grounded not only in the intended outcomes of policy but also in the realities of its own professional culture, material circumstances, and historical identity.

4.4 Situated Context

Alexander First School, named after Earl Alexander of Tunis, is situated on a Ministry of Defence (MoD) housing estate in Windsor. Though formally a local authority-maintained school, its demographic is shaped overwhelmingly by the military community, with approximately 75–85% of pupils identified as children of serving personnel. The majority of these families are affiliated with the Coldstream and Welsh Guards Regiments.

Unlike many typical garrison schools, Alexander First School occupies a unique position within what is locally known as the 'Guards Corridor', a stretch extending across Knightsbridge, Woolwich, Aldershot, and Pirbright. This regional context results in higher-than-average mobility, with Service families frequently relocating within and beyond these locations. Added to this complexity is Windsor's distinctive three-tier education structure—comprising First, Middle, and Upper schools—which contrasts with the more commonly used Primary and Secondary model across the UK. Pupils therefore often transition not only between geographical settings but also across different educational systems, exacerbating challenges in continuity and coherence of learning.

Military life further shapes the family dynamic. Many Service parents are periodically deployed overseas or required to undertake extensive training, resulting in prolonged separations from their children. These separations can vary in duration from a few days to several months, with some extending to seven months or more. Such periods of absence inevitably affect attachment relationships, consistency in routines, and emotional wellbeing.

Cultural diversity is another defining feature of the school. A significant proportion of the pupil population come from Commonwealth backgrounds, most notably Fijian and Gambian families. The presence of the Welsh Guards Regiment also brings children who have previously been taught in Welsh or who come from Welsh-speaking households. As a result, around a third of the school's pupils speak English as an additional language (EAL), requiring tailored support to access the curriculum effectively.

A number of Service children enrolling at the school have only recently arrived in the UK, often reuniting with a parent after extended periods of separation. These pupils face a multi-layered transition: not only are they adjusting to a new national curriculum, but they must also navigate an unfamiliar cultural context,

build new peer relationships, and re-establish attachments with their parent(s). This re-adjustment period is often complex and emotionally charged.

The transient nature of military life also has significant implications for the identification and support of pupils with Special Educational Needs (SEN). Frequent school moves can disrupt the referral and diagnostic process, delay the completion of Education, Health and Care Plans (EHCPs), and inhibit the continuity of specialist support. Consequently, many pupils arrive at Alexander First with unmet or undocumented needs, requiring the school to act quickly and flexibly to provide adequate support.

Recognising the compound effects of mobility, separation, and adjustment, the school places a strong emphasis on social, emotional, and mental health (SEMH). This emphasis stems from a belief that pupils' capacity for engagement, attendance, behaviour, and long-term success is deeply influenced by their emotional wellbeing. For Alexander First School, supporting SEMH is not simply a pastoral priority but an educational imperative, especially in the context of Service life.

In parallel, the school has identified a valuable intersection between SEMH, Service identity, and STEM education. Careers within the Army frequently promote STEM-related skills—such as vehicle mechanics, electronics, cyber engineering, and power systems—offering broad pathways for economic and career mobility. Importantly, these career routes exist across various levels of education and expertise, making them accessible to a wide range of Service personnel.

Recognising this, Alexander First has embraced STEM as a mechanism for both academic engagement and familial reconnection. STEM serves as what the school refers to as a 'trojan horse'—a way for Service parents to re-engage with their children's education by sharing their technical expertise and strengthening bonds. As such, the school has embedded regular STEM-focused activities into the curriculum, including themed project days, hands-on learning experiences, and events designed to involve parents and carers in classroom life.

This uniquely situated context—defined by military mobility, cultural diversity, emotional complexity, and a strategic approach to STEM—shapes the school's interpretation and enactment of policy, particularly in relation to mathematics and Teaching for Mastery. As will be explored further, this context has profound implications for how curriculum guidance is understood, adapted, and delivered at Alexander First School.

4.5 Professional Context

The professional culture of Alexander First School is significantly shaped by the complex and often unpredictable experiences of its pupil cohort, most of whom are children from Service families. According to O'Neill et al. (2010, p.190), children who have experienced trauma and disrupted attachment relationships face an elevated risk of academic and behavioural difficulties. They argue that 'the trajectory for learning across the developmental lifespan is radically affected by early trauma experiences'. For many pupils at Alexander First School, such trauma arises from the intrinsic demands of military life—frequent relocations, periods of parental deployment, and disrupted attachments.

A typical child joining the school may have attended multiple prior settings, sometimes across different countries or educational systems. The adjustment required includes navigating a new school environment, forging new peer relationships, and establishing trust with a new teacher. For others, the emotional strain is amplified by the unpredictable nature of parental absence. These absences can range from a few days to several months, and often without a guaranteed return date. In fact, many parents

choose not to disclose the exact date of return to their children in order to mitigate the emotional toll of potential delays. While this approach seeks to reduce disappointment, it simultaneously heightens the uncertainty children experience.

In response to these challenges, staff at Alexander First School have committed to an approach that places social, emotional, and mental health (SEMH) at the heart of their professional practice. The school is an accredited Attachment Aware School, drawing on research from neuroscience and psychology to understand how trauma and attachment disruption inhibit learning. This knowledge has shaped not only classroom practice but the school's wider ethos and policies.

Further strengthening this commitment, the school is also recognised as a Nurture UK practitioner. The nurture approach prioritises emotional wellbeing alongside academic development, recognising that the two are inextricably linked—particularly for pupils from vulnerable or transitional backgrounds. A dedicated Nurture Room and a qualified Nurture practitioner facilitate targeted interventions for children who require additional emotional support.

Every teaching assistant at the school is also trained as an Emotional Literacy Support Assistant (ELSA), a role developed and supervised by educational psychologists. ELSAs are equipped to deliver one-to-one or small-group sessions to help pupils build emotional resilience, develop social skills, and manage mental health challenges. Importantly, ELSAs are selected for their relational sensitivity—their capacity to build trusting, empathetic connections with children.

SEMH provision is not treated as an auxiliary support but is embedded into core policy areas such as safeguarding and behaviour management. These policies are reviewed annually and introduced to all staff during in-service training days at the beginning of each academic year. Ongoing CPD throughout the year includes specialist input from educational psychologists and practitioners with expertise in trauma-informed and attachment-sensitive education.

To ensure that all members of the school community—teaching assistants, administrative staff, and midday supervisors—share a unified understanding of SEMH principles, the school compensates support staff for attending INSET days, even when these fall outside their contracted hours. This approach reflects a leadership commitment to cultivating a shared professional culture, underpinned by consistency and collective responsibility.

A distinctive feature of the school's professional context is the employment of Service spouses or partners as teaching assistants. At present, around 75% of the school's support staff fall into this category. Their first-hand understanding of military life offers an invaluable cultural resonance. Not only do they bring lived experience into their professional practice, but they also serve as bridges between home and school life. For example, Alexander First School operates pre-deployment and deployment support groups for pupils, facilitated by Service spouses who are themselves managing periods of separation. This alignment between professional and personal experience creates a powerful model of empathy and responsiveness.

However, this staffing strategy also presents challenges. Due to the transient nature of military postings, many Service spouses remain in post for only two years on average. This leads to a higher turnover of support staff compared to civilian schools and necessitates regular re-establishment of the school's cultural expectations. Each new cohort of staff must be inducted not only into pedagogical routines but

also into the SEMH-driven ethos that defines the school's approach to learning and community engagement.

In summary, the professional context at Alexander First School is one of deliberate cultivation—an intentional, informed response to the social and emotional complexities of military life. Through robust training, embedded SEMH frameworks, and alignment with the lived experiences of its staff, the school has established a professional culture that is both adaptive and deeply empathetic. This culture plays a pivotal role in shaping how educational policies—especially those related to mathematics and mastery—are interpreted, enacted, and sustained in daily practice.

4.6 Material Context

Alexander First School is a one-form entry primary school with an integrated Nursery provision, and it is notably smaller than average. In line with the Windsor and Maidenhead local authority's three-tier system, the school caters to pupils from Nursery up to Year 4 (ages 8–9), after which they transition to middle school. Although the school has the capacity to accommodate up to 176 pupils, its actual enrolment is typically closer to 90. This reflects both the local demographic and the school's highly specialised intake. Between 75% and 85% of pupils are children of serving military personnel, while the remaining cohort predominantly comprises pupils with additional needs—particularly in the area of behaviour—who have been drawn to the school's well-regarded Special Educational Needs (SEN) provision.

In response to the increasing complexity of need within its pupil population—particularly with respect to Speech, Language and Communication Needs (SLCN) and Social, Emotional and Mental Health (SEMH)—the school has taken the initiative to establish two specialist internal Hubs: a Speech, Language and Communication Hub, and a SEMH Hub. These hubs were created to fill a pressing gap in provision: many pupils enter the school with clear learning and developmental challenges, yet without an official diagnosis or statutory Education, Health and Care Plan (EHCP). At the time of writing, both hubs operate on the basis of need rather than formal documentation. They provide targeted support and structured interventions for pupils who would otherwise be under-supported in a mainstream setting. Pupils allocated to the hubs split their time between hub-based activities and their regular classroom environment, allowing for both inclusion and individualisation.

Due to fluctuations in pupil numbers over time, the school has previously had to merge year groups in order to remain financially viable. While this is not currently the case, the possibility remains a constant consideration given the school's small population and budget constraints.

From a financial perspective, the school faces significant structural challenges. Its principal income stream—per-pupil funding—stands at £7,460 per pupil (2023–2024), which is modest by national standards and further constrained by the school's relatively low enrolment. Although the school benefits from the Service Pupil Premium (SPP)—a grant of £335 per eligible pupil (2023–2024)—this is intended to provide pastoral rather than academic support and cannot be combined with the Pupil Premium (PP), which is allocated to pupils from disadvantaged backgrounds at a higher rate of £1,455 (DfE, 2024). Crucially, Service children do not meet the eligibility criteria for the PP despite many facing considerable instability and complex needs.

This funding discrepancy has led to a significant imbalance between income and expenditure. While the school supports a high-need cohort, it does so without access to the financial resources typically available

to schools serving disadvantaged populations. The result is a year-on-year deficit, which has necessitated the approval of a licenced deficit agreement with the local authority to continue operating under sustained financial pressure.

To mitigate the shortfall, the school actively seeks additional income through military-affiliated grant funding. However, such grants are both unpredictable and inconsistent, requiring substantial administrative effort with no guarantee of success. The school's experiences between 2018 and 2022 highlight this variability:

Year of funding	Amount Received
2018/2019	£54,604
2019 / 2020	£0.00
2020 / 2021	£34,300
2021 / 2022	£2500

Figure 5.0: Military-related grant funding allocations, 2018–2022

These fluctuations underscore the precariousness of relying on external funding to support core provision. Despite this, the school remains proactive in seeking new funding streams to maintain and expand its offer—particularly in light of the needs of its Service and SEND pupils. The material context of Alexander First School is thus defined by a combination of resourcefulness, financial constraint, and an ongoing tension between ambition and affordability.

4.7 External Context

Alexander First School operates under the close scrutiny of its local authority due to its persistent financial challenges. The school's year-on-year budget deficit has necessitated a heightened level of oversight, particularly regarding spending decisions. As part of this monitoring process, the Deputy Director for Education and the Bursary Leader from the local authority conduct formal reviews with the Headteacher at least twice annually. These meetings require the school to justify its expenditures, including staffing decisions, training provisions, and both educational and non-educational resource purchases.

This arrangement—though framed as supportive—places the school in an unusual and restrictive position. School leaders must constantly navigate the tension between meeting the needs of their pupils and avoiding financial decisions that could be perceived as excessive or unjustifiable by local authority representatives. This tension risks stifling innovation or deterring leaders from implementing necessary changes in teaching and learning if those changes carry cost implications. The result is a narrowing of leadership autonomy, as pedagogical decisions become increasingly tethered to financial defensibility.

In March 2023, the school underwent an Ofsted inspection, resulting in an overall judgement of 'Good'. The published report demonstrated some appreciation of the school's unique Service context, stating:

‘Many pupils have attended more than one school previously, as their parents move regularly because they serve in the army. The challenges pupils face as a consequence are never far from leaders’ minds. Staff ensure that they know pupils well, and want the best for them. They work as a capable team to ensure that pupils make progress and that they are happy learning and playing together.’ (Ofsted, 2023, p.2)

The inspection acknowledged the instability many pupils experience and the school’s efforts to mitigate its effects. This indicates a degree of contextual sensitivity, recognising the relationship between military mobility and educational continuity.

However, under the section titled ‘What does the school need to do to improve?’, Ofsted made a single recommendation:

‘Some subjects are taught in blocks. Where this is the case, pupils find it difficult to remember what they have learned previously. Leaders should consider how best to ensure teaching builds pupils’ learning systematically over time in all subjects.’ (Ofsted, 2023, p.4)

School leaders responded with frustration to this recommendation. They felt it demonstrated a limited understanding of the high levels of pupil mobility and the frequency of mid-year admissions—both defining features of the school’s population. In many cases, pupils questioned during the inspection had only recently joined the school, making queries about their prior term’s learning irrelevant. For leaders at Alexander First, this illustrated the disconnect between inspection frameworks and real-world context, particularly in schools serving transient or highly mobile populations.

While the inspection overall confirmed the school’s strength and stability, it also underscored the pressures schools face to conform to standardised expectations, even when those expectations fail to account for localised complexities. This dynamic reflects the broader tension running throughout the policy enactment discourse: the push for uniformity in performance, and the pull of contextualised, adaptive practice.

Summary

This chapter examined how national mathematics policy, particularly the NCETM’s Teaching for Mastery (TfM) model, was interpreted and adapted within the unique context of Alexander First School. While TfM is underpinned by the Five Big Ideas and supported nationally through the Maths Hub infrastructure, its implementation within a high-mobility Service school required careful contextualisation.

The school’s leadership and staff had to navigate the tension between fidelity to policy and responsiveness to local needs — including pupil transience, varied curricular backgrounds, and staff turnover. Teacher agency, community ethos, and whole-school collaboration were central to reshaping TfM into a workable model of practice that met the needs of Service children.

Ultimately, this chapter demonstrates that policy enactment is never uniform. It is filtered through layers of community, context, and interpretation — highlighting the importance of grounded, flexible, and context-sensitive approaches when embedding national educational reform in complex school environments.

5 Chapter 5: Research Methodology

This chapter discusses the process of deciding upon the most suitable methodology to adopt for the purpose of this study. It is semi-narrative in its presentation as it describes the process of selecting qualitative mixed-method.

The main data collection instruments used are examined with consideration made as to the application of a case-based research approach. Case-based research is particularly valuable in educational research involving Service children for several reasons. Service children often face unique challenges due to the nature of military life, such as frequent relocations, parental deployments, and the emotional strain of living in a military community. Case-based research helps to explore these complexities in-depth within a situated context.

Analysis of the case-based research approach offers a nuanced, context-rich approach that is essential for understanding the unique experiences and challenges faced by Service children in education. Discussion seeks to capture the complexities of military life, the diverse educational needs of the community of children, and the role of the school in supporting them. Through its in-depth, holistic approach, readers are offered valuable insights that can support and inform the use of interventions, policy development, and best practices to improve the educational outcomes and well-being of Service children.

5.1 Introduction

Within this chapter I explain and justify my decisions regarding my research methodology. My research was undertaken in the interpretative paradigm using a qualitative methodology having conducted semi-structured interviews, recorded teachers teaching and collected work samples from pupils. I discuss the methodological considerations of drawing on social constructionism theory. I explain my data collection process and provide information on the context of where the research was undertaken. Following this, my data collection and analysis methods are discussed coupled. Ethical considerations follow, along with discussions of my positionality within the research process. Throughout the chapter I reflect on my actions and justify the processes which led to a clear methodological approach.

My research relates to Alexander First Schools' response to adopting a maths mastery. As described and explained in my literature review chapter, I chose to define maths mastery teaching according to the NCETM's definition as well as understand how teachers' policy enactment affected and were affected by their professionalism, in turn impacting their teaching of maths mastery. My research questions are:

	Research Question	What Answers This Question?
Main Research Question	What are the challenges and opportunities for teachers when using the NCETM's Five Big Ideas as an approach to mathematics teaching?	The idiosyncratic effect it has on learner engagement and practitioner's delivery of curriculum content. Interviews and video footage suggest that learners are better supported in achieving individual success and increased sense of achievement.
Sub-Question	How do teachers attempt to support transient pupils in their mathematics	Many aspects of TfM cited as distinctly 'Far Eastern' approaches can be rooted in long-standing theoretical principles.

	teaching, and how does this relate to the Five Big Ideas?	Bloom's (1968) model for learning provides significant sustenance for more recent manifestations of TfM.
Sub-Question	What are the challenges and opportunities for pupils, particularly transient pupils, when 'Teaching for Mastery' is the guiding approach to their mathematics lessons?	Interviews show teachers are aware of the potential 'seasonal vogue' nature of adopting mastery approaches. However, this is tempered by their overwhelmingly positive view of teaching and learning for pupils in their class. During interviews teachers described the benefits and improvements to teaching and learning post-TfM, with particular benefit for Service children across all ability ranges and lengths of time

I now discuss the interpretivist paradigm.

5.2 The Interpretative Paradigm

In the context of research, 'paradigm' describes a system of ideas used by researchers to generate knowledge, or as Fossey et al. (2002, p.718) describe, 'it is a set of assumptions, research strategies and criteria for rigour.' The interpretative paradigm offers the opportunity to concentrate principally on understanding and accounting for the meaning of human experiences and actions (Tesch, 1990). There is a clear connection between interpretivism and Tsang and Kwong's (2017) social constructionism theory, in which teachers form and reform understanding of the world in addition to being influenced by the time and place in which these events occur. Using the responses and interpretations offered by teachers, researchers are able to observe how experiences and beliefs have shaped their actions and views.

Fossey et al. (2002) argue, data may be interpreted in different ways with every new analysis that is undertaken. However, by drawing on the theoretical framework of policy enactment and descriptions of maths mastery, my interpretations were confined to the context of my research questions. I acknowledge Alvesson and Sköldbberg's (2009) argument that findings can only be valid within the boundaries of specific research projects and recognise this to be true of my research study.

The interpretivist paradigm permits researchers to acknowledge and greet concerns for participants' whilst still identifying their experiences. I discuss my positionality later in this chapter, however, from the outset I could relate to participants' experiences of adopting a maths mastery approach as I myself had undertaken the same journey. My current role as Headteacher and Maths coordinator means I am conscious of teachers' differing opinions towards adopting a mastery approach. Additionally, I accept that teachers' responses are relative to their personal experiences and that there can be no external representativeness of policy enactment theory for maths mastery. Therefore, as Burr (2003, p.204) states, there is no 'ultimate truth' to be discovered or one singular finding. In relation to my own research, the pursuit of a single finding would be impractical given the theoretical framework of policy enactment which would draw on the personal perspectives of teachers and so present a broader, more holistic analysis. Additionally, the response to maths mastery was anticipated to differ depending upon the pupil, e.g. Service children's experience and response was predicted to be unlike that of 'home-grown' pupils.

Consequently, I did not anticipate, nor pursue one definitive finding, rather, in using the interpretivist paradigm, I was able to draw on a wide range of responses from participants.

5.2.1.1 Epistemological and Ontological Considerations

Definitions provided by Vasilachis de Gialdino (2009) of epistemology relate to how knowledge is identified, i.e. the creation of knowledge from research. An interpretivist epistemology provides understanding of human behaviour and actions. In combining interpretivist epistemology with social constructionism theory, I was able to co-construct my knowledge and understanding alongside my participants. As they reflected on their experiences around maths mastery and created an understanding of this, so did I (Kvale, 1996). A view supported by Katz (2002, p.257) who states, 'there is a relationship between a discipline's attitude toward theory and the respect it pays to the materials it studies.' Consequently, knowledge of teachers' experiences is socially constructed.

According to Katz (2002), identification of ontology at the start of the research process is critically important as it determines the choice of the research design. An ontological position stems from an individual's perspective of the social composition of the world around them. Bryman (2012) suggests there being two contrasting ontological stances, objective in which knowledge exists externally, or constructive in which knowledge is created in social interactions. My ontological stance is that of the latter, with knowledge constructed from the varying perspectives and responses of participants related to policy enactment.

Both my epistemological and ontological stances drew on social constructionism. In talking with teachers (participants) and reflecting upon observed teaching, I was able to understand their experiences and co-construct their understanding (epistemology). I gained insight into experiences by co-constructing their perspectives of their reality (ontology). Given this, I was able to articulate and present the teachers' responses, their professionalism and the range of ways policy is enacted around them.

5.3 Case-based Research

5.3.1.1 *Research methodology and Values: A personal perspective*

When selecting suitable research methods, it has been necessary to consider my personal values in relation to the context in which research has been carried out. This research stems from a personal belief that every learner possesses the ability to develop their depth of understanding, achieve a sense of personal achievement and in doing so, increase the perception of their ability.

I approach this research having observed the, sometimes negative, effects that largely instrumental teaching can have on pupils, particularly at the start of their learning.

The positivist notion of the researcher being entirely detached from the research results (Pring 2000 p47) cannot be readily applied to this research.

5.3.1.2 *Insider Research*

The question of the insider research must be addressed at this point. Earlier in this thesis it is already established that this study is not entirely free from bias, as I do harbour a belief that education can be a pathway to increasing social mobility, self-esteem and give rise to Communities of Practice (CoP). This study, however, is aiming to ascertain exactly how the NCETM's interpretation of Teaching for Mastery (TfM) effects teaching and learning and, should that hypothesis be the case, why such an approach is paying dividends? Blaxter et al. (1996, p.14) use the heading of 'Truth, power and values' to frame the

following thoughts around research often being less than objective, suggesting it is a 'social activity powerfully affected by the researcher's own motivation and values. It also takes place within a broader social context, within which politics and power relations influence what research is undertaken, how it is carried out, and whether and how it is reported and acted upon.' (Blaxter et al., 1996. p14)

Part of my research is designed to consider how Service children's learning in particular is affected by decision-making related to curriculum design, pedagogical approaches and teacher attitudes. Partly this is to encourage practitioners to take part in their own research and further understand their learners. Partly it is to challenge my own understanding of teaching and learning, in the ever-changing search for the best way to meet the evolving requirements of learners, this is especially the case as I am not only the Maths subject coordinator, but also the Headteacher. Consequently, the insider/researcher has validity and credibility that may actually exceed that of the purely objective, apathetic observer but this should not preclude the credible researcher being aware of their influence and how to engineer their analysis accordingly.

Again, Blaxter et al. (1996, p.198) summarise this succinctly:

'At the same time as recognising and asserting your own perspective on your data and analysis, it is important not to get too embedded and bound up in this view... stand back for a time and attempt to view your research from the more dispassionate perspective of an outsider.'

Whilst this can be easily stated, it can be far harder to achieve in reality.

One of the aims of the study is to define the NCETM's 'Five Big Ideas' and the broader theoretical underpinning to each concept. It has been necessary to consider legitimate concerns regarding the NCETM's definition of suggested Far Eastern practices giving rise to the notion of a 'new' way of teaching and learning. Consequently, such cautionary considerations and made within this study with the goal of improving our evolving mastery pedagogical approach. To quote Winston Churchill (1939), "Criticism may not be agreeable, but it is necessary. It fulfils the same function as pain in the human body. It calls attention to an unhealthy state of things." Academic research focused on Service children is both lacking and often insufficient in challenging commonly held principles of learning regarding a pupil population which is extremely nuanced. Such an oversight should command attention.

Having established the bias, personal agenda and limitations of this research; clarity may provide the basis from which to establish the essence of the study.

5.4 The Choice of Research Methodology

Both Noor (2008) and Morgan and Smircich (1980) argue methodology is intrinsically linked to the research problem and as such, research methods are derived from the social phenomena under investigation. They state the two basic methodological practices in social science research involve positivism and post-positivism (phenomenology).

Positivism is described as the formation of knowledge through an emphasis on natural science: researchers assume an objective position, curating facts and information from the social world around them, forming an understanding by linking facts and causality (Finch, 1986). By comparison, post-positivism is 'a reality which is socially constructed rather than objectively determined' (Noor, 2008, p. 1602). Consequently, the role of the researcher is not to gather evidence or measure patterns, rather, focus upon the varying understanding and meaning attributed by participants (Easterby-Smith et al.,

1991). Subsequently, Noor (2008) attributes quantitative analysis with positivism, owing to its roots in natural science, and a qualitative analysis with post-positivism based upon the pursuit of understanding social events. Furthermore, both Denzin and Lincoln (1994) and Merriam (1988) suggest qualitative analysis provides the opportunity for researchers to focus on intuition, opinion and discovery rather than testing a dogmatic hypothesis. According to Mingers (2001) mixed method research, in which qualitative and quantitative methods are applied, is being increasingly popular with researchers. However, I felt that the application of the mixed methodology in one study would prove too difficult to manage effectively, especially where various approaches would be applied concurrently.

5.4.1 Case-based Research vs Case Study Research

Edwards (1998, p.1) describes case-based as ‘a phenomenon of interest’ which is ‘systematically examined with a view to achieving an understanding and developing or extending a theoretical framework.’

Kiesler (1981), Kratochwill et al. (1984) and Shapiro (1966) describe case study research as that which from the outset, seeks to answer a specific question by gathering data in a systematic manner in order to answer a predetermined question. Consequently, deductions drawn refer back to the manner in which conclusions were drawn. Similarly, Hilliard (1993) uses the term case study where the data is in the form of a narrative and methods of analysis are qualitative. However, Glaser and Strauss (1967) distinguish between discovering theory and testing theory. According to Edwards (1998), case-based research uses a case narrative in conjunction with repeated quantitative measures, allowing the application of multiple strategies to investigate and test a hypothesis (Edwards et al., 2003). They argue it is not intended to be replicated with exact precision as context draws out previously unrecognised phenomena as well as determining the application of strategies. A view supported by Stuart et al. (2002, p.420) and Gubrium (1988, p.420) who state, ‘case-based research represents the intersection of theory, structures and events’ with context integral to knowledge formation.

Given the context-driven nature of case-based research, Schein (1987) argues that only through this methodology approach are researchers truly able to examine, explore and understand atypical events and phenomena. Yin (1989a) goes further in stating that case studies are of great value when research questions focus on the ‘why’ of situations, with case-based research essential where there is no control over behavioral actions and when the focus is on contemporary events. According to Stuart et al. (2002, p.421) without case-based research ‘we would have a weak and limited understanding of the body of knowledge as a whole and the conditions under which the theories are applicable.’ False assumptions would grow where relationships and causality fail to be examined, or as Stuart et al. (2002, p.421) state, the ‘evidentiary chain’ would be lost. Observations drawn on case-based methodology are ‘often more powerful at indicating causal, predictive relationships than many other forms of empirical research’ (Stuart et al., 2002, p.421). Subsequently, even when the conceptual framework of case-based methodology is defined, replication remains elusive as the contextual observations and responses remain staggering. All distinguishing factors of the research setting are inherently drawn into the ‘evidentiary chain’.

Whilst other Service schools exist, the unique composite of Alexander First School (e.g. the regiments it serves, the specific geographical location, the social demography of the pupils and staff composite) is integral to exploring the ‘why’, yet all of these contingent conditions are difficult to capture and define. This is especially the case when coupled with newly established definitions of maths mastery. All of these factors - paucity of theory, complexity and lack of well-supported definitions - favour the use of case-

based research. A view supported by Stuart et al. (2002, p.421) who argues, that as long as complexity remains a part of the environment being studied, 'methods that allow the knowledgeable researcher to observe and accurately assess the impacts of those contexts are likely to be needed.' Thus, it is clear that 'case studies remain one of the best ways to make sure that researchers are making valid observations and contributions to the body of knowledge.'

5.4.2 Types of Case-Based Research

Defining the case study is a complex undertaking. According to Nunan (1992, p.74) methodologically speaking, the case study is 'a hybrid' involving an assortment of methods for collecting and analysing data, as opposed to a single process. Loboeki (2006) supports this view in stating the case study is not a distinct method, rather a tactic comprised of multi-method approaches.

As previously discussed, my data collection tools were broad and varied including:

- Recorded observational data
- Field notes
- Semi-structured interviews
- Work samples

In this regard, it is clear to see how Nunan's (1992) definition of case study methodology is applied.

Both Kiliańska-Przybyło (2011) and Child (2007) offer 3 distinct types of case study:

- Exploratory - those used as pilot studies for larger projects
- Descriptive - those providing narrative accounts of a particular case
- Explanatory - those attempting to test hypotheses or theories using a single person or homogeneous group

Furthermore, Cohen et al. (2006) provide three distinct characterisations of case study as:

- Those undertaken to understand a case/situation in questions (intrinsic case studies)
- Those confronting a particular theory or issue beyond that which is immediately obvious or apparent (instrumental case studies)
- Multiple studies forged together to gain a broader understanding (collective case study)

Clearly, there are wide ranging definitions and reasons for undertaking a case study methodology. My methodological approach was one of both intrinsic and explanatory case study; I sought to understand the impact of a specific teaching and learning approach (maths mastery) on pupils and practitioners, carefully considering the context of the school and its unique characteristics (e.g. high mobility, Service pupils arriving with varying curriculum coverage/experience etc.). Given the intrinsic focus on context, case study methodology is the most efficient way to explore and report such matters, a view supported by Yin (1989).

Yin (1989) offers further definitions, proposing a case as the analysis of an event, individual or occasion, whilst Kolodner (1997), focuses on its use for deriving theories related to context. In any case study undertaking, Noor (2008) argues the empirical inquisition of the method, with a clear focus on real-world situations which reveal multifaceted evidential findings on a particular phenomenon, rather than a topic

in its entirety. Anderson (1993) supports this in stating any case study method focuses on the how and why of events, allowing context to permeate through investigation.

All research begins by probing existing theory. Definitions of maths mastery (see chapter 2) had been described and defined early-on, however, it was case study methodology which gave credence to tangible enactments of maths mastery (these are discussed in my data analysis chapter). Probing a particular problem or topic in this way is particularly beneficial when, according to Noor (2008, p.1602), 'one needs to understand some particular problem or situation in great-depth, and where one can identify cases rich in information'. Additionally, Kolodner (1997, p.57) attributes the processes of 'encoding, retrieval, and adaptation' offering an in-depth insight into educational philosophy and practice. A view supported by Brown (1988) who states, the knowledge gained through active engagement provides a deeper, more useable knowledge than that gained through prescriptive research approaches.

As previously stated, my case study focused singularly on my school as the effect of context was central to my research. Nunan (1992) promotes the merits of single case study, in describing it as a special type of case study. Single case study integrates case study methods with experimental research 'as some intervention takes place' (Kiliańska-Przybyło, 2011, p.164). However, the noticeable difference in single case study method is attributed to the fact no experimental or control groups are involved. Instead, the behaviour and responses of subjects are measured at various points in time. Consequently, Yin (2004) claims single case study methodology is most effective when employed in education settings as it provides the most effective way in which examining the impact of educational approaches or practices, focusing on the how and why. A view supported by Tellis (1997, p.169) who argues case study research is most effective when employed for 'holistic, in-depth investigation'. Additionally, Noor (2008) argues that single case study in education recognises and accepts the complexity, individuality and unpredictability of education and pupils - the research participants. I believe strong connections can be drawn between definitions and recommendations for single case study research and my research undertaking.

5.4.2.1.1 Case Study Data Collection

Walliman (2001, p.228) argues case study data collection typically focus on qualitative rather than quantitative approaches as the pursuit of understanding how and why is under examination. Consequently, data collection tools which allow participants to convey their thoughts, opinions and values provide the insight sought by researchers. Subsequently, Child (2007) states data collection tools such as interview, questionnaire, observational and documentary evidence are the most resourceful. Owing to this, I employed multiple data collection tools which provided insight into the sentiments and viewpoints of participants.

Pupil work samples offered insight into children's responses to teaching approaches and curriculum design, whilst semi-structured interviews enabled adult practitioners to share their unique perspectives and opinions with the freedom to diverge into areas/topics of importance as they emerged. Video recordings of curriculum delivery and pupil participation was an invaluable qualitative data source. The importance of multifaceted qualitative data is attested by various commentators including Stake (1995) Yin (1994) and Tellis (1997), who argue no one method yields complete advantage, rather, various approaches need to be applied concurrently. A view supported by, Flyvbjerg (2005) who argues that quantitative data is limited in the depth of analysis obtained, whereas 'with the case study, the situation is completely diverse' (Kiliańska-Przybyło, 2011, p.166). I believe the versatility of my data collection offered both supporting and alternative interpretations (Adelman et al., 1976).

Through case study methodology I was not only offered the perspective of individual participants, but an opportunity to evaluate 'relevant groups of actors and the interaction between them' (Kiliańska-Przybyło, 2011, p.169). Kiliańska-Przybyło (2011, p.169) describes this as a 'salient point in the characteristics that case studies possess' essentially offering a 'voice to the powerless and voiceless.' Service children's response to learning, particularly maths mastery, is a significantly under-researched topic (De Pedro et al., 2011). Clearly, my employment of single case study research provided a voice to the underrepresented, a view supported by Nunan (1992) who contends the benefit of case study methodology, aside from identifying and probing the behaviour/nature of the problem, provides a wider environmental and cultural perspective and reflection.

Adelman et al. (1976) suggests that context focused methodology is a greater motivator to practitioners (teachers, school leaders, support staff etc.) as findings are rooted in reality. Consequently, changes to systems and practices are more likely to be adopted when arising from real-life, relatable situations. Cohen et al. (2006, p.277) describe this opportunity to 'step into action'. Reflective action was an anticipated outcome of my research project as I had overseen the implementation of the maths mastery approach and was keen to assess its impact.

This methodological approach clearly yields immense benefits for school leaders seeking to better understand the 'why' within a given context. Although the context of my research could not be duplicated for wider application, the theoretical framework of policy enactment coupled with living definitions of maths mastery provided much commentary on the 'why' of pupils' responses. Arguably, this is of great use to school leaders in establishing the links between policy, action and outcome.

Additionally, case study research is presented in a style and manner easily accessible and 'immediately intelligible' (Kiliańska-Przybyło, 2011, p.170). Furthermore, the broadest scope of audiences can be reached, a consideration I had carefully considered. Accessibility for parents/carers and school governors was of the greatest importance when selecting and applying my methodology. I wanted to ensure I would be able to communicate my actions and findings in a way which could be easily understood and processed by key stakeholders in the school, or as Widdowson (2011, p.26) describes, provide the 'reader with a clear sense of the person...and of the outcome(s).'

5.4.2.1.1.1 Limitations of Case Study Research

Confidentiality is a unique challenge of case study research. Large amounts of details regarding context and participant backgrounds impact anonymity. The challenge is for researchers to adequately conceal aspects without eclipsing pertinent details. I attempted to address this in a number of ways, such as attributing pseudonyms which best reflected the ethnicity and age of participants as well as broadly describing the school's location and context whilst omitting identifiable markers (such as name, local authority, governance etc.). Additionally, I sought high levels of ethical consideration by inviting adult participants to review interview transcripts as well as view recorded teaching videos. In doing so, participants were able to request amendments to transcripts as well as provide their own personal insight into their actions and events. This ensured not only ongoing consent, but continued anonymity.

Whilst there are clear and worthy benefits of case study methodology, criticism is drawn from the contradiction between 'context of discovery' (Giorgi, 1986, p.52) and 'context of verification'. 'Context of discovery' adopts methods which generate ideas and knowledge providing an initial understanding of the phenomenon, whilst 'context of verification' describes the use of studies to examine dependent and independent variables or transferability (Edwards et al. 2003). Case-based research clearly yields strong

value in the discovery phase, such as lived definitions of maths mastery and policy enactment. However, both Kazdin (1981) and Kiesler (1981) argue the limited generalisability and duplication of case-based research is a significant drawback. A view supported by Giddens (1984, p.81) who describes case study methodology as 'microscopic' given that it lacks 'a sufficient number of cases'.

However, the reduction to these terms significantly distorts the immense value of case-based research, which according to Campbell (2004), yields immense insight in hypothesis testing and theoretical development. Additionally, Moras et al. (1993) argues that the value of case-based research is drawn from the observational findings, not the generalisability. In the case of my research study, my data findings (see chapter 5) offer significant insight into definitions of maths mastery, pupil and teacher responses to these definitions and consequent reasons for this. Whilst the context is uniquely specific, the underlying logic through which knowledge is formed is of great value and importance. A view supported by Hilliard (1993) who identifies two distinct validity measures of case-based research beyond replication. Firstly, Hilliard (1993) cites intrasubject over intersubject variation. Case-based research by its very nature is context rich, observing details as they unfold (Jones, 1993). For example, observations of fluency (a central component of maths mastery) were clearly related to a series of small changes in practitioners' pedagogical style (see data analysis chapter). In turn, these changes were a response to specific circumstances, such as an NQT being mentored by the Maths coordinator, a teacher responding to the arrival of Service children from a different local authority etc. Clearly, these events cannot be examined by means of cross-sectional group comparisons.

Additionally, Hilliard (1993) argues in case-based research generalisation is not based on aggregation across cases like that of statistical analysis, rather, replication case-by-case. Stiles (2003) supports this in stating that whilst solitary descriptive statements stemming from a single case study cannot be confidently generalised, when a greater number of observations from cases correspond with theoretical findings, the resulting evidence is on par with that of statistical hypothesis testing (Edwards et al. 2003).

Miles and Huberman (1994) offer further commentary on validation processes in case-based research by describing the process of theory building. They suggest the ability to decipher the processes undertaken in cases, followed by comparing and contrasting such processes yields immediate practical application owing to the focus on phenomena as opposed to replication. 'In this way, a theoretical structure of distinctions, principles, and hypotheses is formulated and progressively refined to account for the whole range of phenomena observed in all cases (Edwards et al., 2003, p.592).' Tellis (1997, p.5) supports this in stating 'the three tenets of qualitative methodology: describing, understanding, and explaining' offer the scope for broader generalisations.

According to Tellis (1997, p.5) 'generalisation of results, from either single or multiple designs, is made to theory and not to populations.' In the context of my research, outcomes are drawn from definitions and responses to Maths mastery,

Hamel et al. (1993) goes further to describe the focus on global aspects within the confines of the local when undertaking case study research. From the outset, small-scale localised matters draw on broader, wider perspectives in mind. When selecting my adult participants, I ensured there was a broad and balanced cross-section of backgrounds and experience as shown:

<u>Experience</u>	<u>Qualification</u>	<u>Graded teaching</u>	<u>PM Target met or not met</u>
- Taught only one year group	- PGCE	- Outstanding	- Met
- Taught across a Key Stage	- BA degree	- Good	- Not met
- Taught across two Key Stages	- Masters or higher	- Requires Improvement	
- Taught across multiple Key Stages (EYFS, KS1, KS2)			

As was the case when selected my pupil sample. I selected books from:

- Service children who had attended the school from more than two years
- Service children who had attended the school for less than one year
- Non-Service children who were not impacted by mobility
- Pupils working below age related expectations
- Pupils working at age related expectations
- Pupils working above age related expectations

As with all research, research participants in case study methodology must be allowed the freedom to withdraw at point following informed consent. According to Noor (2008) this can be elevated by seeking on-going consent as opposed to a one-time acknowledgement. In my own research, parents and carers were offered the opportunity to withdraw their child from the study at any point as well as meet with me (lead researcher) to address any concerns or issues as the study progressed. Additionally, teachers were offered the same freedoms and discussions regarding observations were prefaced with discussions on continued consent and willingness to participate.

A common worry in case study methodology lies in how the research process and writing of the study will encroach upon the theory process. According to Widdowson (2011) it is inevitable that case studies will be influenced by the research process. Berne (1961, p.41) supports this in stating case study researchers must answer to 'How has the research process influenced this case?' rather than 'Did the research process influence this case?' I believe I have addressed the 'How?' in various sections of my methodology chapter as well as in the data analysis.

5.5 Capturing Learner Data

It can be difficult to capture learner data from young people without direct engagement. Whilst I set out with the desire to passively observe without involvement during data collection, the reality of my relationship with pupils meant this was not feasible. I was known to the pupils as the Headteacher but also as a teacher having covered classes in various year groups. Scott and Usher (1996) provide insight and discussion regarding subjective influence in research. They propose that research as a scientific process may not be best served by attempting to remove all subjective influence in favour of a completely detached and neutral review of the research matter. In fact, they state, it is 'impossible to adopt the orthodox stance of complete neutrality and impartiality.' (Scott and Usher, 1996, p.9). Consequently, many pupil responses arose from a desire to share their actions, thoughts or opinions either to me or for my acknowledgment.

Arguably, the data which provides the greatest value is that which is collected in the context of what is happening at the time. Reactions to scenarios, peer-to-peer comments and even outbursts of frustration or confusion are often the most informative and insightful. Consequently, it is important recognise that these interactions are those which inform learners experience. Additionally, in considering the 'Five Big Ideas', the aspect of mathematical thinking cannot be capture without the involvement of the learner.

Given the nature of Service children's transition between schools, Alexander First teachers often accept the past learning experiences, be that positive or negative, of pupils will be a feature in their learning before they can be replaced with new, more positive ones. The cultural context of the school is key to this. Creating a climate in which not knowing how to do something is viewed as an opportunity to learn rather than a reason to fail, creates a distinct landscape which is equally valuable in describing and

5.6 Pilot Study

Connelly (2008, p.411) describes a pilot study as a 'prelude to a larger scale study'. I used the pilot study to not only confirm methods and procedures, but to guide my future study in anticipating potential problems or difficulties; an approach advocated by both Polit and Hungler (2003) as well as Jairath, Hogerney and Parsons (2000).

During the pilot study I had attempted to document observed teaching using my data collection sheet (see appendix 1). My observational cues were drawn from my initial literature review of definitions of Maths mastery. These were not specific characteristics of mastery approaches rather, theoretical definitions of mastery teaching and its origin. This created the challenge of deciding inclusion and exclusion markers for observations. Consequently, I created a tick-list of features to be identified in lessons (see appendix 2) however; this initial design significantly limited my data collection to aspects of mastery teaching whilst omitting other valued aspects linked to mastery teaching. For example, my pilot study data collection sheet focused primarily on teaching (e.g. lesson design, classroom practice etc.) and left little room for data collection in relation to systems in place to facilitate Maths mastery (such as assessment, prior knowledge, connected learning). This demonstrated the adequacy of my initial data collection instrument and thus providing the opportunity to make necessary adaptations. Consequently, in my redesign I was able to draw on the NCETM's Big Idea in mastery which provided not only a theoretical base, but practical direction as well.

Additionally, I had intended on documenting my observations without the use of video recording equipment as I felt that the presence of recording equipment would alter the way in which participants conducted themselves. Wickström and Bendix (2000) describe The Hawthorne effect as a reactive response from participants in modifying aspects of their behavior in response to being observed. I felt the atypical placing of cameras in the classroom could potentially reduce the validity of data gained. Additionally, as Asan and Montague (2014, p.165) state, participation in research projects may be reduced when introducing recording devices instead of live observation, as people may feel there is more risk to them professionally. Recordings can be viewed by 'multiple people over time' with reduced anonymity. However, Brewer (2000) opposes this since video data provides a complete (and visual) record rather than observers' notes. As Headteacher, whilst I am very experienced in carrying out observations in busy classroom settings, during the pilot study it became apparent that the level of detail needed for the data collection, particularly when components occur simultaneously, could not be recorded through my original method alone. I met with each participant following three consecutive Maths lessons and shared my initial difficulties in documenting observations through written methods alone and suggested the use

of video devices (iPads). All participants agreed and were offered their full informed consent to be recorded in subsequent data collection activities. These amendments were then made to my ethics application.

5.7 Data Collection

Qualitative research provides the means by which to understand the experiences of participants within the context of their natural environment and activities, whilst recognising the numerous realities which exist (Newby, 2014). Given this, the data is rich in description and details providing a narrative to the experiences of participants (Vasilachis de Gialdino, 2009). Consequently, using qualitative methodology complements social constructionism in that we 'gain insights into people's [participant's] feelings and thoughts' (Sutton and Austin, 2015, p.226).

Qualitative research is grounded in the interpretivist model (Newby, 2014) prompting participants to actively interpret, reflect up and review their experiences and in doing so, construct understanding of the world (Bryman, 2016). Through conversation researchers are able to begin the process of gaining greater understanding of these experiences.

Kallio et al. (2016) suggest semi-structured interviews provide the opportunity to pursue themes emerging from data. During the interview process researchers are immersed in participants' social settings and environment, through which ideas and co-created understanding is formed. Researchers are presented with the unique opportunity to adjust and fine-tune questions based upon responses as conversation develops.

Cohen, Manion and Morrison (2018) argue a limitation of qualitative research, and something I myself experienced, is that a large amount of data is gathered. In addition to the semi-structured interviews I also collected observational recordings. According to Gross (1991, p.658) 'videotaping observational data has become an efficient and widely used method for recording behavior for scientific measurement'. However, one needs to be selective in what data is chosen for analysis. I took steps to mitigate this such as omitting analysis of facial expressions, body language and change of tone in voice, contrary to Miles and Huberman's (1994) suggestion of their contributing knowledge. As an alternative, I choose to analyse and present teachers' verbatim responses in semi-structured interviews and draw meaning from this. Additionally, in my analysis of recorded teaching footage, I chose to draw on the work of Gross (1991) as well as Cotton, Stokes and Cotton (2010) as a means by which to analyse recorded data (see data analysis chapter).

5.8 Data Collection Tools

5.8.1 *Recorded observational data*

According to Pretzlik (1994) observational research is used in two distinct ways- structured and unstructured. In structured observations, discrete activity is undertaken during which the researcher records physical and verbal behaviour using a predetermined observation schedule based upon categories drawn from known theory. Conversely, unstructured observation do not follow the approach of rigorously checking a list of predetermined behaviours; instead, Mulhall (2003, p.307) states, observers 'usually enter 'the field' with no predetermined notions as to the discrete behaviours that they might observe.' Further differences between structured and unstructured observations stem from the observers position. In structured observations researchers attempt to remain objective and not interfere with the data nor allow their preconceptions to feature in the data collection process. On the other hand, unstructured

observations give rise to the beliefs and views of the researcher and recognise the impossibility of separating researcher from research (Mulhall, 2003). As previously stated, given my position within the school as Headteacher and Maths coordinator, I could not fully remove myself from the research. During the pilot study it became obvious pupils would want to speak and interact with me, showing their work, directing answers towards me, seeking praise and encouragement. Equally, some teachers chose to narrate or contextualise their actions or events as they arose in lessons. For these reasons I undertook an unstructured observational approach.

According to Cotton, Stokes and Cotton (2010, p.463), observational data provides ‘a far more direct route to obtain information about their [participants’] behaviour’ and ‘may provide a deeper insight into their experience’ as well as ‘enhancing accuracy’ of findings. However, they go on to argue that within the context of observational collection, the researcher must attempt to ‘make the familiar strange’ (Cotton, Stokes and Cotton (2010, p.464). That is, to reduce the familiarity of being in a known setting; this was particularly pertinent for me as I conducted research in my school setting. Given my inability to completely remove myself from the situation, I decided to assume a ‘participant role’ in which I would be a part of the situation under study (Cotton, Stokes and Cotton, 2010). Silverman (1993, p.42) supports this in arguing, ‘unfortunately, we have all become a little reluctant to use our eyes as well as our ears during observational work.’

In analysing my observations, I had originally considered adopting Flanders Interaction Analysis Categories (FIAC) (Flanders, 1970) as a means by which to code events. However, my motivation for having selected unstructured observational techniques was to see first-hand the types of interactions and approaches to Maths mastery being undertaken in classrooms and felt many observed behaviours and interactions would be omitted from analysis in using this structured coding system. Instead, I decided to apply the NCETM’s definition of Maths mastery to code and decipher observations. According to both Silverman (1993) and Mulhall (2003), structured coding instruments can often precede less structured observational approaches and consequently felt this offered high levels of reliability and validity.

I chose to collect observations occurring in real-time, in a natural situation rather than according to a pre-ordained set of responses (e.g. teacher directs pupils, asks questions, responds to pupils, pupil responds to teacher, silent pauses etc.). Additionally, it was essential to carefully consider the effect of negative evaluation of participants most valued asset, their teaching, especially were this to become more widely known. Consequently, I chose to focus on features of Maths mastery as opposed to teaching standards or graded observational frameworks and made this clear to participants from the outset.

I attempted to mitigate the intrusive nature (Gross, 1991) of observational recording by placing the recording devices (iPads) in subtle positions within the classroom. Their inconspicuous positioning limited the attention drawn to their presence. That being said, Gross (1991, p. 659) argues the very presence and use of recording devices ‘robs subjects of their anonymity’ and that ‘it is difficult for them to not care about how others perceive them’. In addressing this, I undertook clear steps such as ensuring informed consent was gained, participation in the research was on a voluntary-basis and that non-participation will not affect participants’ professional status in anyway. Indeed, there was one teacher who elected not to participate and consequently does not feature in the research project (the impact of this being the scope of the research limited to Years 1 to 4).

Additionally, when making recordings it is harder to anonymise data and so my response was to ensure tight control over access to such data. I drew upon the guidance in on research ethics, BERA: British Educational Research Association (2004) to achieve this.

According to Cotton, Stokes and Cotton (2010, p.465), these numerous actions would ensure my observational data would 'be less influenced by the researcher's own agenda and will be (at least in the raw form) relatively free from bias.' Furthermore, I chose to adopt Bloom's (1953) approach of 'stimulated recall' as a means by which to combine observations with interviews. By using recorded footage as prompt or stimulus for discussion, I was provided with the participants' own interpretation rather than a presumed understanding. I believe that use of observed data coupled with semi-structured interviews provided greater validity to my analysis and subsequent findings.

5.8.2 Semi-Structured Interviews

Carter et al. (2014) describes the interview research tool as, 'the most powerful tools for gaining an understanding of human beings and exploring topics in depth' whether that be structured or unstructured interviews. I selected semi-structured interviews as it allowed for spontaneity, flexibility, and responsiveness to individuals (Barriball and While, 1994). Additionally, within my standardised interview scheduled I would be afforded the opportunity to take into consideration the varied educational experiences and personal backgrounds of participants. Follow-up questions could be tailored to their unique circumstances.

I selected interview questions to explore certain topics, such as the introduction of a Maths mastery approach, the strategies undertaken to achieve this, as well as its perceived benefits for highly transient Service children. In selecting and compiling the interview questions I reflected upon the actions and changes I myself had undertaken as Maths coordinator. Burr (2003) refers to this process as one in which researchers' own assumptions will be evident in the questions asked, or as Rowley (2012, p.263) describes, 'the origin of the research question influences the choice of interview question.' I concede that such assumptions were present as the complete removal of one's view and position would be impossible (Burr, 2003).

According to Swauger (2011, p.499) 'qualitative research requires researchers to develop relationships with participants' as a consequence of the hierarchical nature between researcher and participant. According to Alexander (2010) participants often feel privileged to have been asked to participate and share their stories and experiences and so a power dynamic exist between the interviewer and the participants. However, Bosk and DeVries (2004) argues the use of an informal interview process can assist in alleviating such potential issues of power. I reminded participants that I too had undertaken a journey in adopting a Maths mastery approach, so creating a shared, positive experience. Ramcharan and Cutcliffe (2001, p.363) describe this action as 'ethics of care', a view supported by Munford et al. (2008). However, I accept that I still set the agenda and directed the conversation through pre-selected questions and pursued information relevant to me research. Although Smith et al. (1995, p.20) challenge this in stating that in the semi-structured interview process, 'the respondent can be perceived as the expert on the subject and should therefore be allowed maximum opportunity to tell his or her own story.'

The conversational approach I undertook during the interview process allowed participants to share and discuss their experiences in general terms. In the proceeding chapters I will provide the interview questions which proceeded participants' responses. Certain topics such as implementation and context

were introduced through my questions. My interview questions (see appendix 3) were designed to focus definitions of Maths mastery, participants' (teachers') experience of delivering a Maths mastery curriculum and the perceived benefits for their pupil cohort.

Secondary questions were asked in accordance to participant's response and my need to explore further. In doing so I adopted the strategies and guidance advocated by both Smith et al. (1995) and Kvale and Brinkmann (2009) to guide my practice. I asked secondary questions to enable participants to expand upon their initial response or where a too brief an explanation had been provided. Additionally, when sharing video footage, I asked questions which would help to clarify my own understanding or interpretation. For example, when interviewing Poppy (pseudonym explained in the data analysis chapter) I had asked the initial question 'how much do you direct student learning in Maths?' to which Poppy responded, "...so I tend to give them the options..." It was these "options" I wanted to discuss and so I then shared a video clip with her and subsequently asked her to expand upon what she was watching in relation to the original question and her reference to "options". Cohen, Manion and Morrison (2018) advocate this approach as means to establish ambiguous understanding.

My questions were linked to the NCTEM's Five Big Ideas in Teaching for Mastery using the insight from my literature review and emerging definitions of Maths mastery. For each Big Idea I considered the conceptual aim as intended, and used this to inform question design as follows:

- Coherence emphasises the importance of teaching mathematics in a connected and structured way, where each new concept builds on previous learning. Small, incremental steps are introduced logically to develop deep understanding, allowing pupils to see how different mathematical ideas interrelate. Coherence ensures that learning is not fragmented, and students build a solid foundation that supports more complex concepts.

Questions to explore coherence were based around the theme of building connected knowledge.

- Representation and structure focus on using multiple representations (such as objects, pictures, and symbols) to reveal the underlying structures in mathematics. The Concrete-Pictorial-Abstract (CPA) approach is central to this, helping pupils move from tangible experiences (e.g., using physical objects) to abstract thinking (e.g., manipulating numbers and symbols).

Questions to understand representation and structure drew on themes of visual and conceptual understanding.

- Mathematical thinking refers to the process of questioning, reasoning, and making connections between ideas. It involves pupils developing the ability to think logically, justify their reasoning, and explore different ways of solving problems.

Questions to understand mathematical thinking we designed to promote discussion about exploration and reasoning.

- In TfM, fluency is about developing the ability to recall mathematical facts quickly and accurately, as well as the capacity to apply procedures flexibly and efficiently. However, fluency goes beyond just memorisation; it involves a deep understanding of the underlying principles that enable pupils to apply knowledge to different situations.

Questions to define fluency explored the theme of efficiency and flexibility in problem-solving.

- The NCETM advocates two types of variation in the teaching process: conceptual variation (presenting different representations of the same concept) and procedural variation (using different approaches to the same problem). This allows pupils to understand the depth and breadth of mathematical concepts and how they can be applied in different contexts.

Questions to understand the implementation of variation were designed to explore and understand what, if any, diverse approaches to deepen understanding were implemented.

Having considered the theoretical underpinning for questions based on the Five Big Ideas, I then attributed questions to topic areas:

- teaching strategies
- attitudes to mathematics
- cognition development
- classroom climate
- memorisation/fluency
- application of knowledge
- variation theory
- Army cohort
- pure and applied mathematics
- informed practice

Again, these topic areas were based on findings from the literature review. In particular, I drew on the work of McLeod (1994, p.643) who provides much insight into establishing research on affect and its links to on teaching in mathematics. He states, ‘the research community is still struggling to build a suitable framework for the study of beliefs and attitudes related to mathematics learning’, suggesting much mathematical research has focused primarily on methodology rather than theory (such as TfM). Using his cautionary perspective on mathematical research design, I carefully considered the questions to be used so that there was scope to probe and analyse the social organisation of the school as well as the specifics of teaching and learning; this is cited as central to understanding equity and diversity issues in mathematics education (McLeod, 1994).

Additionally, attributing topic areas in this way forced me to think explicitly about what I wanted to cover and more specifically, the difficulties I might have encountered, for example in terms of wording or my positionality. Having considered in advance the topic areas to be covered, I felt more able to concentrate thoroughly on what participants were saying and prompting them to open-up and talk in depth.

My purpose for employing semi-structured interviews had been to explore participants' on-going self-story. Given this, I employed Kvale and Brinkmann's (2009) guidance on allowing participants access to questions prior to the interview process. I offered all participants copies of the interview questions beforehand, however only one teacher looked at the questions beforehand with others explaining they felt happy and confident in answering questions on the day. Either way, teachers did not appear to be overly prepared or ill-equipped.

5.8.3 Work Samples

According to Callinan and Robertson (2000, p.248) work sample methodology offers 'higher predictive validity.' The use of work samples in my research aimed to explore teachers' (participants') ability to make instructional decisions regarding Maths mastery. Both Shavelson and Stern (1981) and Stiggins et al. (1992) support this in describing how teachers make a range of instructional decisions prior to, during and after teaching. In relation to Maths mastery and the NCETM's description, decisions during teaching might focus on whether students were demonstrating procedural fluency or number facts. Whilst judgements made after teaching through marking and the review of pupils' work, may determine whether conceptual variation (same idea, different problem) would be needed to move pupils' learning on. Whilst I agree with Bernstein-Colton and Sparks-Langer's (1993) argument that teachers' decisions and adjustments are influenced by the classroom context, I believed that work samples would provide an important insight into how and why certain aspects of policy is enacted.

I referred to Kohler, Henning and Usma-Wilches' (2008) research on work sampling to guide my practice in this methodological approach. I will now outline my approach and justification for its use in my research.

Callinan and Robertson (2000, p.249) state 'a work sample needs to be individually developed and validated,' meaning criterions are relevant to participants and the research study. Consequently, I referred to the NCETM's definition of Maths mastery when identifying aspects of mastery in work samples. This remained the definition used for the duration of my study and across all aspects of analysis (interview, video analysis). Furthermore, this definition could be steadily applied across all year groups ensuring further consistency. However, Schmidt and Hunter (1998) argue that work samples focus on performance-related factors and are unconnected to overall intellect so are most effective when used in union with additional research methods. In combining work sample, interview and recorded teaching, I believe I was able to combat such bias.

According to Kohler, Henning and Usma-Wilches' (2008, p.2108) work samples 'provide a framework for understanding how teachers modify or adjust their teaching in accordance with students' ongoing learning and performance.' I used the opportunity to discuss teachers' responses to pupils work and how it informed their subsequent practice. As a teacher myself, I recognised that participants (teachers) would be interpreting and responding to information about pupil learning via completed work and tasks as much as they would through lesson engagement. Completed work provides a union between student cues from the lesson and their subsequent interpreted understanding. Invariably, teachers then use this when

deciding upon the best course of action, in this case, how and which aspects of Maths mastery instruction to adopt or modify.

Bachor and Baer's (1999) research into trainee teachers, found pedagogical decisions were based on intuition and insight as opposed to actual indications of pupil learning (i.e. written work). Given the breadth of teaching experience and varying lengths of service of the participants in my study, this would be a consideration worth including when assessing how Maths mastery policy was enacted by both new and seasoned teachers.

Additionally, the very nature of the study and its subject matter meant that work samples would be needed to ensure reliability and validity of findings. In using the NCETM's definition of Maths mastery there would be facets which could not be captured or monitored through observational data alone. For example, variation theory is identified as one of defining features of the NCETM's mastery definitions. I used this definition when analysing pupils' work. I was able to observe evidence in work samples of movement from simple to more complex procedural variations both within the lesson but also across a sequence of lessons. I was then able to connect observed teaching strategies with pupil work to better understand how mastery was being defined, how policy was enacted and the perceived benefits for pupils. Additionally, in discussing perceived benefits of a Maths mastery approach, participants would routinely refer to pupils' work to support and explain their thoughts and opinions and at the very least, acting as an aide memoire during discussions.

Simply put, I believed my data and findings would yield greater validity and reliability when linked with observed teaching as not all Maths mastery approaches or definitions could be evidenced through observed teaching alone; equally, not all mastery features (such a mathematical thinking) could be ascertained through work sample alone. Clearly there needed to be union of the two.

5.8.4 Field Notes

Kite (1999) who describes field notes as the stage before the writing of ethnography. Given this, my additional field notes provide additional assistance in data collection and analysis.

I drew from the research of Van Maanen (1988), Sanjek (1990), Emerson et al. (1995) to guide the form, use and construction of my field notes. My field notes acted as analytical memoranda and as such were short-hand, often bullet-pointed notes. This approach is advocated by Emerson et al. (2001) who argues that if too much time and focus is spent on writing detailed notes, then the deeper, intuitive experience of being submersed within a research context will be lost. Consequently, I opted to 'become saturated in the experience' drawing from it (Mulhull, 2003, p.311). However, I concede that my notes, given their structure, would only be understandable to myself as the author, thus creating limitations. However, Clark (2000) advocates the use of a decision-making tool to mitigate this issue so ensuring validity and reliability. Consequently, I adopted a schematic approach to my field notes (Mulhull, 2003) to include:

- Environmental features- what the classroom environment looked like and how it was utilised by teachers (participants)
- Participants and pupils- strategies used to respond to one another, interaction such as questions and responses
- Routine- daily processes and practices (chronologically)
- Dialogue- specific words and phrases used related to Maths mastery

- My personal inflections- experiences, knowledge which may influence the way in which I filter what I observe

Additionally, in jotted down phrases, words, or notes rather than extensive records, I was able to avoid drawing negative attention from participants so averting a potential change in behaviours. My field notes were combined with my other data collection tools. My approach to triangulation of data is discussed later.

5.8.5 Reliability and Validity

Joppe (2000) defines reliability in terms of consistency and accuracy of representations over time, as well as the ability to replicate results using a similar methodology. Spiers et al. (2018, p.15) refines this description as ‘credibility, transferability, dependability, and confirmability.’ In the context of qualitative research, Spiers et al. (2018) describe how the researcher needs to move between the design and implementation to ensure interconnectivity between question formulation, literature, recruitment, data collection strategies, and analysis. My interview process was an opportunity to ensure reliability within the study.

During my interview process I aimed to reduce inconsistent instruction given, according to Reinard (2006, p.4), this is ‘is notorious in some interview studies.’ When responding to participant’s comments or questions, such as being asked to define words in questions, I ensured I used the same definitions across all participants. For example, I asked the question ‘should the curriculum emphasis mathematical concepts or application of these concepts?’ which required further clarification for some participants. I used the same definition of the terms across all interviews. According to Hopkins (2000) very different definitions of terms across interviews would result in varying accuracy and increase instability in the data. However, as discussed previously, within the interview I asked follow-up or exploratory questions based on participant response. Therefore, I acknowledge that I asked questions differently within the interviews and so responses varied accordingly. However, within each interview, questions were grouped according to their topic area and so consequently, I suggest that this helped to mitigate such irregularities. Additionally, all participants were asked if they had anything to add when the end of the interview process had been reached; if follow-up questions had not been asked, here provided the opportunity for participants to contribute.

According to Reinard (2006, p.4), ‘researchers must assure that the data examined for measurement adequacy are from the target population used in the full study.’ When collecting work samples, I gathered evidence from all teachers, across them same length of lessons. Equally, I employed the same definitions of mastery when extracting information. Furthermore, I ensured my sample size was consistent across years groups and included the same selection criteria. For example, I selected books from:

- Service children who had attended the school from more than two years
- Service children who had attended the school for less than one year
- Non-Service children who were not impacted by mobility
- Pupils working below age related expectations
- Pupils working at age related expectations
- Pupils working above age related expectations

These criteria could be used across all year groups whilst be relative to each individual year group and circumstance. For example, pupils working below age related expectations were identified using the same assessment criterion across the school rather than relying on individual interpretations or perceptions.

According to Spiers et al. (2018, p.17), 'research is only as good as the investigator' a view supported by Charles (1995) who highlights the researcher responsiveness and associated bias as a potential risk to reliability and validity.

During analysis of interview transcripts, I initially selected responses which resonated with my own experiences of Maths mastery as well as my understanding of the school setting. For example, I initially identified pupil behaviour as a theme in inhibiting policy enactment. This was based on my understanding of the behaviour composite of some year groups, particularly those with high levels of social, emotional and mental health difficulties. As I attempted to examine this theme in greater depth across all interview transcripts, I realised my interpretation failed to accurately capture what was presented in the data. I found participants had in actual fact discussed facets of behaviour (such as changes in dynamic as new pupils arrive, time taken to acclimatise to the setting, girl to boy ratios) but not attributed a negative behavioural connotation which I myself had. Subsequently, I recognised my interference in this process and adjusted my positionality. As I continued my analysis I focused on my theoretical framework as well as how and why teachers enacted aspects of Maths mastery to guide my analysis.

I offered participants the opportunity to review and amend their interview transcripts as suggested by Cohen, Manion and Morrison (2018), so ensuring the validity of data. Morse et al. (2002) warns however, participants may be inclined to expand or change their view point upon review of transcripts and in doing so, impact the validity of data. However, I did not experience this and none of my participants opted to amend their transcript. Guba and Lincoln (1981) recommend examining data in this way as a mean to attain trustworthiness.

5.9 Data Analysis

According to Ngulube (2015), the amount of data generated for analysis via qualitative approaches tends to be extensive and consequently requires a structured mechanism for managing a methodological review. I decided to approach my data analysis methodology based on Creswell's (2007) three qualitative data analysis methodology strategies of:

- Preparing and organising the data (text data as in transcripts, image data as in photographs)
- Coding (reducing the data into themes through a process of coding and condensing codes)
- Presenting the data (in the form of text, tables, figures or as discussion)

In doing so, I was able to ensure analysis moved in 'analytical circles rather than using a fixed linear approach' (Creswell, 2007, p.150) so that whilst entering the process with a qualitative data set, I was able to exit with an account or narrative. Creswell (2007) argues that in between this process, the researcher touches on several facets of analysis and circles around and around, reducing the data into meaningful segments and assigning names to these segments.

5.10 Preparing and Organising Data

My qualitative data collection tools consisted of:

- Interviews

- Video footage of learning
- Video footage of teaching
- Work samples
- Photographs (such as during the use of resources)
- Field notes

Consequently, given the voluminous amount of data these produced, I initially began by getting a sense of each data field in its entirety. I watched videos, listened to and then read transcripts of interviews in their entirety several times. I looked through photographs and re-read field notes and work samples repeatedly or as Patton (1980) suggests, I ‘immersed’ myself in the details, trying to get a sense of it as a whole before breaking it into parts. Given my use of the NCETM’s Five Big Ideas (Coherence, Representation and Structure, Mathematical Thinking, Fluency, Variation) pre-set segments or categories for coding were anticipated. However, given the case-based nature of my research and desire to understand the context of the school, I elected to use pupil focus groups which were indicative of the school. These focus pupils comprised of:

- Non-Service
- Service- New arrival
- Service- Home Grown
- EAL
- SEN
- Previously Higher Attainer
- Previously Lower Attainer

These demographics were representative of the pupil population across all Key Stages and academic year groups. By layering voluminous data collection tools with pre-set coding categories (the NCETM’s Five Big Ideas) and focused demographics, I was better positioned to capture individuals in their own right, as well as consider multiple perspectives. Additionally, this approach to categorisation provided better opportunity to illuminate the understanding of the phenomenon under investigation (maths mastery) as conceptualised by Leech and Onwuegbuzie (2007).

5.11 Coding

According to Leech and Onwuegbuzie (2007), coding is a term used to refer to the method of constant comparison analysis. A view supported by Williamson et al. (2013) who suggest coding plays a key role in category identification in qualitative data analysis. It is a process that assists the researcher to move data to a higher level of abstraction. Flick (2002, p.178) describes the task of coding as the action to ‘break down and understand a text and to attach and develop categories and put them into an order in the course of time.’ During my process of coding data, I began by assigning units of analysis to the descriptive and inferential information I had compiled over the course of the study. To do this I created a coding grid in which I used the Five Big Ideas as the main headings and then created sub-sections for the data collection tools: interviews, pupil observation, teacher observation, photos, field notes and work samples.

As there were no commonly agreed or standardised descriptions or definitions of The Five Big Ideas beyond their theoretical underpinning, I then sought to identify and establish a tangible framework through which I could identify notions of The Five Big Ideas. In order to do this, I sought to identify the theoretical concept at the heart of each Big Idea. To begin with, I spent time considering each Big Idea

and the main principles underpinning each Idea. Following this, I was able to match theoretical frameworks which aligned with each Big Idea as follows:

- Mathematical thinking emerged from a framework provided by Schoenfeld (1985)
- Fluency emerged from a framework provided by Schoenfeld (1985)
- Variation was based on Marton and Tsui's (2006) description
- Representation and Structure emerged from Bruner's (1966) interpretation
- Coherency drew from the work of Liping Ma (1999) Cai et al. (2014)

In using and applying these theoretical frameworks I was better equipped to establish clear parameters for the inclusion and exclusion of collected data material. Stake (1995) argues that such an approach allows the data from various methodological tools to be coherently sorted using the same filter.

Figure 6: Data coding sheet

	Coherence Connecting new ideas to concepts that have already been understood, and ensuring that, once understood and mastered, new ideas are used again in next steps of learning, all steps being small steps.	Representation and Structure Representations used in lessons expose the mathematical structure being taught, the aim being that students can do the maths without recourse to the representation.	Mathematical Thinking Ideas are worked on by the student: thought about, reasoned with and discussed with others.	Fluency Quick and efficient recall of facts and procedures and the flexibility to move between different contexts and representations of mathematics.	Variation Varying the way a concept is initially presented to students, by giving examples that display a concept as well as those that don't display it. Also, carefully varying practice questions so that mechanical repetition is avoided, and thinking is encouraged.
	Colour code- teacher observations				
	Colour code- pupil observations				
Y1 Poppy	- Stem sentences - Modelling methods/approach - Use of apparatus	- Modelling- use of worked examples - Closed procedural tasks	- Talking partner discussion 'Think Tank' (Y4) discussion - Missing parts/incomplete models - True/False and Prove it tasks	- Daily counting - Scaffolded examples (minimum deduction from LO) - Prove it/ Stem sentences	- Multiple representations - Links to other subject areas (money and place value)
	- Stem sentences - Use of apparatus	Modelling- use of worked examples	- Stem Sentences - Verbal explanations and responses - Whiteboard demonstration of methods - Creating own questions to be answered	Reliance on counting with fingers	
Y2 Helen	Stem sentences	- Equivalents show in various pictorial representations - Asks how many different ways could you divide... - How many different ways can you make...	- Would you rather questions to promote reasoning - Would you rather have...or... (real life context) - How many pieces would you need to make it whole again?		
	Use worked examples to track back through steps taken		- Children respond with "If I had...it would be..." - Repeating key principles in their response (...parts make a whole) - If I had...I would need... - I know that 8/8 makes a whole		

Figure 6: As previously described, interview questions were designed to draw out themes related to each of the Five Big Ideas. The top row documents the interview questions and the arrows illustrate which of the Big Ideas the questions were associated with.

Figure 7: Data coding sheet with Five Big Ideas

Coding

	1. What is your understanding of maths mastery and how has that understanding evolved?	2. What sorts of things are taken into consideration when starting to think about planning mathematics lessons?	3. To what extent does the maths policy influence your practice?	4. How much do you direct student learning in Mathematics ?	5. What methods of teaching and learning do you consider as mastery?	6. What role does your relationship with the pupils play in your mathematics lessons and their mathematical understanding?	7. What are your thoughts on memorised learning and mathematics?	8. What do you feel students respond most effectively to in mathematics?	9. What do you feel students respond least effectively to in mathematics?	10. How do you encourage students to use their creativity in mathematics?	11. To what extent do students' backgrounds influence how they learn mathematics?	12. Should the curriculum emphasise mathematical concepts or application of these concepts?	13. How much do you worry about students' attitudes towards mathematics?	14. What have you learnt most from maths mastery training and/or approaches?
Year group	Key words- INTERVIEWS													
Y1 Poppy	small step resources practical				concrete material reasoning small step Stem sentences	approachable calm routine non-directive safe	personal exp. greater depth need to know	practical challenges choice prove-it talk/explain modelled	sheets less practical no variation	teach' modelled	low expectations parental engagement	both	positive parents surprised	time allowance stem sentences
Y2 Helen	small step time allowance number	cohort last year		retention application	open q's discussion variation challenge q's Stem sentences	approachable attitude	reasoning	variation discussion prove it hands on	problem solving listening no concrete	resources self-selection	parents attitude resources streaming mobility gaps	both	positive risk takers	sense of freedom rich experience curious child-centred depth
Y3 Nancy	broaden	prior knowledge fluency									language mobility gaps		life aspirations	
Y3 Judith	breadth depth	curriculum resources	curriculum	topic	methods topic varied		times tables division misconceptions	video visual practical motivation	text book motivation	word problems	parental support movement change order	balance	differences positive attitude	different perspective
Y4 Ruth	fear	prior knowledge misconceptions		practical model teacher talk errors	small step rules vocabulary Stem sentences	safe fun modelling	times tables reasoning understanding	challenge tactical	word problems easy talking at them	artistic drawing pictures variation	gaps diff. approaches diff. schemes	application	engaged accomplishment build skills getting better	not fear no pressure better pace
Year group	Habits observed- LESSON OBSERVATIONS													
	Coherence Connecting new ideas to concepts that have already been understood, and ensuring that, once understood and mastered, new ideas are used again in next steps of learning, all steps being small steps.			Representation and Structure Representations used in lessons expose the mathematical structure being taught, the aim being that students can do the maths without recourse to the representation.			Mathematical Thinking Ideas are worked on by the student: thought about, reasoned with and discussed with others.			Fluency Quick and efficient recall of facts and procedures and the flexibility to move between different contexts and representations of mathematics.		Variation Varying the way a concept is initially presented to students, by giving examples that display a concept as well as those that don't display it. Also, carefully varying practice questions so that mechanical repetition is avoided, and thinking is encouraged.		
	Colour code- teacher observations													
	Colour code- pupil observations													
Y1 Poppy	- Stem sentences - Modelling methods/approach - Use of apparatus			- Modelling: use of worked examples - Closed procedural tasks			- Talking partner discussion 'Think Tank' (Y4) discussion - Missing parts/incomplete models - True/False and Prove it tasks			- Daily counting - Scaffolded examples (minimum deduction from LO) - Prove it/ Stem sentences		- Multiple representations - Links to other subject areas (money and place value)		

Figure 7: Illustrates how video footage was coded for each Big Idea. Having applied a theoretical lens through which to consider each Idea, I was able to discern actions and responses which aligned with the theoretical framework. Consequently, actions and dialogue could then be coded and grouped according to each Big Idea. This would be essential in answering the research question.

Consequently, when reviewing interview transcripts, I was able to cross-reference NCETM Big Ideas with participant's responses against observed teaching and relate this to work samples. For example, when exploring Representation and Structure, staff were asked 'How much do you direct student learning in mathematics?' I then recorded teachers' instructional use of procedural tasks such as their use of concrete materials and then drew on pupils' work samples capturing worked models.

Furthermore, I then noted some words or phrases as an aide-memoire so that I could think aloud reflectively and conceptually. I then used these word/phase cues to begin to explain relationships between different parts of the data and build descriptive analysis. Consequently, I was then able to review video footage, both of teachers and pupils, and again, using each identified theoretical interpretation, consider where examples and instances of The Five Big Idea were emerging. I took screenshots of video moments/events and then catalogued these within the coding sheet under the appropriately identified Big Idea.

Using the codes in this way meant that I was able to ascribe meaning to data from all participants, including those of focus pupil groups and the wide demography of teachers. The same parameters could be applied and so giving rise to the contextual implications and nuances. Creswell (2007) describes this approach as one in which the researcher moves from reading data into the spiral of describing, classifying and interpreting.

Additionally, having used prefigured codes (The Five Big Ideas) I heeded the advice of Crabtree and Miller (1992) who advocate researchers to be open to additional codes emerging during analysis. I sought to identify 'the story' of individual experiences and the context of those experiences, process and interactions. Additionally, I also accounted for opportunities to capture the cultural themes and how the culture-sharing worked and might be categorised. Furthermore, given my clear positionality within the study (as researcher, Maths coordinator, Headteacher), I drew from the deconstructive work of Martin (1990, p.355) who focuses on issues of desire and power. Using his data analysis strategies, within the context of the Five Big Ideas I was able to consider:

- *Draw and consider distinctions between dichotomy (such as nature/culture, context/embellishment).*

For example, teachers were asked 'To what extent do students' backgrounds influence how they learn mathematics?' The aim of this question was to illicit discussion and thoughts relating to the cultural context of the school, in particular the high-rates of pupil mobility within the military community.

- *Examine silences-what is not said or what is absent/missing.*

During teacher interviews I attempted to facilitate opportunities in which teachers could provide their own explanation regarding the observations I had made that would go beyond my own interpretation. During my interview with Poppy for example, I was keen to understand her teaching strategies related to mathematical thinking. I began by asking, 'How much do you direct student learning in Maths?' Poppy's initial was very literal in describing what she would want pupils to achieve in a lesson by directing them to this learning goal. However, keen to understand the teaching strategies she undertook, I then played a video from her lesson capturing a child's use of planned resources. By watching the video footage back, Poppy was able to review actions and moments she'd missed from the lesson which in turn, prompted her to add more depth and detail to her initial response.

- *Focusing on the element that is most alien or peculiar- to find the limits of what is conceivable or permissible.*

Not only did I want to understand how The Five Big Ideas were enacted, but I also wanted to understand commonly enacted Big Ideas and how this potentially varied between practitioners with different levels of training and length of service. Consequently, obvious questions such as 'What methods of teaching and learning do you consider as mastery?' were asked, but additionally, I also asked 'What role does your relationship with the pupils play in your mathematics lessons and their mathematical understanding?'

- *Separating group-specific and more general sources of bias by 'reconstructing' with substitution of main elements*

Given my positionality within the research project as the Headteacher, maths coordinator and researcher, I was aware that not only could my position give rise to bias outcomes, but so too could my pre-existing knowledge of the context, pupil groups and practitioners. Consequently, I sought to ask questions which both directly and in-directly related to The Five Big Ideas. For example, I asked practitioners 'What do you feel students respond most/least effectively to in mathematics?' which gave rise to discussion regarding teaching and learning strategies, curriculum design and the Big Ideas. However, I also asked questions such as 'How much do you

worry about students' attitudes towards mathematics?' and 'How do you encourage students to use their creativity in mathematics?' which afford the opportunity to discuss differing pupil groups in a way which was broader and more interpretative allowing for the interviewee to direct and determine the ultimate scope for the answer. Thusly, I was better positioned to describe in detail, develop themes, and provide an interpretation in light of perspectives in literature and also insights and intuition.

Following coding and analysis procedure, I then set about providing a detailed description of what I observed. This detail was provided *in situ*, that is, within the context of the classroom, year group, lesson and school, a particular importance when considering the case-study nature of my research. Creswell (2007, 151) argues descriptive detail 'becomes a good starting place to start in a qualitative study...and it plays a central role in ethnographic and case studies.'

5.12 Presenting the Data

According to Esin et al. (2014), narratives are powerful forms of giving meaning to experience or as Mattingly and Garro (2000, p.1) argue, 'narrative mediates between an inner world of thought-feeling and an outer world of observable actions and states of affairs.' Clearly, events do not narrate themselves rather, it is through the experience of the event stories emerge. This means retelling the story is retrospective and the narrator already knows the ending. However, narratives do not simply express singular reality rather, they are produced in social interactions between individuals attached to cultural and institutional formations. A view supported by Somers (1994, p619) who describes them as public narratives. These are 'narratives attached to cultural and institutional formations larger than the single individual.' Therefore, in capturing such narratives, I was afforded the means by which to explore and describe the realities and experiences of individual participants against the backdrop an ascribed context (Atkinson et al., 2003). This was a useful means to illuminate both the individual experiences and social processes that shape these experiences. Owing to my desire to better understand how Maths mastery was enacted in a school with high Service pupil population, this approach appealed to me in that I was better positioned to see multiple, and sometimes contradictory layers of meaning, to reconstruct understanding through linking these layers, and to explore and understand more about individual and social processes (Esin et al., 2014).

5.13 Research Ethics

A range of ethical challenges arises from case-based research which must be addressed to protect the rights and well-being of all participants, especially children. The application of the NCETM's Five Big Ideas in maths mastery provides additional considerations, given the dual involvement of both children and teachers.

5.13.1 Positionality as Headteacher and Maths Coordinator

As both Headteacher and Maths Coordinator at the research site, my positionality was deeply embedded within the life and leadership of the school. This dual role created opportunities and tensions. On the one hand, my proximity to staff, policies, and pupils provided unique access to the lived realities of Teaching for Mastery (TfM) implementation. On the other, it risked introducing bias, given my professional investment in the success of the TfM model. I was aware that my authority could influence staff willingness to participate or affect the candour of their responses. To mitigate this, I made clear distinctions between my leadership and researcher roles during data collection. For

example, I explained to participants that my role in the project was that of researcher, not evaluator. Furthermore, I declined to give developmental feedback or comment on pedagogy, even when invited to do so.

As discussed in section 5.14 on reflexivity, I also engaged in regular peer debriefing and critical reflection to ensure that my interpretations remained grounded in the data rather than coloured by professional goals. While my insider status helped establish trust and transparency, it also required conscious distancing from hierarchical dynamics. This was particularly important in interviews and lesson observations where power asymmetries might otherwise influence responses. My position also enabled me to protect participant anonymity more thoroughly, given my contextual knowledge of the setting. However, as Elias (1991) and Venkat and Brown (2009) suggest, researchers embedded in small or unique communities must remain particularly vigilant to issues of over-identification and inadvertent exposure. These concerns informed all aspects of my ethical planning and reporting.

5.13.2 Ethical Considerations Regarding School Identification

At the outset of this study, I had planned to use a pseudonym for the school in order to protect its identity. However, on reflection, it became evident that complete anonymisation of the school was not feasible. Given my position as headteacher during the period in which the research took place, it would have been possible for someone to identify the school through publicly available information such as Ofsted reports, local news articles, or school communications.

Recognising this limitation, I took additional measures to ensure the anonymity of individual participants. Specifically, I adopted the following strategies:

- Vagueness about personal characteristics: When discussing individual teachers or pupils, I avoided specifying potentially identifying details such as exact year groups, roles, or unique attributes.
- Changing pseudonyms across contexts: To further obscure identity, I did not consistently use the same pseudonym for a participant when discussing different aspects of their practice or beliefs. This prevented a single profile from being pieced together.
- Withholding precise timelines: I was intentionally vague about the dates when data were collected, reducing the possibility of linking events described in the research to specific, identifiable moments in the school's public history.

These measures were implemented in line with the principle of do no harm and to maintain participant confidentiality to the greatest extent possible within the practical realities of the research context.

5.13.3 Informed Consent- Consent from Teachers

Teachers were integral to the implementation of the NCETM's Five Big Ideas and, as active participants, were asked to provide informed consent in accordance with BERA (2024). This involved explaining the purpose, scope, and potential outcomes of the study in accessible language. Meetings were held with teachers to discuss the study, their rights, and the use of video data—an unfamiliar practice within the school at the time. To ensure transparency, I shared my observation tick sheet (Appendix 2) and explained how analysis would focus on pedagogy through the lens of the Five Big Ideas.

While participants expressed interest in receiving feedback for professional development, I clarified that my role in this research was distinct from my professional role as Headteacher or Maths Coordinator. As

discussed in section 5.13.6, I took care to reinforce that my focus was the enactment of mastery principles, not teacher performance.

To avoid placing teachers under scrutiny or discomfort, and in response to post-viva recommendations, I eliminated from this thesis any comments or narrative that could lead to identification or be construed as evaluative. Descriptions of teaching practice are anonymised and only included where directly relevant to pupil learning or conceptual understanding. This ethical stance aligns with the principles of mutual respect and dignity for participants, as detailed in section 5.13.11 on ethical reporting.

5.13.4 Informed Consent- Consent from Parents and Children

Children, as the primary subjects of the study, required special consideration. Although they were not able to legally provide consent, it was essential that they still gave their agreement. In accordance with BERA (2024), parents/legal guardians must provide informed consent on behalf of their child, which requires the researcher to provide a clear explanation of the research objectives, methodologies, and the involvement of children. Consequently, I invited parents/legal guardians and members of the school's governing body to a meeting in which the purposed research project was discussed and shared. I used the pilot study as the basis for discussion, sharing data I anticipated collecting (video footage of teaching, work samples, interviews etc.) and what my role would be in the process, such as how I would be observing rather than teaching which some parents may have anticipated given my active teaching background. Parents/carers were offered the opportunity to ask questions or raise concerns. I made it clear to parents/carers that they would be able to revoke informed consent at any point in the pilot study or during the main data collection point.

I allowed a week between the initial meeting and handing out informed consent letters (see appendix 4). I felt that this would allow for questions or queries to be raised. Informed consent letters were sent to all pupils in Years 1 to 4 as well as teachers.

I set a deadline for parents to return consent forms and followed this up with just one reminder to return slips. For pupils who did not return completed forms I assumed this was owing to their parent/carer wishing not to take part. However, I found completed forms were being returned up to and including the time of my data collection. Delayed response from parents/carers mostly related to them forgetting, whilst others had explained that they did not provide consent owing to planned relocations with the army during the data collection point and so had opted out. Either way, I made it clear that there were no repercussions for not participating.

Following the return of pupils' informed consent, I met them in their class to explain why I would be in their lesson and to canvas how they felt about that. According to David et al. (2001, p.348) this would 'privilege their own self-selection and decision to participate in research, rather than that given by their parents and/or their teachers.' Responses to these meetings varied according to the age of pupils; Year 1 pupils (5 and 6 years old) were less enthralled with discussions, however, Year 4 pupils (8 and 9 years old), were keen to understand why research was being undertaken and how they would be involved. David et al. (2001, p.349) offer guidance in this area, in stating information and discussions with child participants should be 'adequate to their competencies in order for them to make informed decisions.' Consequently, this is the most effectual way to include a child during the informed consent process and so I adjusted information to suit the age of pupils respectively.

5.13.5 Protecting Participants' Identities

In case-based research focusing on the NCETM's Five Big Ideas, all participants' identities must be kept confidential. I took steps to ensure data was anonymised, taking care to remove identifiable features when reporting findings. This included ensuring the school, teachers and pupils could not easily be identified. However, the inability to ensure complete anonymity was discussed given the school's unique demography coupled with its location. I took care to use pseudonyms which retained the cultural heritage of pupils in an effort to capture the context of the school and its community (Elias, 1991).

Venkat and Brown (2009, p.4) state, if researchers consult and attempt to address the concerns of respondents, 'there will be less chance of research participants feeling that they have lost ownership of their stories.' Therefore, I presented key stakeholders (governors) and participants (teachers) with the data collection sheet to assure them research aimed to explore the components of maths mastery and the school's ability to implement them, rather than a critique of teacher's performance or abilities. Additionally, I met with teaching assistants and support staff to discuss the research project and what data would be collected although, data would not be collected in relation to their activities.

5.13.6 Data Storage and Access

According to Mulhall (2003) safeguarding of data is a critical ethical responsibility. Data collected during the process of the research study, be that interviews, observations, or work samples was stored securely and only accessible by myself. As my data collection included physical copies (e.g., field notes) and digital data (e.g., video recordings) I ensured both hard and electronic materials were appropriately stored and password protected. Additionally, I ensured I complied with GDPR regulations regarding the storage, handling, and sharing of data, ensuring that participants' privacy was maintained at all times.

5.13.7 Power Dynamics and the Role of the Researcher- Addressing Teacher Concerns

Case-based research necessitates consideration as to the power dynamics inherent in the teacher-researcher relationship. Given the remit of the research project and its focus on how the Five Big Ideas for TfM, teachers may have felt that their practice was under scrutiny, which could have led to heightened anxiety and self-consciousness. In turn, this had the potential to alter their natural behaviour and practice. Barriball and While (1994) recommend considering teachers as collaborators in the research process, ensuring that their voices and perspectives are valued.

In the context of implementing the NCETM's Five Big Ideas, it was essential to make clear that the study was not evaluating teachers' competence, but instead, exploring the ways in which these ideas were applied in the classroom and responded to by pupils.

5.13.8 Power Dynamics and the Role of the Researcher- Child-Researcher Dynamics

Elias (1991) suggests children are particularly vulnerable in the research context, where the researcher is an adult figure and thus holds inherent authority. To combat this potential power dynamic, I attempted to create an environment in which children were able to express themselves freely, without fear of negative consequences for their participation or responses. However, this had to be done in such a manner as to avoid inadvertently influencing pupils' responses or learning behaviours during the study. Consequently, I elected to remain neutral and not interject during whole-class and independent learning, responding and interacting with pupils when it was instigated.

5.13.9 Minimising Harm and Maximising Benefit- Minimising Disruption to Learning

One of the primary concerns during my case-based research was to minimise any disruption to the normal learning environment. I sought to ensure classroom observations did not interfere with the normal flow of lessons or the children's ability to engage in learning. This meant consideration was made as to my physical positioning so as to not obstruct pupils' view, as well as that of the iPads used to record pupils and the teacher to minimise intrusion.

5.13.10 Minimising Harm and Maximising Benefit- Ensuring Positive Educational Outcomes

By its very nature, the NCETM's Five Big Ideas seeks to enhance pupils' mathematical understanding and mastery. Consequently, the study has the potential to positively impact both pedagogy and children's mathematical development. However, throughout the research process it was necessary to ensure pupils and staff did not experience undue pressure in attempting to establish the impact of TfM. I believed that the study's potential benefits enhanced, rather than hindered, the children's learning and teachers' practice.

5.13.11 Emotional and Psychological Well-being

It could be argued that the NCETM's Five Big Ideas are academically focused and that this may risk causing emotional harm in instances when a child struggles to correctly grasp a mathematical concept or Big Idea. It was necessary to ensure the structure, timings and process of teaching and learning remained as 'normal' as possible, irrespective of my presence in the classroom.

5.13.12 Reporting and Disseminating- Ethical Reporting

Previously discussed ethical principles must be considered when presenting case-based findings. Asan and Montague (2014) state findings and results must be presented accurately and without bias. Crucially, this includes avoiding framing participants in a negative light, especially in instances where challenges or areas for improvement have been identified. Consequently, I elected to view data through the lens of each Big Idea in order to relate actions and responses to a theoretical framework of causality rather than ascribe meaning or critic to individuals, be that pupils or teachers.

5.13.13 Reporting and Disseminating- Sharing with the School Community

Given the case-based approach of the study, disseminating findings would need to account for sensitivities of the school community. It was important to share the results of the study with participants and school leadership in a manner which supported and encouraged reflection and dialogue. I sought to facilitate professional development and enhance the educational experiences of both teachers and pupils. As a result, during the school's maths evening for parents/carers, I shared findings related to the study and how this impacted our teaching and learning practice.

5.14 Reflexivity and Positionality

As outlined in Chapter 1 (Section 1.2), my positionality as both Headteacher and Maths Coordinator played a formative role in shaping this study. These dual roles granted me insider access and contextual familiarity but also raised concerns about power, influence, and researcher bias—particularly as the NCETM's Five Big Ideas had been introduced under my leadership. Reflexivity was therefore not a discrete step but an ongoing ethical and methodological practice throughout the research process.

The case-based design required careful consideration of issues such as informed consent, confidentiality, and role boundaries. At the time of designing the research (in 2017), the school was one

year into adopting a maths mastery approach, a change I had championed to address the school's unique challenges, such as high pupil mobility and learning gaps among Service children. Given my involvement in initiating this pedagogical shift, I recognised that including interview questions about the role of senior leadership or the maths lead could unduly influence participants' responses. As Lavis (2010) cautions, researcher authority may shape participant narratives, particularly where perceived evaluation is involved. To address this, I avoided direct questioning about leadership influence and instead used semi-structured interviews to allow participants to raise this organically, thereby reducing the risk of response bias.

Reflexivity also influenced the evolution of my data collection methods. Initially, I used written observation notes during pilot phase observations, adopting a format similar to school lesson observations. However, this yielded unfocused data, as I was unintentionally applying a wide evaluative lens—scrutinising curriculum coverage, pupil behaviour, support staff, and other performance-related areas. Recognising this, I shifted to a more focused research lens, introducing a video-based method and redesigning the observation tick sheet to align with the research questions. This transition required me to consciously detach from my professional practices and re-enter the classroom as a researcher rather than a Headteacher.

I recorded these tensions and adaptations in field notes between the pilot and main data collection phases. These reflections supported the development of more valid tools, such as my data coding sheet, which tracked elements of maths mastery among both pupils and teachers. It also made clear that certain features—such as pupil reasoning or learning connections—were not always observable and required multimodal capture (e.g., through dialogue and video analysis).

Additionally, reflexivity enabled me to assess where to draw ethical boundaries in reporting. For instance, I excluded staff comments that, while analytically rich, could inadvertently identify participants or suggest evaluative critique. These decisions align with the ethical framework discussed in section 5.13.4, and reflect guidance from Elias (1991) and Venkat and Brown (2009) on protecting participant ownership and dignity within small, tightly-knit communities.

Finally, I regularly engaged in peer debriefing and journaling (see section 5.13.1), helping to expose assumptions and ensure interpretations remained grounded in evidence rather than personal or institutional ambitions. This form of reflexivity ensured that the study maintained credibility while preserving the trust and well-being of those involved.

5.15 Summary

In adopting a qualitative methodological approach, I was able to focus on teachers' experiences and reflections. I extracted data which presented teachers' experiences and elicited their values thus providing a rich narrative to policy enactment. Semi-structured interviews focused on definitions of Maths mastery and avoided getting stuck in semantics of Maths teaching, rather, I was able to pursue discussion points with immediate effect. However, this approach could be argued as reducing reliability. However, Kvale and Brinkmann (2009) advocate this approach in that the researcher is able to co-construct understanding with participants as they reflect upon their experiences. The use of interview, lesson observation and work sample as a collective meant I mitigated the potential to misconstrue or control interpretations. Recorded observations were shared with participants who then provided their own explanation, rather than relying

upon my own interpretative analysis. Whilst being left with a large amount of data, triangulating of collected sources was helpful in identifying sub-themes and themes arising.

Efforts were made to ensure data was reliable. Whilst questions surreptitiously arose from responses, I followed particular topic areas and asked the same initial questions to all participants, only expanding upon and exploring their response when appropriate, an approach advocated by Kallio et al. (2016). Additionally, teachers were offered a copy of questions ahead of the interview.

I took steps to address and counteract my bias and consequently, I believe my data is valid within the boundaries of my research. All participants had the opportunity to describe and reflect upon their experiences. As the Headteacher and Maths coordinator I was personally invested in my research and I did have preconceived notions regarding Maths mastery. Initially I designed my observational record and interview questions drawing on Davezies and Garrouste's (2016) theory of compensatory education. Whilst my research questions remained the same, my theoretical framework changed to include thematic analysis. My interview questions remained pertinent as I believe the focus remained on policy aimed at offsetting educational inequalities and so consequently, my data (including interview responses) provided the insight needed to explore this.

I undertook a thematic analysis which included re-reading interview transcripts and creating a table of teacher's responses. Additionally, I created a data log which categorised work samples and recorded teaching according to the NCTEM's 'Five Big Ideas in Teaching for Mastery' (2021). I compared the topics mentioned during interviews, as well as observed teaching practices in order to collate findings into emergent themes. Re-examining interview transcripts, work samples and recorder teaching as themes arose meant my analysis was rigorous. I also considered my analysis to have been robust as comparisons between participants' data, sub-themes identified and modifications and omissions then made through re-examination. These actions led to the finalised themes. Additionally, my theoretical framework explored teachers' policy enactment using the work of Ball, Maguire and Braun (2012). In doing so, I was able to maintain a focus upon how teachers interpreted, reimagined, redefined and re-enacted policy.

The table of themes of themes and data log has been modified many times as I analysed data individually as well as collectively so collating responses into sub-themes. By combining teachers' responses with observed teaching practices, I enabled sub-themes, and later themes, to emerge organically from the data which was linked to the literature. By using teachers' responses literally, I was able to address the main research question (what are the challenges and opportunities for teachers when using the NCETM's Five Big Ideas as an approach to mathematics teaching?) as well as consider the similarities and differences of teachers' experiences within this, and begin to identify causes.

My ethical considerations supported and maintained research integrity as defined by Wright (2016). I gained informed consent from both teachers and parents and carers, whilst also meeting with pupils to discuss my work and research purpose. I accept that whilst I considered positionality at the design stage of my research, I could not completely remove and mitigate my position as Headteacher from the study. My response to this issue was ethical as I offered individuals, parents/carers and pupils the opportunity to withdraw (Dhakal, 2018). I have taken steps to protect the identity of participants and data, as well as complied with GDPR guidelines. Having explained and justified my methodological considerations, the focus of the next chapter considers is the outcomes of data collection.

Summary

This chapter has defined the main research methods employed by this study. Case-based research has been presented and demonstrated the clear personal perspective which permeates the study. As the Headteacher, Maths coordinator and researcher, insider research is inevitable and this has been openly discussed. I share a common background with the participants (both pupils and teachers), which afforded me a better grasp of the institutional and cultural specifics of the environment, which helped in gaining the trust and engagement of participants.

The ethical considerations when working with young people in education are presented in order that the methods are suitable for such a research cohort, especially given the frequently displaced Service community. It is argued that an interdependence should be established between the instruments used to collect data, the methods deployed and the questions to be answered. The emphasis on an approach which unifies research on affect and research in teaching mathematics offers a more favourable perspective to give depth and context to the overall study.

6 Chapter 6: Results and Analysis

This chapter is concerned with picking apart the contents of the data to try to frame the results in a context which can be used to consider how each of the NCETM's 'Five Big Ideas' are enacted for TfM. In order to distinguish and identify actions related to each concept of TfM, a theoretical underpinning is provided for each big idea. This offers parameters in which to discern the actions, comments and responses of both teachers and pupils. Theoretical underpinnings for each 'Big Idea' presented are:

- Mathematical Thinking- Schoenfeld (1985)
- Fluency- Schoenfeld (1985)
- Variation- Marton and Tsui (2006)
- Representation and Structure- Bruner (1966)
- Coherence- Liping Ma (2010)

Additionally, analysis of teacher interviews is used to consider how each 'Big Idea' is conceptualised and how this influences teacher performance. This chapter may be of particular interest to those wishing to see the detailed learning responses of pupils representing a diverse cross-section of pupils and how it is interpreted.

According to Cousins (2005) in case study research, data collection and data analysis tend to proceed at the same time. Stake (1995, p.71) continues in describing this process as one in which analysis offers researcher the opportunity to give 'meaning to first impressions as well as to final compilations.'

Having outlined the method of both data collection and organisation, this chapter now analyses the findings with a focus on the NCETM's 'Five Big Ideas'. These Big Ideas provide the basis for all NCETM and Maths Hubs work in the field of teaching for mastery (NCETM, 2017- website) and can be characterised as Maths mastery. The Five Big Ideas are:

- Mathematical Thinking
- Fluency
- Variation
- Representation and Structure
- Coherence

According to the NCETM the Five Big Ideas were identified from common aspects of effective teaching and learning and consequently used in the development of teaching for mastery work groups as a useful focus on learning and teaching. Given this, they are an important focus when considering both policy enactment theory and definitions of mastery teaching and learning.

Whilst the Five Big Ideas are not intended to be separate notions, in order to establish how they are enacted and their perceived benefits upon selected focus pupils, I have reported findings for each Big Idea in relation to each focus pupil group. In analysing the data field in this way, I have been able to draw understanding not only in responses to the Big Ideas, but also comparisons between the varying pupil groups. In doing so, this reflects the importance of the school's context and pupil backgrounds.

6.1 Focus Pupils

The selection of focus pupils played a valuable role in the case-based research methodology by providing targeted, detailed, and contextually rich data that contributed towards a comprehensive understanding of the research question. Pupils selected represented diverse perspectives, experiences, and characteristics of the schools' context. Appendix 6 offers detailed synopsis of each child's educational experience and offers the reader an insight into why they have been selected as a focus pupil. Focus pupils were as follows:

Year 1		Year 2	
Pupil	Characteristic	Pupil	Characteristic
Tahib	Non-Service EAL Higher Attainer	Mostafa	Non-Service EAL Lower Attainer
Lacey	Service- Home Grown Higher Attainer	Warren	Service- Home Grown Higher Attainer
Andrew	SEN Lower Attainer	Everly	Service- Home Grown Lower Attainer
Samisoni	Service- New arrival Higher Attainer	Elodie	Service- New arrival Higher Attainer
Year 3		Year 4	
Pupil	Characteristic	Pupil	Characteristic
Morad	Non-Service EAL Higher Attainer	Nish	Non-Service EAL
Chris	Service- Home Grown Middle Attainer	Freya	Service- Home Grown HA
Albert	Service- New arrival LA	RJ	Service- Home Grown HA
Molly	Non-Service HA	Anesha	Service- Home Grown SEN
		Alice	Service- New arrival LA

Figure 8: Table illustrating focus pupils

The cross-section of pupils selected provided insights into the contextual factors influencing maths mastery at Alexander First School and provided the means by which to gain a nuanced understanding of how contextual factors shape their perspectives, behaviors, and outcomes.

Pupil's previous end of year assessment grading was used to identify their previous attainment level and whether this was lower, higher or middle attaining.

6.2 Mathematical Thinking

According to the NCETM (website), mathematical thinking is a central composite to how pupils learn mathematics and given this, is best described as a process approach. A view supported by Schoenfeld (1985, p.11) who in describing mathematical thinking states:

'the goal is to explain, as accurately as possible, what takes place during the solution attempt. What mathematical knowledge is accessible to the problem solver? How is it chosen? How is it used? Why does the solution evolve the way it does? In What ways do the approaches taken to

solve the problem reflect the individual's understanding of this area of mathematics, and what is the relationship between that understanding and the individual's problem-solving performance? And finally, what accounts for the success or failure of the problem-solving attempt?'

Consequently, it is best analysed through examples, but before doing so, I briefly examine some contexts provided to illuminate mathematical thinking.

There are many different 'windows' through which mathematical thinking can be observed although we must remember observation is drawn from the solution process. The NCETM (2020, <https://www.ncetm.org.uk>) defines mathematical thinking as thinking which involves, 'looking for pattern in order to discern structure; looking for relationships and connecting ideas; and reasoning logically, explaining, conjecturing and proving.' As a mathematics coordinator supporting the delivery of mathematics, my personal experience was one in which teachers routinely endeavoured to develop such thinking in pupils, yet routinely found pupils' thinking to lack the depth, longitudinal and secure foundations necessary to achieve this. Equally, definitions of mathematical thinking are often linked to concepts of problem-solving and metacognition, two terms which themselves are somewhat ill-defined and poorly grounded.

Accordingly, I have drawn from the framework provided by Schoenfeld (1985) and NCETM in my analysis of mathematical thinking. I focus on data analysis related to:

- Resources
- Heuristic strategies
- Control exerted on problem-solving
- Belief systems
- Dialogue and vocabulary

6.2.1 Mathematical Thinking- Resources

To analyse pupils' mathematical thinking, it is necessary to consider why solving a problem evolved the way in which it did (Schoenfeld, 1985, p.17) and in doing so, we ascertain the 'instruments' used by the pupil. Analysis of such tools enables the researcher to establish an 'inventory of all the facts, procedures, and skills - in short, the mathematical knowledge- that the individual is capable of bringing to bear...'

As previously mentioned in the research methods chapter, I chose to undertake a case-based approach to my research and in doing so, was focused with the genetic epistemology rather than mathematical epistemology. Consequently, in order to understand what a child does when working mathematically (or employing mathematical thinking), practitioners ascertain what the pupil knows, believes or suspects to be true (Schoenfeld, 1985). Equally, practitioners must know how that information is arranged, amassed and retrieved. Schoenfeld (1992) describes these cognitive structures as 'Resources' in which researchers are able to consider the cognitive structures, nature, architecture, memory and access to mathematical thinking. Later I will describe the use of physical resources or manipulatives, but for the time being, Schoenfeld's (1985) 'resources' described within my analysis of mathematical thinking as follows:

- Relevant facts known
- Algorithmic procedures known
- Routine procedures
- Relevant competencies

In analysing mathematical thinking in this way, I am able to better understand the outward 'tools' various focus pupils yielded in their arsenal of otherwise inner mathematical thinking.

Year 1 Analysis- Relevant facts known

During one lesson (img:0665) in which pupils work to recognise equal groups, Samisoni (new arrival Service child and higher attainer) begins by reading the required number of cubes for the task (13) and then announcing:

Samisoni: You can't share two equal groups of 13 [he then sets about creating pairs of cubes with one tower of three cubes]

MK: Why?

Samisoni: Because it's an odd number [waving his hand over the towers and indicating the increase in height of the three-brick tower]

Video transcript Year 1 lesson

Samisoni began the task by applying his understanding of committed known facts (that 13 is an odd number) before testing his understanding (by grouping the last tower into 3 cubes) and then applying his global understanding of odd and even numbers to reason his outcome.

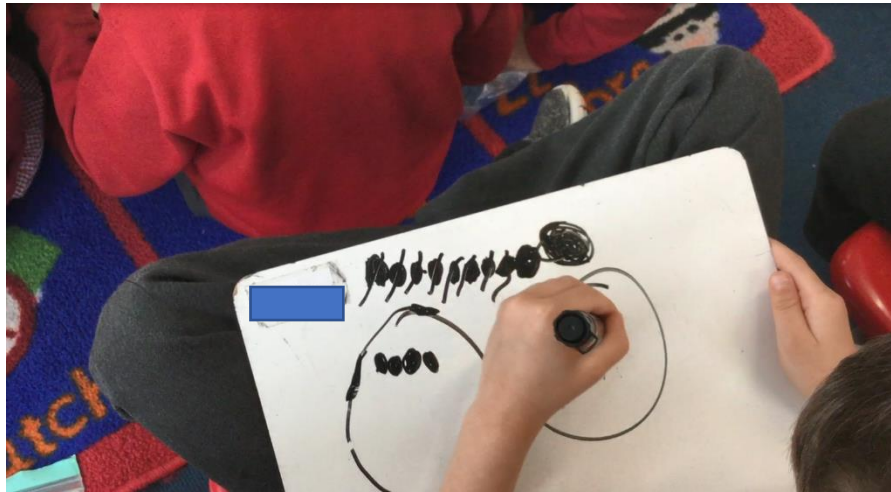
Compare this to Andrew's undertaking of a similar task (img:0620). Field notes (01) taken as activities were undertaken describe Andrew's attempts to share the number 10 into two equal groups.

Field Notes (01) Andrew (img:0620):

- Counts and re-counts dots repeatedly to draw 10
- Carefully takes time to draw then cross-off dot- only crosses when drawn
- Counts dots in circles repeatedly

Having drawn 10 dots and two empty circles on his whiteboard, Andrew makes no assertions regarding known facts or possibilities of the solution. Rather, he meticulously crosses off one dot before re-drawing it in one of his circles, followed by the next until he has shared the dots between the two circles. Finally, in order to garner an answer, Andrew counts the number of dots in each circle twice before reaching a final result.

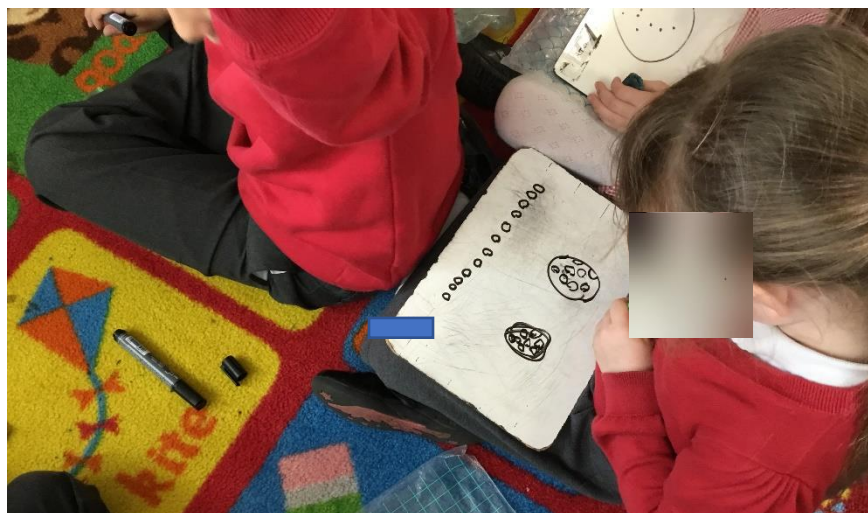
Image 1: Teaching in-put whiteboard photo of Andrew- Year 1



Where Samisoni's mathematical thinking demonstrated the ability to apply one's intuitive understanding *before* applying formal aspects, Andrew seemed to lack this capability and so seemingly resolved problems without having applied such aspects of mathematical thinking.

In contrast, Lacey's understanding of the same whole-class task as Andrew (this time using the number 16) demonstrated a strong propensity to consider what might be mathematically possible and then apply generalised knowledge or global understanding to 'test' this thinking.

Image 2: Teaching in-put whiteboard photo of Lacey- Year 1



Having previously shared 12, Lacey is tasked with shared 16. This time, rather than draw dots representing 16, she immediately begins to demonstrate her mathematical thinking:

Lacey: [Before beginning the task] The answers 6.

MK: How do you know?

Lacey: Because if I count in my 2's the answer is 8 [begins counting in 2's on her fingers] see, it is 8! So I put 8 circles in this one [points to one circle] and 8 circles in this one [points to the other circle] so that 16. Also, you know, 16 is an even number too.

Video transcript Year 1 lesson

Here Lacey's mathematical thinking demonstrates the ability to understand the implications of formal procedures (multiplication facts) as well as drawing on known facts. As with Samisoni, Lacey was also able to apply an intuitive understanding before a formal aspect of learning.

Year 2 Analysis- Routine Procedures and Relevant Competencies

In Year 2, Elodie (img:0559) demonstrates her mathematical thinking when finding fractions of a given number.

Elodie: [After reading the task] If you count it out then you have 10 and 10 [gesturing 10 with her hands once, then again]. And then you have the 4, er, split it into 2. Then you have 12 [gesturing to her left side] and 12 [gesturing to her right side]. And 12 add 12 equals 24.

Video transcript Year 2 lesson

Here, Elodie narrates her actions and doing so demonstrates the aspect of mathematical thinking related to both 'routine procedures' and 'relevant competencies'. She displays an ability to not only outline a prescribed and well-known procedure (partitioning), but also the ability to produce a mathematical argument verifying her solution. She justifies her actions and outcomes seemingly aware of how this approach was the best means to the solution.

Similarly, whilst engaging in a game of matching fractions and their pictorial representation, Everly's narrated actions provided insight into her mathematical thinking.

Image 3: Teaching in-put whiteboard photo of Everly- Year 2



Everly: This is funny because this card says $\frac{1}{4}$ and I've got this [holding a pictorial representation of $\frac{1}{10}$]. The numerator is the same, but its trying to catch me out because I know the denominator isn't 10. It's [point to the denominator 4] got to be a picture with 4 parts to it.

Everly: Here! [selects the corresponding pictorial representation] This is the one because there are 4 parts and 1 part coloured and this $\frac{1}{10}$ matches this card [placing the correct corresponding $\frac{1}{10}$ representation].

Field notes (02) Year 2 lesson

Here, Everly demonstrates her mathematical thinking related to relevant competencies as she reasons her current and next actions based on a secure procedural knowledge related to manipulates and prescribed knowledge. Whilst there is limited scope in her completion of the task, it could be argued there is a fair amount of choice as to her means of obtaining the solution. By outlining her thinking and corresponding understanding of the topic (fractions), Everly is able to articulate a sound justification for her mathematical procedures.

According to Schoenfeld (1985), relevant competencies stem from a teacher's desire to provoke in the student mathematical thinking which would not happen by itself alone, or were it too, the student would not be conscious to this. Consequently, it is necessary to consider how teachers planned and accounted for mathematical thinking. Here I drew on interviews I had conducted with teachers.

Helen (Year 2 class teacher) shared her thoughts on the use of mathematical thinking.

MK: So, you've obviously mentioned lots of those maths mastery approaches, what would you say of those, would be the most effectively you've picked up on?

Helen: I think they like...I think they like the discussion with others. I suppose its opportunities to discuss they're mathematical thinking. I think they enjoy working with a partner, it gives them a bit of reassurance and sometimes they can come up with a sort of new idea or a new piece of information together with a partner and which I think is quite good. I think they enjoy...open-ended activities.

They enjoy the sense of challenge so they're working on something. That's a problem they enjoy...I suppose something they feel is testing them in a way.

Interview with Year 2 Class Teacher

Helen's reflection demonstrates her conscious effort and awareness of providing opportunities which facilitate mathematical thinking. By assisting pupils in coming "up with a sort of new idea or piece of information", mathematical thinking related to relevant known facts, routine procedures and relevant competencies are afforded and strengthened. According to Schoenfeld (1992, p.3) 'goals for mathematics instruction depend on one's conceptualization of what mathematics is, and what it means to understand mathematics.' Taking this into consideration, Helen's decision to amplify pupils' ability to spot connections, patterns and harness their empirical understanding appeared to be rooted in her belief mathematics is an inherently social activity in which knowledge and understanding arises from peer-to-peer interaction in which they narrate, comment and challenge one another's understanding and knowledge.

However, Ruth's (Year 4 class teacher) personal perspective on mathematical thinking presented differently. During an input activity in which pupils are asked to add given amounts of money, Ruth tasks Anesha with narrating how she could reach the solution.

Ruth: ...so, 50p and 20p. How did you do that?

Anneka: Err...[pause]

Ruth: Which is the bigger number Anesha?

Anesha: Err...50p

Ruth: 50p, shall we put that in our head and jump on the 20p?

Anesha: [nodding]

Anesha: [Appears to be counting in 1s using her fingers. She starts and re-starts this three times].

Ruth: Are we counting in 1s Anesha or could we make it easy for ourselves? Could we do a big jump? What big jump could we do? What times table are they both in- our 20 and 50?

Ruth: Can you think of a times table they both might be in?

Anesha: 5s?

Ruth: Ooo, yeah, they are in the 5s. A bit bigger?

Anesha: 20s?

Ruth: How about our 10s? They're in our 10s time table. So could we do 2 jumps of 10 then?

Anesha: [nods]

Ruth: Yeah, so we're on 50...

Anesha: 51?

Ruth: Ooh..so 50, 60...

Anesha: 70?

Ruth: So we can do jumps of 10 in our head, can't we.

Video footage Year 4 Class Teacher

From Ruth's interaction with Anesha, she appears to place an emphasis on using facts and procedural capabilities when calling on mathematical thinking. In this way, mathematical thinking seemed to be regarded as a body of retrievable information and actions. During the teacher interviews, other practitioners also described their preference for retrievable facts and procedures as a marker for mathematical thinking. Whilst no video footage captured Judith eliciting pupils' mathematical thinking in the same way as Ruth, during the interview she was clear as to the importance of such an approach.

MK: What are your thoughts on memorised learning in mathematics?

Judith: So just like learning rapid recall all of times tables?

MK: Yeah.

Judith: Well it is really important. I've been doing a lot of focus on on the timetables. BUT, not just the time table so I've been trying to do the rapid recall linked to the division and word problems linked to the division and multiplication. So it is really important because once they get on to higher things...decimals and that...they have to have that rapid recall, BUT it's got to be to be relevant as well, you've got to apply it to different areas.

Interview with Year 3 Part-time Class Teacher

This is in contrast to Helen who emphasises the empirical nature of mathematical thinking with an emphasis on observing, deducing and theorising.

However, just as mathematical thinking is considered an inherently social activity for the learner (Schoenfeld, 1985), so to is the act of practitioner planning and preparation. Anecdotally, as mathematics coordinator I have found planning for mathematical thinking to be an equally social construct in which staff routinely seek advice, support and insight from their colleagues. In this way, there seemed to be an understanding and acknowledgement that, not only do personal perspectives impact the 'conceptualization of what mathematics is', but so too does the cohort of pupils.

Given the collective interpretations of mathematical thinking, it would appear that there was an inextricable link between thinking mathematically and demonstrating mathematical fluency which I will now go on to discuss.

6.3 Mathematical Thinking: How this relates to the literature

The key ideas for approaching mathematical thinking were drawn from Schoenfeld's (1985) theory. Schoenfeld's framework highlights the interplay between declarative and procedural knowledge, the role of heuristics, metacognitive control, and the influence of beliefs on mathematical problem-solving. By applying Schoenfeld's theory it is possible to clarify the essential components of mathematical thinking and how this relates to maths mastery teaching strategies and curriculum design. Consequently, data analysis focused on identifying thinking which involved mathematically rich thinking skills to understand ideas, detect relationships among ideas, and solve problems using ideas- ideas referring to mathematical concepts or knowledge.

During problem-solving activities for a number of year groups, data captured the ability to apply intuition during the process as a marker of successful mathematical thinking. According to Giardino (2010), intuition is an essential component in developing a deep understanding of mathematical concepts. In drawing on their intuitive thinking, pupils often approach problems using informal strategies such as estimating or visualising. According to Giardino (2010) children's application of visual intuition in mathematics is a decisive aspect of the problem-solving process.

Younger pupils were noted to apply intuition based on visual stimuli. For example, in Year 1 when solving problems related to equal groups, pupils previously identified as higher attainers, instinctively 'guessed' how to share based on what they initially saw. Pupils were observed distinguishing concepts via the images and applying spatial relationships in order to reach solutions. This was often done without the need for formal or symbolic reasoning. For younger learners such as Year 1, this type of intuition was essential in helping them grasp an otherwise abstract mathematical idea through concrete visual experiences.

Comparing this with older children's use of mathematical thinking, data analysis showed pupils tended to draw upon committed and known facts to support them during problem-solving activities. For example, in Year 4 during a problem-solving task involving adding given amounts of money, pupils of all previous attainment abilities (lower through to higher) were observed to have exclusively relied upon retrievable information and actions. While this can be useful for quick recall in more complex calculations, it can be limiting if pupils don't develop number sense alongside this memorisation. Pupils like Anesha (home-grown Service child with SEN needs) instinctively reverted to calling upon known number facts to reach solutions. However, in instances such as Anesha's where her number fact knowledge was insecure, she lacked the ability to see through the task using mathematical thinking. The inability to memorise basic arithmetic facts, such as multiplication tables and addition facts, was a clear inhibitor to problem-solving and by association, mathematical thinking.

Interestingly, that which the teacher merited arose as a key component of mathematical thinking employed by pupils. During interviews both Poppy (Year 1) and Nancy (Year 3) described their unenthusiastic personal position on memorised learning. They both held views such as “I thought it was a bit Victorian-y” (Nancy, Year 3) and were less keen on it as a pedagogical approach. Taking this into consideration, data analysis showed pupils in these classes adopted mathematical thinking strategies away from memorised learning, opting of strategies such as visualising and using their ‘gut instinct’.

An emerging theme from mathematical thinking was pupils considering what might be mathematically possible. Both Service and non-Service pupils were observed to have considered what might be mathematically possible in learning, using exploratory thinking where to apply logic and creativity to approach problems. The outcome appeared to deepen their understanding of mathematical concepts and foster a mindset that encouraged investigating and discovering new ideas. During discussions and interactions, pupils began to ask ‘what if’ questions and ponder predictions posed by their class teacher, such as ‘What would happen if you changed this number?’ or ‘Is there another way to solve this problem?’ Owing to this, pupils considered what might be mathematically possible and started to generalise from specific examples. They looked for patterns and relationships that could then be applied in broader contexts.

Encouraging this mindset fosters curiosity and a love of learning that is essential for lifelong success in mathematics and other disciplines.

6.4 Fluency

Whilst the NCETM provide perspectives on the implications for lesson planning and the design of problems when developing pupils’ fluency, this principle is easily lost in translation in practice and lacks clear definitions (Parker, 2021). In contrast, Schoenfeld (1992) argues mathematical fluency is best understood when understanding the individual’s behaviour, e.g. what actions are pursued and in which way. In doing so, an external moderator is able to ascertain what mathematical tools the individual has at their disposal. Simply put, in researching mathematical fluency, one must understand what information relevant to the mathematical situation/problem is available and how that information can be accessed and used.

Given this, I have elected to use Schoenfeld’s (1985) dimensions of proficiency (fluency) in mathematical problem-solving and in doing so, removed the vagueness of data inclusion/exclusion related to mathematical fluency. Additionally, Schoenfeld’s (1985) aspects provide a suitable joining of operational and number fluency, otherwise referred to as procedural and conceptional fluency (NCETM 2014).

Schoenfeld’s (1985) lens for fluency provides three aspects to consider when analysing data:

- Knowledge base
- Problem-solving strategies
- Metacognition actions

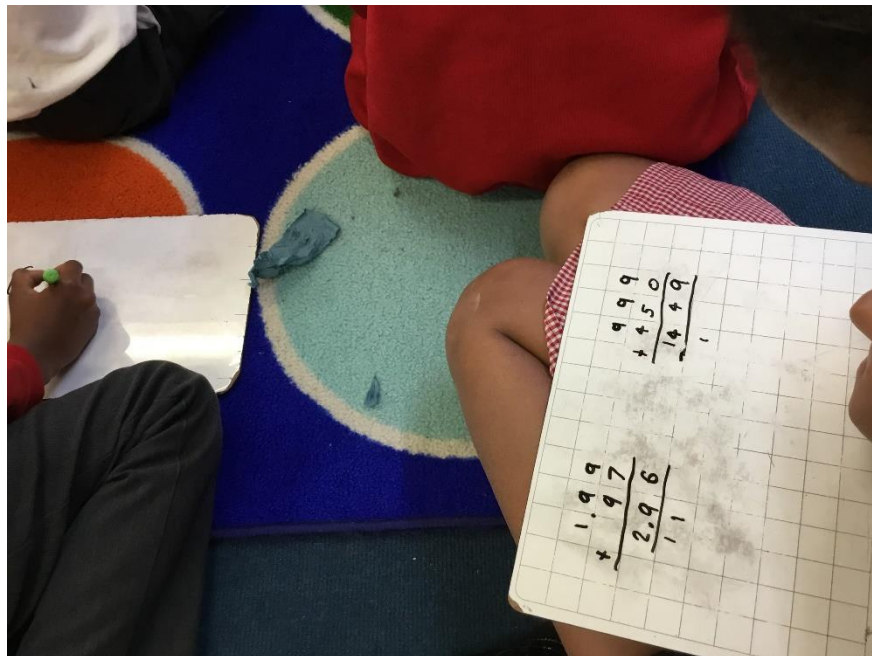
Knowledge base

The National Curriculum (DfE, 2013, p.99) describes fluency as, ‘conceptual understanding and the ability to recall and apply knowledge rapidly and accurately’. This assumes that pupils are to process and store information mentally before taking actions externally that correspond with their internal workings.

Informal and intuitive knowledge

During a Year 4 lesson on solving simple money problems I observed Freya (home-grown Service child, higher attainer) select two 'lucky dip' at random and reveal their price and instantly set about finding their combined total.

Image 4: Teaching in-put whiteboard photo of Freya- Year 4



Freya: [speaking to the child next to her] I already know what the answer is! It's going to be just a bit less than £3

Child: How'd you know?

Freya: Because I can change £1.99 to £2 and 97p to £1 which together is £3 but they're less than that so it's...about 4[p] less than £3...so I already know it's £2.96 but I'll do this...

[Freya then proceeds to begin a formal written method to add the amounts and find the total]

Freya: [speaking to the child next to her] See! I told you I was right!

Field notes (03) Year 4

Here Freya begins the task with a strong intuitive knowledge linked to rounding and estimating totals. She appears comfortable with the notion of estimating totals using known number facts. It would also appear that Freya was capable of drawing on automatic recall of known addition facts.

When undertaking the second task (finding the total of two amounts of money- £9.99 and £4.50), Freya's initial response was to begin by verbalising her thoughts and expected outcome and once again, provide an insight into her informal and intuitive knowledge.

Freya: [speaking to the child next to her] Ok, so...that's basically 10 and 5 which is 15 so...my answer will be about 14 and a half or £14.50-ish

[Freya then sets about using a formal written method to add the amounts together]

Freya: 9 and 5 is 14. Put the 4, carry the 10. So...the answer is...£14.49. So, I was basically right! [shows her whiteboard to the child next to her]

Field notes (04) Year 4 lesson

Once again, Freya appears to draw on her long-term memory of known addition facts to initially reach a solution. In this way, Freya was able to confirm and check her work with a degree of both accuracy and appears confident.

Such automaticity was a frequent characteristic of higher attaining pupils from various backgrounds.

Facts and definitions

Tahib (non-Service, higher attainer) and Lacey (home-grown Service, higher attainer) in Year 1 both routinely drew on established number facts when navigating problems. The task required pupils to share a given amount equally. The task required pupils to consider a question (such as: can you share 10 equally between 2 groups?), followed by making a prediction as to whether or not they thought the question could be achieved. Pupils then used resources to test their hypothesis and finally conclude as to whether or not they were correct.

Image 5: Independent work photo of Tahib- Year 1

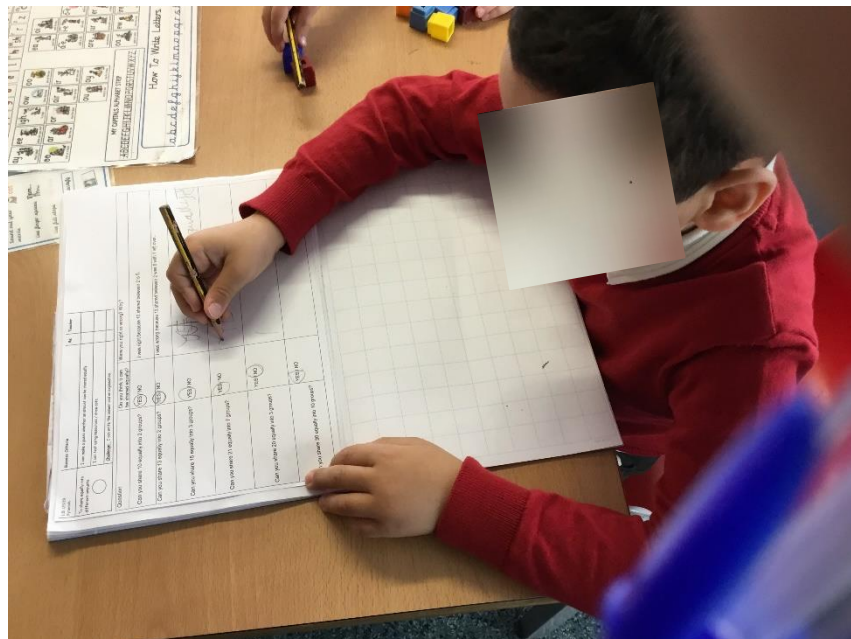


Image 6: Independent work photo of Lacey- Year 1

L.O: 3/5/19 Pyramids		Success Criteria	Me	Teacher
To share equally into different amounts.	I can make a guess whether an amount can be shared equally.			
	I can test using resources / draw dots.			
	Challenge: I can write the answer and an explanation.			
Question	Do you think it can be shared equally?	Were you right or wrong? Why?		
Can you share 10 equally into 2 groups?	YES/NO	I was right because 10 shared between 2 is 5.		
Can you share 13 equally into 2 groups?	YES/NO	I was wrong because 13 shared between 2 was 6 with 1 left over.		
Can you share 15 equally into 3 groups?	YES/NO	I was right because 15 shared between 3 is 5.		
Can you share 21 equally into 7 groups?	YES/NO	I was right because 21 shared between 7 is 3.		
Can you share 20 equally into 3 groups?	YES/NO	I was wrong because 20 shared between 3 is 6 with 2 left over.		
Can you share 30 equally into 10 groups?	YES/NO	I was right because 30 shared between 10 is 3.		

Following a whole-class input activity on equally sharing given amounts, Tahib returns to his table and immediately sets about undertaking the task of establishing whether given amounts can indeed be shared equally (img:0669). Pupils are then required to explain and justify their answers (as shown).

Tahib (Image 5) immediately draws conclusions for each answer, circling yes/no without hesitation. Similarly, Lacey also answers each question with automaticity. Field notes documenting the interaction between each child and Poppy (the class teacher) reveal the children's fluency related to facts and definitions.

Poppy: [sitting at a table with Tahib and Lacey] So, how did you know you could share 15 equally into 3 groups?

Tahib: I just know it in my head.

Poppy: Can you show me how you know it in your head?

Tahib: Well, I do 5 [holds up one finger], 10 [holds up another finger], 15 [holds up another finger]...so that's this [shows Poppy 3 fingers]. But I do it in my head. Its equally [sic]. And 5, add 5, add 5 is 15.

Field notes (05) Year 1 lesson

Tahib then sets about writing 'there are 3 equally 5'. Tahib is clearly able to call upon reliable and memorised complementarity facts (multiplication and division). In doing so, Tahib is free from cognitive overload and able to focus on core knowledge and concepts such as equal amounts and sharing. Similarly, Lacey uses her multiplication times tables knowledge to find a solution.

Poppy: What do you think the answer to this question is Lacey? [pointing to last question: Can you share 30 equally into 10 groups?]

Lacey: Yes.

Poppy: How do you know?

Lacey: Because 3 equal groups of 10 is 30. 10, 20, 30 [holds up 3 fingers]. I remember last time we did it.

Poppy: Did what?

Lacey: [turns to a previous lesson (image 7) in which she had used 30 cubes to make 3 equal groups of 10]

Field notes (06) Year 1 lesson

Image 7: Previous work photo of Lacey- Year 1

ADDITIONS	SUBTRACTIONS
To make equal groups	Success Criteria
	I know what equal means
	I can make equal groups of 2, 5 and 10 and write the answers
	Challenge: I can complete a challenge by making my own amount of equal groups

Take 10 cubes. Complete the sentences below.

I can make 5 equal groups of 2. ✓

I can make 2 equal groups of 5. ✓

I can make 1 equal groups of 10. ✓

Take 20 cubes. Complete the sentences below.

I can make 10 equal groups of 2. ✓

I can make 4 equal groups of 5. ✓

I can make 2 equal groups of 10. ✓

Take 30 cubes. Complete the sentences below.

I can make 15 equal groups of 2. ✓

I can make 6 equal groups of 5. ✓

I can make 3 equal groups of 10. ✓

Challenge: Take 12 cubes. How many different ways can you put them in equal groups? Write down you find: 7

Lacey appears to demonstrate fluency in her memorised facts and definitions. By comparison, some Service children found this aspect of fluency particularly challenging and often reverting to slower, serial strategies such as counting.

In Year 4, Alice (new arrival Service child, lower attainer) attempted to answer a monetary subtraction (35p - 24p) independently on her whiteboard. Video footage captured her efforts.

Alice: First I'm going to 4 take away...well, 5 take away 4.

[Alice then looks to her hand, spreading 5 fingers and drawing back fingers to leave 1]

Alice: That would be 1. And 3 take away 2. That would be 1. So the answer would be 11.

Video footage Year 4

Whilst Alice is quick to self-correct (four minus five), when undertaking the subtraction, she reverts back to counting and subtracting on her fingers. Whilst this is effective in answering the question, it slows her pace of work and also indicates a degree of uncertainty and lack of confidence. As Parker (2021, p.38) argues, fluency of automaticity ‘can buoy children’s confidence and free up cognitive space to learn new ideas and solve problems.’ Given this, problem-solving strategies offered great insight into pupils’ mastery fluency. Analysis drew on the work of Schoenfeld (1985) who offers a conceptualisation of what it means to think mathematically and summarises understanding relevant to mathematical thinking and problem-solving. Given this, the following subheadings are used to consider learner and practitioner responses to TfM.

Problem-solving strategies

Algorithmic procedures

During the formal interview process all teachers were asked: What are your thoughts on memorised learning and mathematics? Responses provided insight into practitioners’ stance on algorithmic procedures and its associated fluency.

The use of memorised learning to commit times tables facts to memory appeared to be generally expected and required by teachers at Alexander First School. Poppy (Year 1) who was an NQT (Newly Qualified Teacher) and had completed the Maths Hub Maths Mastery training, was very clear on her opinion of memorised learning.

MK: What are your thoughts on memorised learning in mathematics?

Poppy: Um, for me when I did it was a nightmare, I hated memorising things because like I needed to understand them, like why I was doing it and using like reasoning and stuff like that so I personally don’t [sighs]...I don’t know...for some I think, for the greater depth [pupils]they are quite good at memorising some things but not...they need to learn how to reason so umm...I don’t know...personally I don’t think they should be taught to just memorise things like times tables because they need to know like what they’re doing. They need to know what three lots of something is first, then perhaps they can see that in their head, if they’re memorising it and looking at the blocks that’s fine, but just kind of like, bang, type of thing.

MK: Do you think that would change maybe as they move up the school or do you think it’s the same?

Poppy: Yeah, I think like as they get to Year 4, the times table thing [standardised assessment], they have to be able to do it like in that sort of like second. So I understand that they’re probably going to have to memorise it, but I’m hoping that they would have been taught like that, like in Year 1...so that they’re not just like memorising a random fact, they could if they’re asked afterwards, they could explain what it is...

Interview with Year 1 Class Teacher

Poppy’s response suggests the notion that fluency in maths mastery can sometimes be engulfed by a disconnected memorisation of facts over reasoning. A view echoed by Nancy (Year 3) who shared her thoughts on memorised learning and mathematics.

Nancy: Well before... [adopting the school’s maths mastery approach] I thought it was really old fashioned [laughs]...so I sort of steered away [from using memorised learning]

MK: For what reason?

Nancy: Well I suppose it thought it was umm...I thought it was a bit Victorian-y always thought it wasn't....I'd been ingrained...I [was] probably taught in Teacher Training as well that it was very...you didn't do that because...maybe it wasn't a real understanding I thought. We're just chanting it. But now I realise that there is a place for it because now I realise you can chant it and then you'll understand it and then you'll use. So it's like the steps of it. Yes, your memorising and then it becomes your fluency.

Interview with Year 3 Class Teacher

There seemed to be a shared consensus that fluency of algorithmic procedures was essential for sequence completion, reliability and accuracy, yet practitioners firmly believed this needed to be married with conceptual understanding as well as rapid recall, otherwise pupils ran the risk of performing actions in isolation rather than with connectivity. A notion supported by Helen (Year 2) who stated:

Helen: I think there's a place for children who will memorise number facts, for example children seem to enjoy the routine of learning times tables which is fine as long as they know why...what, what they are doing. So children will often say to me "I can count in 5s, I can count in 2s" but if I say to them can you show that to me? If I asked them to get blocks and said "could you show that sequence?" then usually they can it's whether it's...it's useful if they have the reason that comes behind the learning. It's not so useful if it's just rote learning because they will stumble when it comes to doing more complex problems.

Interview with Year 2 Class Teacher

Helen's statement: "it's useful if they have the reason that comes behind the learning. It's not so useful if it's just rote learning because they will stumble when it comes to doing more complex problems" supports the view that mastery fluency seeks to not only remember but understand *why* they are doing what they doing and so require mindful actions over mindless tasks.

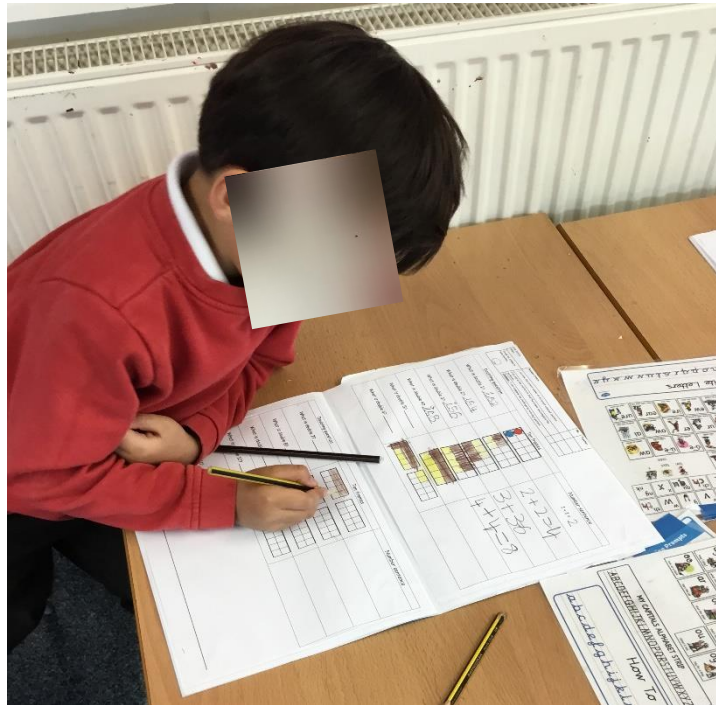
Metacognition actions

Relevant competencies

When using Schoenfeld's (1985) lens for fluency in defining metacognition actions, there is a clear distinction between learners' use of facts and algorithmic procedures versus relevant competencies. Facts and algorithms are either correct or incorrect when applied appropriately, relevant competencies are likely to yield correct solutions but are not guarantees to success.

During a Year 1 lesson on using tens frames to make doubles, pupils are presented with a tens frame with a given amount, pupils then have double this amount complete the tens frame to show how it has been doubled. Samisoni (newly arrived Service, higher attainer) and Andrew (newly arrived Service, lower attainer) approached the task with differing relevant competencies.

Image 8: Work photo of Samisoni- Year 1



Having read the question, Samisoni (image 8) set about applying his knowledge and understanding of known doubles and the two times table to reach a solution.

Samisoni: OK, [reads question 1 aloud...] this is so easy, everyone knows double 1 is 2!

Samisoni: [Reads second question aloud...] OK, so, double 2 is 4 so I'm going to do [starts colouring in the tens frame] 2 brown and 2 yellow, that's my answer.

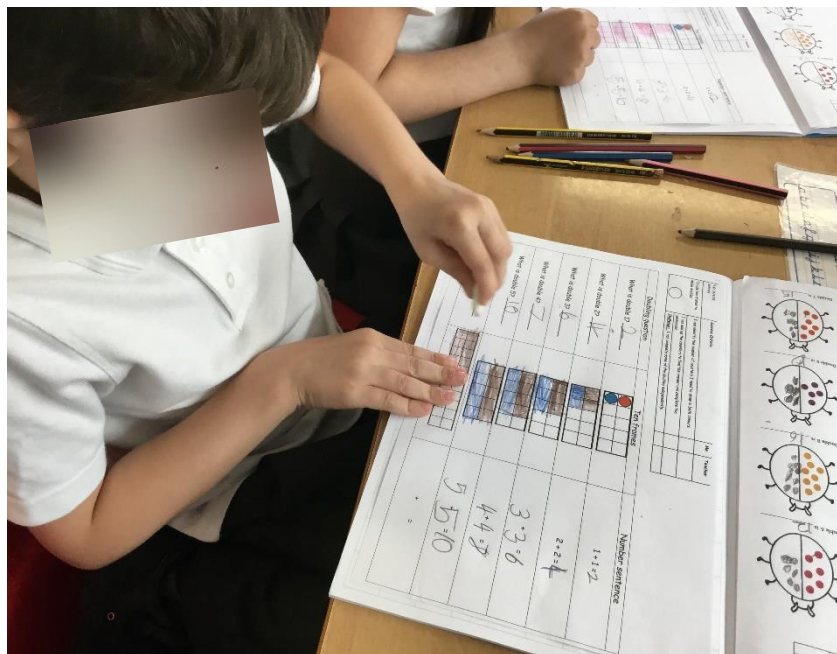
Samisoni: So next...3 add 3, or double 3 [laughs] is 6. [Colours 3 parts of the tens frame] 3 on the top and 3 on the bottom. Now...half of 8 is 4, or double 4 is 8 [laughs and continues colouring the tens frame].

Field notes (07) Year 1 lesson

Samisoni draws on what appears to be a routine course of action in knowing what he seeks to achieve. He knows when it is appropriate to use his knowledge of multiplication and addition facts, as well as inverse division facts. In this way, Samisoni's fluency related to metacognition is driven by knowledge which drives and determines the solution search process. He demonstrates a firm understanding of key mathematical facts and in doing so, is confident in working flexibly between different operations. Similarly, Andrew attempts to draw on his somewhat routine processes to reach a solution.

During the same tens frame lesson, Andrew (image 9) drew on his routine course of action, counting on his fingers. In contrast to Samisoni, Andrew lacked the ability to make connections or draw upon an understanding of key number facts or operational routines.

Image 9: Work photo of Andrew- Year 1



Teaching Assistant: [reads question 1 aloud]

Andrew: [Andrew holds 1 thumb up on one hand and the other thumb up on his other hand]. 1 and 1 is 2. [He then counts the dots in the tens frame to check his answer]. Yep...it's 2.

Teaching Assistant: [reads question 3]

Andrew: ...3 [holds 3 fingers on his left hand] and 3 [holds 3 fingers on his right hand. Andrew then raises each finger to his nose and counts each digit in his head]. 6! It's 6!

Field notes (08) Year 1 lesson

Andrew repeats this routine course of action for the first three questions, each time holding the given number of fingers on each hand and counting them to reach an answer. He then turns to the tens frame and colours the appropriate number of squares seemingly having understood their physical representation.

Whilst both pupils demonstrated competencies they believed to be true and accurate (counting on fingers or using known addition facts), and these can be identified as that which they hold true to be, the importance of understanding these rules of discourse in the domain was lacking for Andrew. For example, when attempting to work out double 4, Andrew was observed to have continued with his chosen method of holding up the given number of fingers separately on each hand and then counting their combined total. However, when counting the total, he incorrectly counted 7. Although he had correctly depicted 8 on the tens frame, having miscalculated when counting, he was unable to self-correct or identify his error. Consequently, possessing relevant competencies is not sufficient alone; rather, this must be coupled with knowledge about rules and importantly, the ability to make connections drawing upon these rules.

Knowledge about rules

According to Schoenfeld (1985) increased sensitivity as to what pupils are thinking provides not only insight as to their knowledge and how they form mathematical sense, but how practitioners might develop this further.

During the teacher interviews when asked: *What methods of teaching and learning do you consider as mastery?* The use of questioning and directed talk (stem sentences) were consistently mentioned. In particular, their use in exploring and expanding pupils' knowledge about rules to develop fluency.

Helen: I think it's probably allowing for...if you're using questions making sure they're open questions, question which allow for lots of discussion. It's...I found what's really useful quite often is to have the children explain things like, how do you know if something is...

...Questions like that I find really useful. It's quite interesting for me to see how more able students deal with those questions. And actually some of the children you feel may be struggling slightly will sometimes really surprised me. So lots of discussion I think is really important.

Interview with Year 2 Class Teacher

Poppy: Um, so something that would be stand-out mastery would be using like the stem sentences, where you teach them like what something is then they repeat it back to you perhaps, or they're answering questions in the long sentences rather than just saying the number...

Interview with Year 1 Class Teacher

Both responses suggest the lack of contentment with pupils simply recalling facts, rather there seemed to be a deliberate attempt to motivate pupils to consider and think about the underpinning concept and steer away from superficial and disconnected understanding. Furthermore, there seemed to be a deliberate and intentional desire to ensure pupils developed an understanding of the interconnectedness of knowledge rather than simple rules and actions.

During a Year 2 lesson (img 0591) on finding fractions of given quantities and shapes, Helen appeared to use questioning to reinforce Everly's (home-grown Service, lower attainer) understanding of the key principles associated with fractions.

Children were shown a selection of images depicting fractions and asked to identify those incorrectly shown.

Everly: [identifies a shape in which $\frac{1}{4}$ has incorrectly been shown] It's not because its got 2 big bits, a medium one and that's the only small one [pointing to each section as she gives her explanation].

Helen: OK, and what do we know about quarters? What do they have to be?

Everly: Equal.

Helen: OK so we haven't got quarters.

Everly: No.

Video footage Year 2

Helen uses her interaction with Everly to affirm the rules and conventions of working with fractions. She seems to want Everly to pay attention to her actions and relate this to known facts and mathematical information. In doing so, this appears to support Everly's fluency. Similarly, Ruth (Year 4 class teacher) uses focused discussion and targeted questions to test understanding, confirm core knowledge and link mathematical concepts to develop fluency.

During a whole-class input on estimating, calculating and measuring money in both pounds and pence, pupils are tasked with writing a chosen amount in pounds and pence on their whiteboard. At random, pupils are selected to come to the front of the class displaying their whiteboard, before another child is selected to order the given amounts in ascending order. Video footage (img 0681) captures Ruth's interaction with a child (not a focus pupil) and her efforts to confirm knowledge rules for fluency.

[Three children are stood at the front of the class displaying given amounts in pounds and pence. A forth child has successfully re-ordered the children in ascending order using their monetary figure].

Ruth: How'd you know (child's name), going from smallest to largest? Are you sure?

Child: No! (Child) should go first. [children move accordingly and child answering smiles and nods his head in agreement].

Ruth: How do you know (child) should go first?

Child: Because she has the smallest number.

Ruth: How do you know?

Child: Because she has 4, 8,...£48.62p

Ruth: OK, and what have the other 2 boys got [money values on their whiteboard]

Child: £49.99

Ruth: So how do we know Lisa's is the smallest? What number am I looking at?

Child: Errr....

Ruth: You've got it.

Child: [pause]

Ruth: Am I looking at the pounds or the pence?

Child: The pounds!

Ruth: Good boy. So, you know that 48 is smaller than 49, don't you?

Child: [nods]

Ruth: Good job!

Video footage Year 4

Whilst working within the concept of money, Ruth uses the task to reaffirm knowledge and understanding of place value. Arguably, she avoids cognitive overload and strengthens knowledge about rules (such as the place value of digits and decimals) through discussions and in doing so, exemplifies the components of fluency.

In no particular order, having analysed data relating to two of the Five Big Ideas (mathematical thinking and fluency), I shall move to the third: variation.

6.5 Fluency: How this relates to the literature

Schoenfeld's (1985) theory on mathematical fluency was used to capture fluency during the research study. The theory is centred on the idea that mathematical proficiency involves more than just knowing facts and procedures, rather, it requires the capacity to use information flexibly and adaptively to solve problems. Schoenfeld (1985) emphasises the importance of developing not only practical skills but also a deeper understanding of how to apply mathematics in varied contexts. The action of problem-solving promotes the skills of analysing and applying mathematical concepts in unfamiliar situations. Schoenfeld (1985) argues that fluency is demonstrated through one's ability to approach problems from multiple angles, using a combination of strategies and exploration.

Interview analysis captured teacher's insight into fluency. For example, during discussion, Helen's reflection demonstrated her conscious effort and want to provide opportunities which facilitated mathematical thinking. This was achieved through problem-solving tasks which were captured via pupil work samples as well as video footage. Analysis of data showed problem-solving tasks occurred across all year groups and involved pupils of all prior attainment abilities.

During video analysis, instances of successful problem-solving involved pupils adopting the following approach as outlined by Schoenfeld (1985):

- Interpreting the problem
- Formulating a plan
- Enacting a plan
- Reviewing the solution

The particular area which provided useful insight was around 'interpreting the problem'. Pupils initially began the task by interpreting the problem to determine what was being asked. For pupils identified as previously higher attaining, such as Tahib in Year 1, they would immediately set about establishing the key information and parameters for the task. The difficulty in analysing this was that pupils seemingly struggled to articulate how they were interpreting key information, often responding with statements such as "I just know it in my head" (Tahib, Year 1). Consequently, discerning exactly *how* pupils were interpreting problems could not be ascertained. However, in using Schoenfeld's (1985) theoretical lens determining fluency, we can begin to observe frequent instances of pupils demonstrating 'declarative knowledge'. That is to say, previously higher attaining pupils frequently demonstrated a strong command for 'knowing what' - the facts, concepts, definitions, and theorems of mathematics. Schoenfeld (1985) states this is the foundational knowledge needed in order to solve problems.

Having interpreted the problem, observations then captured pupils demonstrating their 'procedural knowledge' (Schoenfeld, 1985). This describes the knowledge of how and the methods used to perform mathematical operations. Once again, for pupils previously identified as higher attaining (both Service and non-Service) they demonstrated high-levels of competency in knowing which method to select and which mathematical operation to apply during problem-solving. During problem-solving tasks, pupils like Lacey (Year 1) were observed to have approached problems from different angles and, moreover, chose from a repertoire of strategies previously committed to memory. For example, during a problem-solving task Lacey stated: "I remember last time we did it" she then proceeded to apply a strategy she associated with the underlying concept.

The need to call upon memorised procedural knowledge to enable fluency was an emerging theme. In Year 4, Freya, a home-grown Service child previously identified as a higher attainer, appeared to draw on her long-term memory of known addition facts to initially reach a solution. In this way, Freya was able to confirm and check her work with a degree of both accuracy and confidence.

Using Schoenfeld's (1985) theory of mathematical fluency, strategic knowledge emerges from the data analysis. Strategic knowledge describes learner's ability to elect when and how to employ declarative and procedural knowledge effectively. It involves using heuristics, or problem-solving strategies, to navigate through non-routine problems and adapt to changing conditions.

Given the prevalence of memorised procedural knowledge coupled with declarative knowledge in instances of fluency, questions arise as to how learners with interrupted learning experiences, such as highly mobile Service children might achieve fluency if they lack the automaticity coupled with a memorised repertoire of strategies. Given this, considerations then shift as to how practitioners may combat such as short-comings.

Despite TfM advocating a deep teaching and learning of topics before moving on at its heart, just adopting pedagogy will not bring about desired results alone. Pedagogical approaches, TfM or otherwise, must be performed within meaningful situations.

During this study, fluency was observed to be most effective when teacher's discourse accounted for the individual learner coupled with a secure understanding of the topic *content* over a secure knowledge of the topic *structure*. That is to say during interviews, some teachers paid particular attention to and focused upon the curriculum structure of TfM over a profound understanding of the subject matter itself.

6.6 Variation

According to the NCETM (Sept. 2020, https://www.ncetm.org.uk/media/8d85bba06845025/variation_handout_september_2020.pdf) the core focus of teaching *with* variation is to draw attention and focus to the crucial features of a mathematical concept or idea through varying the non-crucial features. Beyond the terms procedural and conceptual variation, the NCETM do not provide specific remit as to how maths mastery variation should be enacted by practitioners. Given this, I have elected to use Marton and Tsui's (2006) description of mathematical variation as the lens through which I analyse my data. In doing so, I am able to identify and describe situations which are easily recognisable.

According to Marton and Tsui's (2006) description of variation, it not only enables learners to experience the critical components for learning, but also promotes the development of certain capabilities. They provide four patterns of variation:

- Contrast
- Generalisation
- Separation
- Fusion

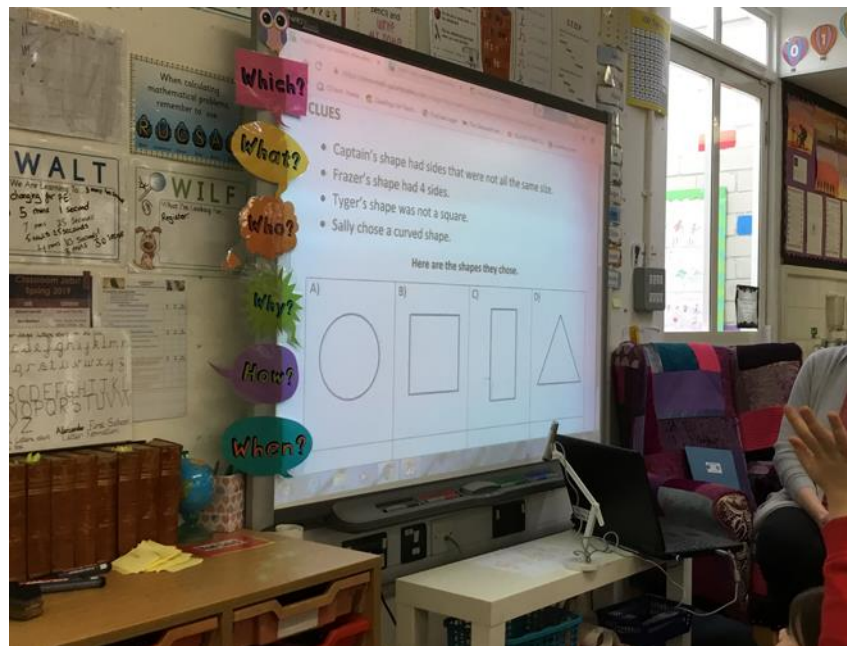
Accordingly, data has been selected where these forms of variation have been identified.

Contrast

As previously mentioned, in order to experience the critical components of an aspect, learners must have something with which to compare/contrast it with. Contrast variation was a commonly adopted approach across years groups at Alexander First School.

In Year 4, Ruth used contrast variation to develop pupils' understanding of comparing and classifying geometric shapes. She displayed a selection of shapes alongside a description of each character's chosen shape with pupils tasked with matching the correct description to the shape.

Image 10: Teaching input- Year 4



During this task pupils were encouraged to contend with what curved meant and how this related to each shape. According to field notes, pupils worked in pairs to discuss the term curved and then set about applying this as an inclusion/exclusion factor for each shape. This was captured between Nish (non-Service, higher attainer) and Alice (newly arrived Service, lower attainer).

Nish: Curved means round [gestures circular motion with both hands]

Alice: Yeah, like a circle [gestures circular motion with her right hand]

Nish: So, there's only one shape which has a curved edge...

Alice: [interrupting] the circle, Sally's shape has to be the circle! No other curved.

Nish: I was going to say that. It can't be any of the others unless they had curved edges, which they don't so correct, Sally's is the only circle.

Field notes (09) Year 4 lesson

This exchange between Nish and Alice demonstrates their experience of understanding the 'manyness' (Marton and Tsui, 2006, p15) of shape. In contending with the descriptions of shapes alongside their

physical representation, pupils discern aspects and features central to comparing and classifying geometric shapes. Moreover, as Ruth has tasked pupils with discerning and relating potential dimensions of the statements and shapes, it becomes necessary for pupils to define the shapes and in doing so, they identify the critical features of that which they are learning.

When reflecting upon this exchange during her interview, Ruth provides her own insight on how she has applied variation to teaching and learning.

MK: And in terms of, say again, thinking back to some of your lessons, that idea of variation and changing, making very small variations and changes to the children's work. So how, how have you come about doing that?

Ruth: ...it's making sure they can do it in different ways and different representations ...When we were doing place value, we were looking at it in money as well. So we were looking at the thousands, hundreds, tens and ones with like notes and pound coins and 10ps and 1ps instead. So that they could do it with deans and rods, they could do it with place value cards, but they also realise that money is also another representation of place value.

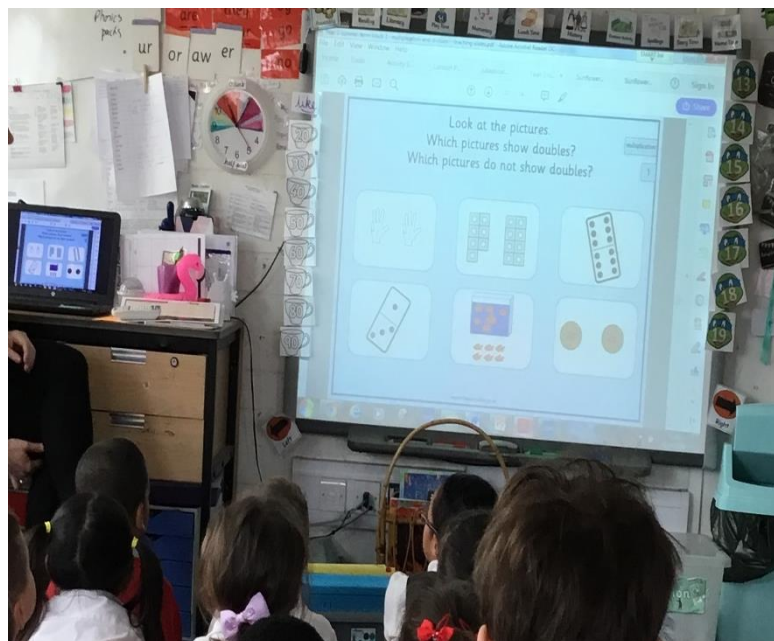
MK: And do you think that that is something that you had previously done?

Ruth: I would never have thought of doing it like that before, but math mastery sort of, it is shown that children have to recognise it in different ways.

Interview with Year 4 Class Teacher

Ruth's employment of contrast variation suggests an understanding of how to exploit the crucial features that pupils ought to focus on in order to grasp the concept of their learning. She alludes to the substantive knowledge she seeks to impart and subsequently, the conditions and variations needed for learning. She is also clear that her pedagogical approach has changed since the introduction of a maths mastery approach.

Image 11: Teaching input- Year 1



Similarly, in Year 1 during a whole-class input activity on identify doubles (image 11), Poppy sets about evoking the notion of what double means, how it is represented and then apply this knowledge to reach a solution. In being presented with non-examples of doubles, pupils draw on and strengthen their knowledge and understanding of doubles. Using the pictorial representations, Poppy exploits the aimed-at meaning of double.

Seeing the differences precedes seeing the sameness and in doing so, learners are supported in attributing meaning to an otherwise novel concept. Furthermore, in spelling out the focused knowledge and understanding for a given concept, both Ruth and Poppy appear better equipped to identify and explore learning failures. When pupils have not grasped what is intended, they have not discerned the necessary theory/concept. This was a notion Poppy shared during her interview.

When discussing aspects of the maths mastery teaching approaches that Poppy felt the children did not respond to or responded less to, she provided the following response:

Poppy: I don't know, I mean I think this year they've enjoyed all of it. They all like maths, I don't know if that's just that year group [laughs] or it's just me, um...so I don't know...

Poppy: Yeah, maybe, yeah like different ways of doing [variation], yeah like we did a lot of umm...how can you make 10 in different ways and we did it with ummm...again Numicon and the 10 frames, which they really liked and using different colours and how many different ways can you make it? But when it came to making 10 on a number line, for some reason it was, I don't know...they couldn't do it.

Interview with Year 1 Class Teacher

Poppy's response demonstrates her awareness that not only had some key concepts not been adequately grasped (such as making 10), but also showed an awareness that her pupils struggled with contrast variation. Her response suggests pupils responded well to contrasting pictorial representations but continued to struggle with the core knowledge component related to making 10.

Additionally, Poppy's suggestion that "...it's just me,..." alludes to the notion that perhaps pupils struggled with approaches to variation owing to her own pedagogical challenges. As previously discussed, Ruth (Year 4) was clear that the employment of variation theory was a shift from her typical practice. Similarly, Helen (Year 2) also suggests the use of variation theory was indicative of a shift in her pedagogy when moving towards a maths mastery approach.

MK: I think your lessons, that I've observed, variation was a consistent theme that I've seen in the teaching. Is that something that's quite different from your previous practice?

Helen: I'd say so, yes, yes. I think so...um I think previously I used to encourage children to, to undertake challenge activities, however some children I was aware, and they have to be guided more to sort of, attempt something which they felt was trickier.

Interview with Year 2 Class Teacher

Practitioner's skilfulness in choosing, presenting and demonstrating variation presents its only challenge, especially where this is considered, as Helen suggests, a marked departure from previous practice. Arguably, knowing what mathematical knowledge and skills pupils should attend to requires a high level of subject insight and judgement. Interestingly, Poppy an NQT at the time, both struggled with the concept of variation (noted in her comment regarding its limited positive impact) as well as attesting to her

pedagogical difficulties in presenting it to pupils. Contrast this to Helen (Year 2), who had been part of the Maths Hub training and been teaching for over 10 years, she presents as more confident and eager to utilise contrast variation in her teaching and learning.

Subsequently, consideration must be paid as to the practitioner-centred nuance associated with this Big Idea.

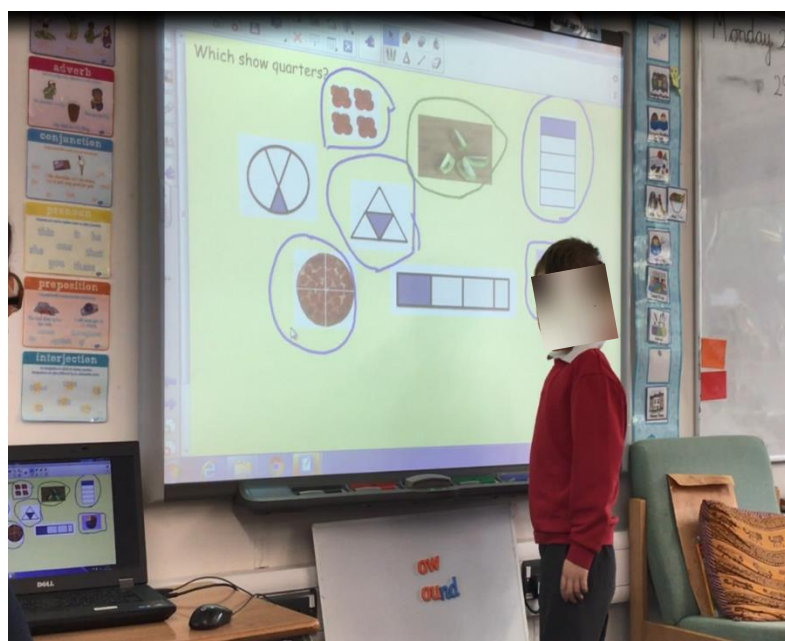
Generalisation

A central tenet in variation theory is that patterns of variance and invariance are necessary for learning. Generalisation in variation seeks to deliberately extend the range of reasoning beyond examples given to clearly recognise and investigate commonality across further instances (Marton and Tsui, 2006). Consequently, a distinction must be made between *generalising actions* and *statements of generality* (Ellis, 2007b). In doing so, one is able to focus on the processes pupils use when engaged in generalisation of variation. Generalising variation actions are considered as:

- *Relating*
- *Searching*
- *Extending*

Relating, searching and extending begins with pupils perceiving features. However, rather than simply noticing variation or invariance, pupils are encouraged to find similarity. During a Year 2 teaching input on recognising, finding and naming fractions from a set of objects and shapes, Helen employed the use of generalisation for variation to support generalised variation theory.

Image 12: Teaching input- Year 2



Having displayed a collection images, Helen invites Warren (home-grown Service, higher attainer) to consider which correctly show quarters. The following exchange is had:

William: These three [points with hand] are big ones and this one [uses hand to denote small size] is a small one.

Helen: OK. Even though we have four pieces?

William: [sitting back down and shakes his head]

Helen: We've got four pieces of that whole, they're not equal pieces so we don't have quarters. Anything else that needs changing?

Video footage Year 2 lesson

Field notes then follow-up where video footage ends.

Helen: What would I need to change to make it quarters William?

William: You would need to make all four bits the same size like the pizza. You know?

Helen: Good. Ok.

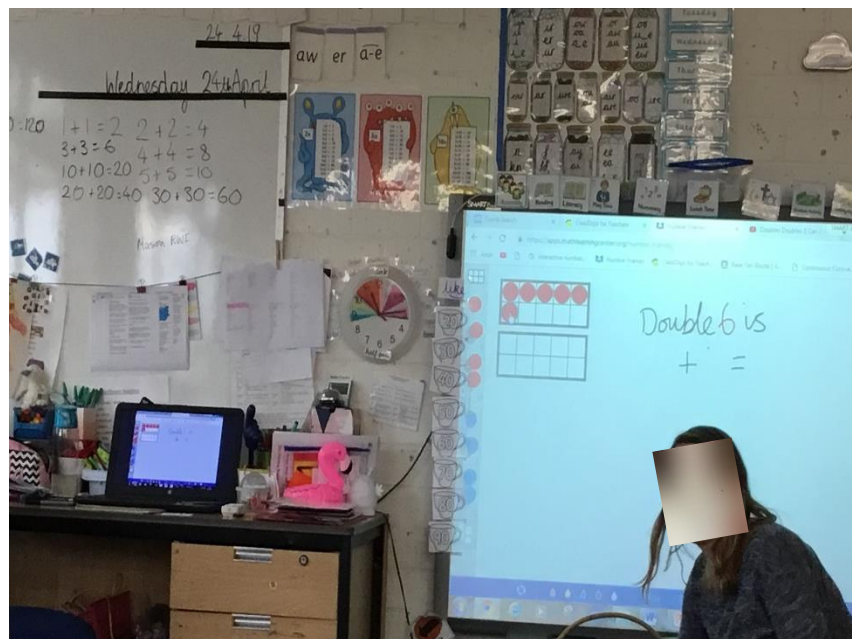
Field notes (10) Year 4 lesson

Here Warren is able to discern that quarters involves the division of something into four pieces, but moreover, these must be equal pieces. In this way, generalising the varied images prompted Warren to identify commonalities and disparities. Additionally, Helen was better equipped to capture and ascertain how Warren was reasoning. Given her previous interview responses, Helen would then use this to inform her practice and extend pupils understanding.

Separation

Marton and Tsui (2006) describe separation variation as the awareness of one aspects distinction from other aspects. An input activity from Poppy (Year 1) best describes this.

Image 13: Teaching input- Year 1



During a lesson on making doubles, Poppy writes a series of doubled number sentences on the whiteboard. She begins with $1 + 1 =$ and asks pupils to suggest the answer. She repeats this process until she begins $10 + 10 =$ where she pauses. Field notes provide the subsequent exchange.

Poppy: [writes $10 + 10 =$ on the whiteboard] What do you notice about this doubling number sentence and this number doubling number sentence [points to $1 + 1 = 2$]? What looks the same? What looks different?

Andrew: The 10 and the 1 looks a bit like the same.

Poppy: Good, what is different though?

Andrew: [pauses and shrugged his shoulders]

Tahib: The 10 is bigger than 1

Poppy: OK, so how might this [points to $1 + 1 = 2$] help me to answer this [$10 + 10 =$]

Tahib: Oh! If you know $1 + 1 = 2$ you know $10 + 10 = 20$!

Poppy: Great! It's 10 times small so there is no zero. So, if you know $2 + 2 = 4$ [points to previously written doubling sentence], how can this help with [begins writing $20 + 20 =$]?

Samisoni: $2 + 2 = 4$ so we know $20 + 20 = 40$

Poppy: How do we know that?

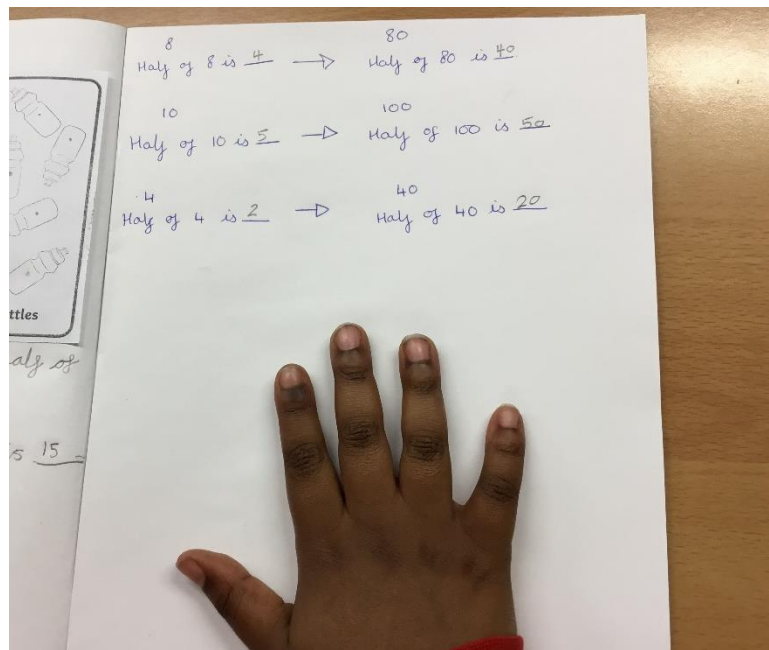
Samisoni: Because 20 is ten times bigger so you add the zero to get 40

Poppy: Well done. [she then continues with $3 + 3 = 6$ and $30 + 30 =$]

Field notes (11) Year 1 lesson

In Poppy's exchange, pupils were prompted to secure an awareness of the relationship and connection between place value and doubling. Poppy attempts to expose the structural relationship and associated knowledge pupils can draw on to form solutions and attempts to do so by varying one small feature (place value) to expose the systematic separation. Similarly, Helen (Year 2) used separation variation to promote critical features.

Image 14: Teaching activity- Year 2



During a lesson on finding fractions of given amounts, Helen works alongside Elodie (newly-arrived Service, higher attainer) for focused group work. She begins by asking Elodie to find half of eight, ten and four. Elodie answers the questions using mental recall. Helen then begins to write a series of follow-on questions and engages Elodie in discussion as captured in field notes:

Helen: Excellent work Elodie! So now, if I asked you to work out half of 80 [writes sentence in Elodie's book and returns it to her]...if I asked you to work out half of 80 how would you do that? What could you use? What do you already know that could help you?

Elodie: I already did half of 8 is 4 so I can use that and know half of 80 is 40, you're just changing the zero really.

Helen: Ah, ok! What question might I ask you know? [pointing to half of 10 question]

Elodie: Half of 100?

Helen: Excellent! And what would be your answer?

Elodie: 50?

Helen: How did you know that?

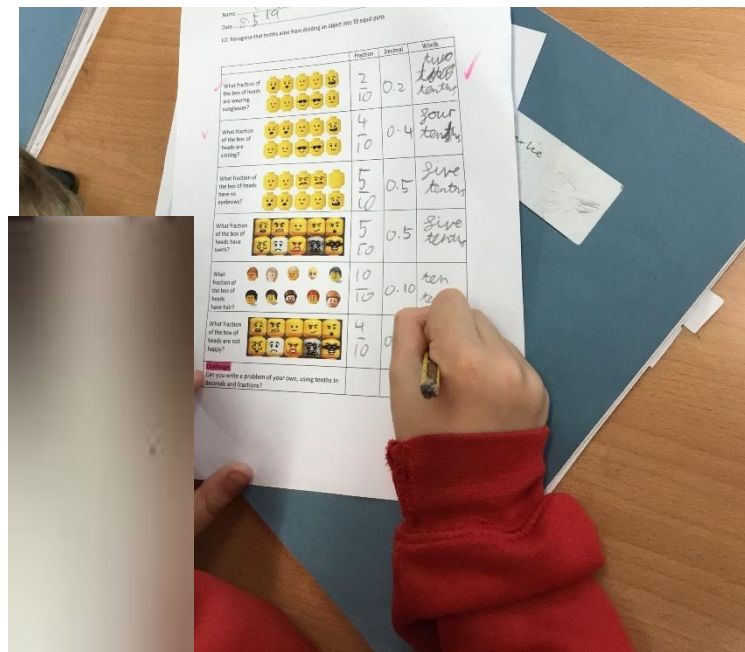
Elodie: Because I just know....[pauses]...but half of 10 is 5 and so half of 100 is 50 also.

Field notes (12) Year 2 lesson

Helen leads Elodie to consider the relationship between place value and division. Elodie recognises the connection between knowing half of 10 and how this can be used to understand half of 100. In stating "...you're just changing the zero really" she also alludes to an understanding that each place value in a number is different from the place value next to it by a factor of 10. Consequently, the separation variation is attributed to the focused attention on exposing this. However, the absence of data to explicitly capture both Poppy and Helen's intended interaction, was a recurrence when analysing practitioners' use of

variation theory. There seemed to be the lack of making the variation explicitly known to pupils. Similarly, in Year 3 Judith employed the use of separation variation.

Image 15: Teaching activity- Year 3



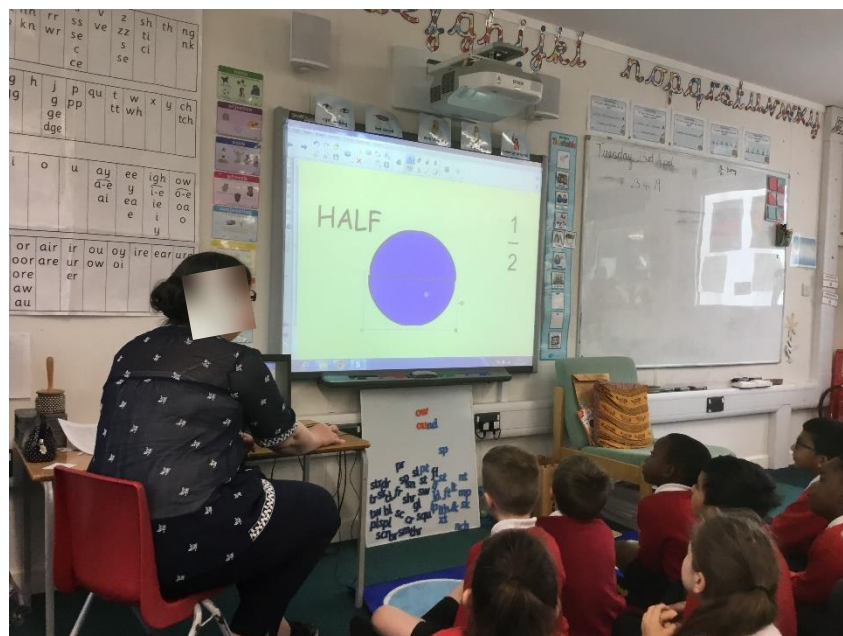
During an activity to recognise that tenths arise from dividing an object into 10 equal parts (image 14), Judith presented pupils with a task in which they were required to find fraction and decimal equivalents of a given quantity followed by writing the decimal in words (image 14). In requiring pupils to work between fractions and their decimal equivalents, children's focus is drawn to the distinct knowledge and understanding associated with fractions and decimals separately but also their collectively.

If applying Marton and Tsui's (2006) definition of separation variation, it would appear practitioners use of questioning and intentional conversation (referred to a 'ping-pong' approach within the literature review), is of paramount importance. This is because, in order to develop a child's understanding of how and the ways in which aspects being studied that are distinct from one another, practitioners must directly state, discuss and unpick these. However, whilst data could be obtained for instances of tasks and activities which aimed to promote separation variation, there was not also the accompanying teacher-pupil dialogue and discussion which one would have expected.

Fusion

Marton and Tsui (2006) describe fusion variation as that which integrates the most critical features of a specific aspect together simultaneously to co-varyate. In fusing the separated-out critical features or dimensions of variation together, a whole concept appears. In this way, fusion variation can be regarded as a conceptual understanding and the observation of dependency variation- understanding change in one variable cause change in another. Consequently, to do this pupils must experience all aspects of knowledge related to that topic at the same time in order to understand how aspects connect and relate when varied.

Image 16: Teaching input- Year 2



In Year 2, Helen began a lesson on finding fractions of given quantity by showing pupils a circle (image 15). Field notes capture her subsequent interaction with pupils:

Helen: What do we have here?

William: It's a circle.

Helen: Good. How many equal parts have I divided my circle into?

William: 2

Helen: Good. How might I write this information as a fraction? How would I show someone I have 1 part of the circle here [points to one half]?

William: Well, you do a 1 for the numerator and 2 for denominator.

Helen: Why?

William: Because the 1 for the numerator is telling people you have 1 part you're holding, and the 2 for the denominator because its divided into 2 equal bits.

Helen: Good. Would my fraction change if I changed how I divided my circle? [she re-orientates the shape so it is now divided top to bottom rather than across as originally posed].

Here [places her hand on one half].

William: [laughs] No. You still have 1 for the numerator because you've got 1 bit and 2 for denominator because its divided into 2 equal bits, it doesn't matter if you do it like that or like that [gestures with hand cutting action horizontally and then vertically], its still the same amount of pieces.

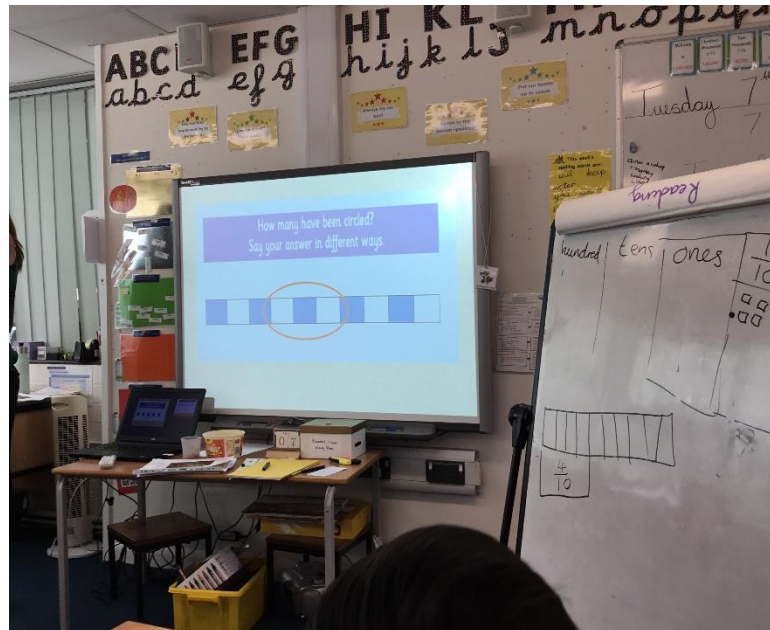
Helen: Good William. I can tell you really understand that.

Field notes (13) Year 2 lesson

Helen's interaction with Warren (home-grown Service, higher attainer) suggests a desire to sculpt William's understanding of fractions. Through fusing an understanding of properties of shape and fractions, Warren is supported in securing a deepened understanding of fractions. Although arguably, it is in Helen's question and interaction rather than the task alone which promotes fusion variation.

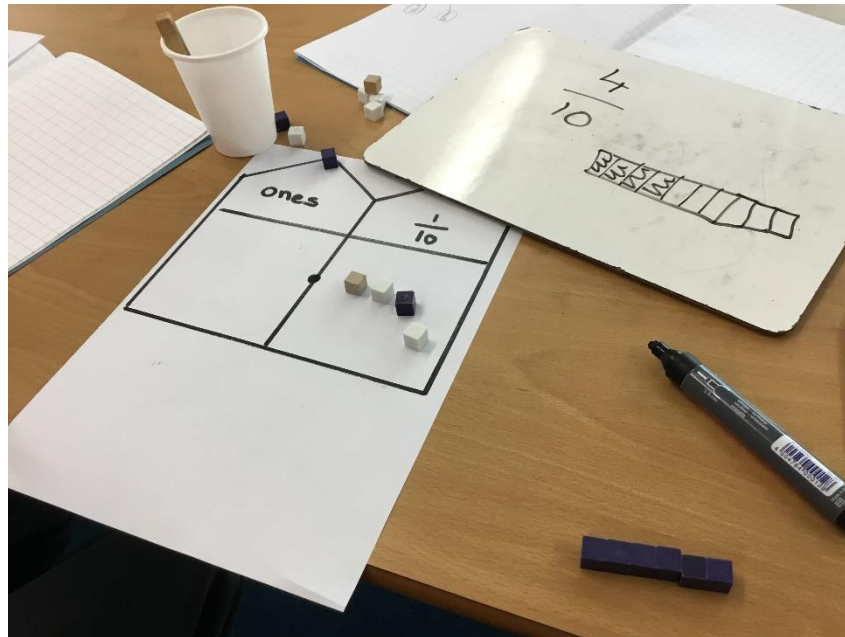
Similarly, in Year 3 Nancy uses fusion variation to deepen pupils' conceptual understanding.

Image 17: Teaching input- Year 3



During a lesson on recognising, finding and writing fractions of a discrete set of objects (image16), Nancy showed pupils an illustration (image 16) and then tasked them with representing this using concrete materials. Chris (home grown arrived Service, previously identified as being middle attaining) then set about using a provided template (image 17) and Dienes resources to represent the fraction Nancy had shown.

Image 18: Teaching activity- Year 3



This task encouraged pupils to observe how fractions and decimals represent the same value. Nancy promotes this during her discussion with Albert as captured in field notes:

Nancy: So, Chris, how might you be able use a decimal number system to show the whole number and fraction [pointing to image on the whiteboard]?

Chris: I used 4 ones.

Nancy: Where did you put the ones?

Chris: Here [pointing to 1/10 section on template]

Nancy: Ok, on the tenths. Why?

Chris: Because you have no whole 1s but 4 tenths [pointing to image]

Nancy: Ok, so we separate the whole number from the fraction by inserting a . which is called a decimal point. Do you have any whole numbers?

Chris: No.

Nancy: So how would you say this as a decimal?

Chris: 0.4

Nancy: And how would you write that as a fraction?

Chris: [writes 4/10 on mini whiteboard]. Its 4/10.

Nancy: What does the numerator and denominator tell us? [pointing to each]

Chris: The numerator tells us we have 4 parts and the denominator tells us its been divided into 10 parts

Field notes (14) Year 3 lesson

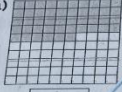
In Nancy's exchange we see how she uses observation to deepen Chris's understanding of the separated-out critical features of variation drawn together to then capture the whole concept of recognising fractions and their decimal equivalents. This use of fusion variation promotes the interconnectedness of substantive mathematical knowledge across varying disciplines bringing it together through one foci.

Image 19: Learning Task- Year 4

Fractions (including decimals)

1 $\frac{34}{100}$, $\frac{35}{100}$, $\frac{36}{100}$, $\frac{37}{100}$, $\frac{38}{100}$, $\frac{39}{100}$, $\frac{40}{100}$, $\frac{41}{100}$, $\frac{42}{100}$, $\frac{43}{100}$, $\frac{44}{100}$, $\frac{45}{100}$

2 What fraction of each grid is shaded?

a)  $\frac{16}{100}$

b)  $\frac{71}{100}$

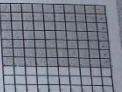
c)  $\frac{69}{100}$

3 Write a tenth and a hundredth to describe what fraction of each grid is shaded.

a)  $\frac{8}{10} = \frac{80}{100}$

b)  $\frac{3}{10} = \frac{30}{100}$

c)  $\frac{5}{10} = \frac{50}{100}$

d)  $\frac{7}{10} = \frac{70}{100}$

4 a) $5 \div 100 = 0.05$ b) $28 \div 100 = 0.28$

c) $67 \div 100 = 0.67$ d) $80 \div 100 = 0.80$

5 a) $0.3 \div 10 = 0.03$ b) $0.8 \div 10 = 0.08$

c) $0.6 \div 10 = 0.06$ d) $0.1 \div 10 = 0.01$

count up and down in hundredths; recognise that hundredths arise when dividing an object by one hundred and dividing tenths by ten

Total: 20 out of 20 Mastery: NYA

In Year 4, Ruth's use of fusion variation was captured in a work sample on finding fractions and decimals. Pupils were provided with an independent activity (image 18) in which pupils worked to identify fractions of depictions. The task began with Freya (home-grown Service, higher attainer) identifying the missing fractions from a pattern. She was observed to have quickly completed the pattern with no outward discussion or expression. She continued working in this manner until she reached Task 4, which presented her with a division sentence. Field notes denote her reaction:

Freya: This is easy!

Ruth: How come?

Freya: Because $5 \div 100$ [five divided by one hundred] is like the 100 square with 5 coloured in. So, its like imagining it in my head. So, it like, 0.05 because you have 5 hundredths.

Field notes (15) Year 4 lesson

The task promotes an understanding of the fusion between fractions and decimals in representing the relationship of part by whole. Pupils are encouraged to understanding conceptually that in both fractions and decimals, we represent the whole by 1.

Again, in considering the task, teacher and learner, fusion variation would appear to be a form of variation theory which was most effective when eliciting pupils' awareness. In turn, this would assume a high degree of knowledge, understanding and skill on the practitioner's part in sculpting meaning and concepts through deliberately selected examples and thoughtful discussion.

Having completed discussions on the variation, I now move to the next Big Idea, Representation and Structure.

6.7 Variation: How this relates to the literature

Marton and Tsui's (2006) variation theory focuses on how exposing the critical aspects of learning can help strengthen conceptual understanding. It is engrained in the notion that understanding grows as learners experience and notice the differences and similarities in modelled learning. Marton and Tsui (2006) advocate presenting subject material in ways that allow learners to contrast dissimilar examples, and consequently grasp the key features of a concept.

The ability to distinguish is central to variation theory. Data collection results demonstrated pupil's ability to notice and distinguish important features of a concept. For example, in Year 4 observations captured a task in which pupils were encouraged to contend with what 'curved' meant and how this related to each shape. According to field notes, pupils worked in pairs to discuss the term curved and then set about applying this as an inclusion/exclusion factor for each shape. In doing so, it is argued that pupils become aware of the critical aspects of their learning through experiencing variation.

During teacher interviews, variation theory emerged as an aspect which practitioners identified as a distinctly mastery. Nancy for example stated, "you'd approach the same questions in slightly different styles" whilst Helen discussed presenting learning in different ways she explained, "I can see a difference between children who have come in and the children that have been here last year. So, I feel that maths mastery has helped them be really secure with the knowledge that they have." Given practitioners' endorsement of variation theory, it was not surprising that it represented a distinct shift in practitioner habit. In particular, this appeared to be a shift from procedural teaching which would previously have emphasised memorisation of steps and repetitive practice, with pupils moving towards developing a conceptual understanding. Teachers were noted to consistently present varied examples where key features of a concept remained constant, while non-essential features were varied. This appeared to help pupils understand the underlying principles of a concept rather than just memorising procedures. For previously identified lower attaining Service children in particular, this appeared to assist them in grasping foundational concepts by allowing them to notice and focus on the critical features of a concept, essentially securing foundational knowledge. Additionally, during the initial introduction of problems and tasks, these pupils appeared to struggle with procedural fluency in that they lacked a secure understanding of the underlying concepts. Variation theory appeared to help them by contrasting different examples, which in turn helped them to construct a deeper understanding.

In contrast, previously identified as middle attaining pupils benefited from variation as it appeared to support these pupils in transitioning from structured procedural learning to more flexible, adaptive thinking. For example, in Year 3 when learning to find fractions and decimal equivalents of a given

quantity, 'middle attainers' appeared to respond positively to seeing different applications of the same concept (decimals and fractions) and in doing so, they began to generalise mathematical ideas. Added to this, both Service and non-Service children previously identified as higher attaining, responded to variation theory by using the models and examples provided to explore and extend their learning. Pupils appeared to be supported in thinking critically and creatively about mathematics. For example, Warren (home-grown Service, higher attainer) responded to fusion variation by demonstrating a deepened understanding of properties of shape and fractions.

That being said, variation theory appeared to be a TfM aspect which required a significant level of practitioner knowledge and insight. From observations carried out, this may be attributed to the requirement of systematically varying one dimension of learning at the same time as keeping others constant. To do this, practitioners must have a secure understanding of the topic content, understand the theoretical principles of the subject matter as well as understanding the best way to present this facet to pupils. Teachers must then use this understanding in order to have a clear grasp of variation and invariance. Analysis of data would suggest that where teachers had received training and development in TfM, such as Poppy (Year 1) there were increased instances of variation theory, irrespective of length of teaching service. In contrast, where practitioners had not received training from facilitators such as the Maths Hub, there were less instances of variation in teaching. Needless to say, confidence would increase when teachers understand how to vary certain elements of a lesson while keeping the core idea constant and therefore adapt teaching to include this approach.

Marton and Tsui's (2006) Variation Theory provided a framework for designing learning experiences that promote deep understanding.

6.8 Representation and Structure

NCETM (2017) describe representation and structure as a focus on considering how different models can be used to explain one mathematical concept, and also how some models can expose the links between different areas of maths. In order to distinguish representations and structure during data analysis I have elected to use Bruner's (1966) interpretation of representations and structures as the lens through which I examine data. In doing so, Bruner's (1966) interpretation allows for structures to be interpreted as the design of curricula and the underlying structure of subject matters, but also, his interpretation of the learner as structure. These are observed, deduced and inferred through a child's gestures, actions, behaviour and verbal utterances. Thusly, structure has two meanings, structure of subject matter and learner's structure- bringing together the internal and external manifestations of this Big Idea.

Additionally, the use of Bruner's (1966) interpretation offers a chronological analysis to be undertaken. Conceptual learning begins with an experience from actions undertaken (enactive) that is subsequently translated into images of the experience formed (iconic). The accumulation of actions and iconic representations give rise to the adoption of the mathematical symbols (symbolic).

Consequently, there are three modes of representation and structure through which data has been analysed:

- Enactive (representation through action)
- Iconic (visual and other summarising images)
- Symbolic (algebraic and mathematical symbols)

I shall now begin analysis data relating to enactive representation and structure.

Enactive

Bruner (1966) considered representations grew in sequence beginning with enactive. This is primarily focused on the motor responses of performing various tasks to learn new ideas. Enactive learning involving hands-on or direct experiences such as the manipulation of materials was frequently captured in Polly's Year 1 lessons in which pupils learnt through activity and materials.

Image 20: Learning Task- Year 1



Whilst working on the learning objective to share equally into different amounts, Polly (Year 1) provides pupils (of all abilities) with a range of items such as empty egg boxes, cake trays and sweet boxes to use when sharing given quantities (image 19). Pupils discuss how many groups there are, such as 12 using an egg box, and then set about sharing a given number of dienes ones.

During Poppy's interview, when asked what she considered prior to planning a maths lesson, she made specific reference to her consideration of motor responses and hands-on learning or direct experiences for pupils.

Polly: ... So I'll start from the small step and branch out from that and think, what resources have I got, what things have I made that I can use again? What physical resources, what things online can I find? And then I go on a hunt on that sort of thing.

...then I sort of work out the order to do each lesson um, so I normally base it around the practical resources, especially for say maybe the lower ability.

Interview with Year 1 Class Teacher

Poppy's description provides an insight into her considered use of manipulatives to support enactive representation and structure theory. She emphasises learning through activity and materials, rather than through recitation or choral learning for example. Her use of physical materials when teaching the concept of sharing suggests a desire to focus on physical exercises and her interview response supports this in describing the use of manipulatives to aid the visualisation of sharing. For example, Andrew and another child (both newly arrived Service, lower attainer) working together (having chosen each other as partners). Together the children set about attempting to share what should have been 24 dienes ones into 12 empty cupcake cases (image 20). However, the children had incorrectly gathered 27 dienes ones and attempted to equally share these. Field notes captured the last part of Poppy's interactions with the children relating to this:

Image 21: Learning Task- Year 1



Poppy: So why is that [incorrect]?

Andrew: Is it because there's more here and here [points to sections which include 3 dienes as opposed to 2 dienes]?

Poppy: So, what does that mean?

Andrew: Well, we've got 2 in all them others, but more in these ones so its not equal?

Poppy: So how many did you have?

Andrew: [counts each individual dienes ones cube] 27

Poppy: So, can you equally share 27 between 12?

Andrew: No, it's not equal because some will have more and not others

Poppy: Good. What you going to do?

Andrew: Take them out [removes the additional dienes ones to leave 24 dienes ones].

Field notes (16) Year 1 lesson

According to Bruner's (1966) theory of enactive representation and structures, the merit of the structure depends on its effectiveness in simplifying information and gifting this to the learner to then be synthesised. Poppy's use of enactive representation through concrete models appeals to several senses that can be seen, touched and moved by learners. Additionally, Andrew's response suggests an understanding of the concept of division and equal parts. It could be suggested that Andrew *discovers* the true meaning of sharing through this task.

I now use this instance to discuss the role of the learner when considering representation and structure. During Poppy and Andrew's interaction (field notes 16) he propositions an error in his solution which Poppy proceeds to elicit the reason as to why this is. Andrew appears to draw on his intuition to establish he has the incorrect number of dienes cubes shared. There seems to be an expectancy from him that the representation before him (the tray and cubes) should somehow appear differently. It presents as an unconscious part of his structural understanding of how equal parts, sharing, dividing and arrays should present. It could be argued that representations which illicit intuition advances pupils' cognitive development.

Additionally, Poppy (Year 1) refers to how she considers the transference of abstract concepts to tangible exploration.

Poppy: So normally, if we're using Numicon, I'll think how am I going to introduce that on the board? Or the Interactive Whiteboard? And then, um, we'd do the example, then they use and then they apply it in a task, maybe like in a written task on a sheet.

Interview with Year 1 Class Teacher

Poppy's account of employing Numicon, the interactive whiteboard and written task, alludes to both a desire to facilitate enactive representation, but also, a planned progression from concrete to abstract book-based tasks. This was echoed by Helen in Year 2.

During a teaching input on identifying and describing the properties of 2-D shapes, including the number of sides and lines of symmetry, pupils in Year 2 were invited to come to the whiteboard. The use of interactive images/diagrams in this way can be defined as virtual manipulatives. Enactive representations of this kind require learners to manipulate and work them different ways. Year 2 pupils were able to change the colour of ink used to demark different lines of symmetry, pupils rotated shapes to consider whether a new or same line of symmetry had been identified and changed the size of shapes (making them smaller and bigger) to consider whether this had any impact in finding lines of symmetry. Enactive representation in this way showed the creative thinking of pupils and freedom to test theories understanding they could revert back to their original shape at any time.

Additionally, as they demonstrated their understanding, Helen 'tested' their hypothesis by re-enacting their suggested line of symmetry on cut-out shape which she folded based on the children's suggestion (image 21). Consequently, Helen created a union between children's implied understanding, images to articulate understanding and physical resources to test understanding.

Image 22: Teaching Input- Year 2

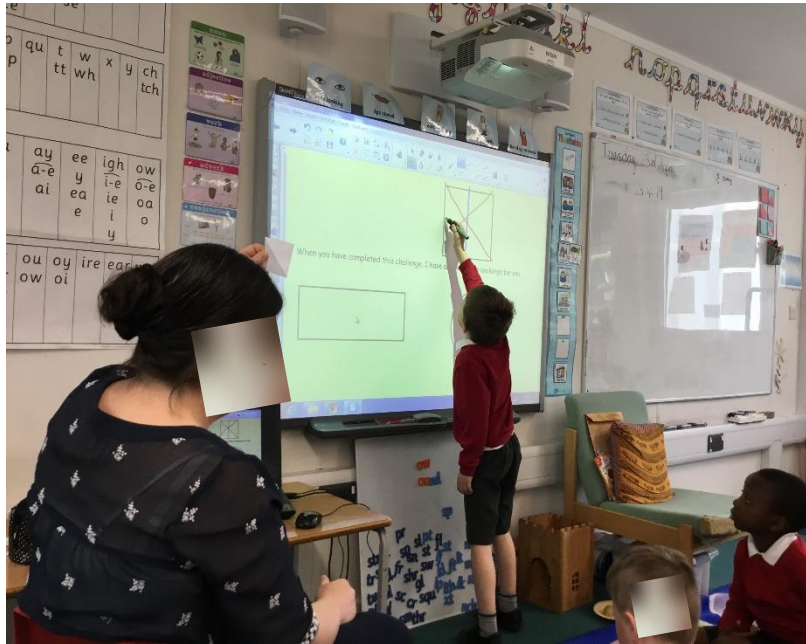


Image 23: Learning Task- Year 2



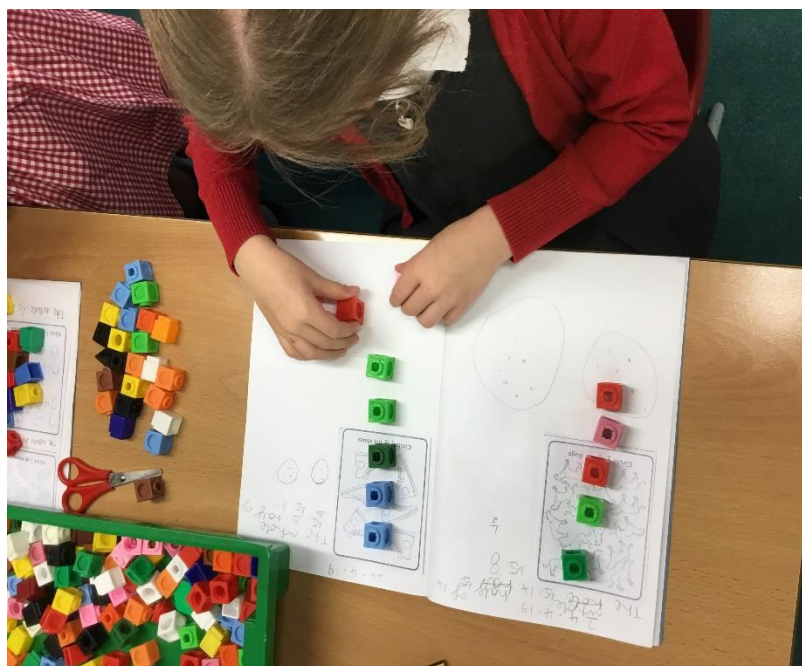
Having completed the whole-class input, pupils then return to their desks where they re-create the whole-class activity (image 22). Pupils begin by considering and telling their partner where lines of symmetry

may occur and then using cut-out shapes to fold in differing ways to identify and test whether or not they were correct.

In this particular lesson, enactive representation tests pupils' understanding and encourages their recall of subject matter, but is not necessarily the means by which to acquire new understanding. However, when teaching pupils to recognise, find, name and write fractions, Helen (Year 2) deployed enactive representation to establish understanding.

Following a whole-class teaching input, pupils were tasked with independently finding fractions of a given quantity (by picking a number card at random). Everly (home-grown Service, lower attainer) was observed to use enactive representation to support her conceptual understanding of fractions.

Image 24: Learning Task- Year 2



Having selected a number card, Everly counted out the correct number of multi-link cubes in a pile, she then methodically created two separate groups by placing a cube in each row, one after another. Having completed the task (image 21) to share twelve multi-link cubes between two groups, independently, Everly then collected another cube and shared the following exchange with her partner:

Everly: [Laughing] I'm gonna put 1 more cube here [places cube in one row]

Child: Everly! [Laughing]

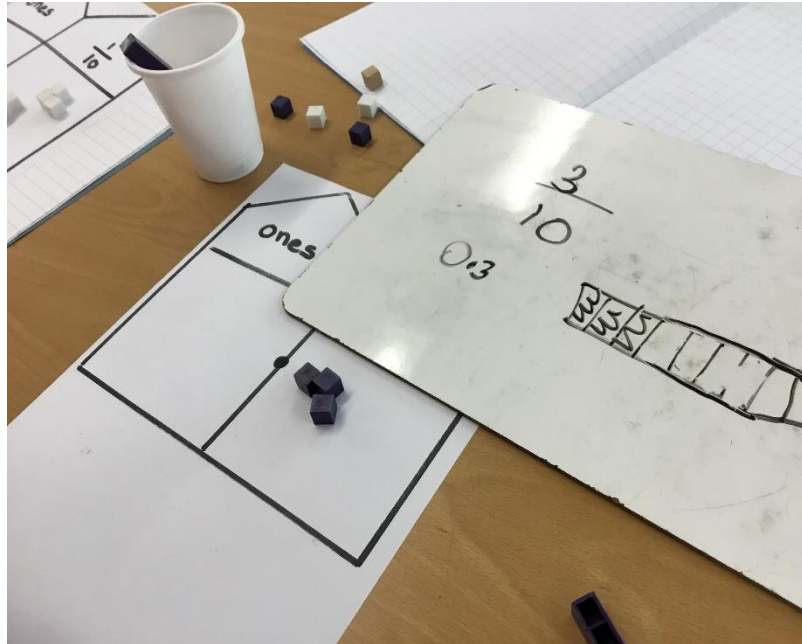
Everly: No. I'm not really, because otherwise they won't be equal. See this one has more [gesturing with hand the difference in length on cubes] than this one. They have to be the same to be equal.

Field notes (17) Year 2 lesson

This captures how enactive representations used in this way aided children's conceptual understanding related to the key principles of fractions.

Similarly, in Year 3 forming new understanding was captured via enactive representation. Whilst teaching to recognise, find and write fractions both Judith and Nancy (Year 3) directed pupils in using Dienes to support their conceptual understanding.

Image 25: Learning Task- Year 3



Pupils of all abilities were observed (image 24) to use dienes to represent decimal numbers. For example, Albert (newly arrived Service, lower attainer) represented tenths (0.3) using the resource. During her interview Nancy described her use of resources to support enactive representation and structure.

Nancy: So you would offer different resources, pictorial resources... to develop their fluency so that they become quick and efficient...

Interview with Year 3 Class Teacher

Nancy's account of her use of resources and the task design, suggest a desire to use enactive representation to ensure a more precise and comprehensive mental illustration as evidenced during her interaction with Albert:

Nancy: So what are the small cubes representing here [pointing to cubes]

Albert: They're 3 tenths

Nancy: OK, how did you make it?

Albert: I took...one, two, three...

Nancy: Three what?...

Albert: Three tenths!

Nancy: Then what?

Albert: Put them in the tenths because there are no full ones, just three tenths. I don't have enough for one.

Nancy: Right, how many more would you need?

Albert: 7 tenths

Nancy: And then what would you do?

Albert: I'd use one of these [holds a ten rod] because that's a ten

Field notes (18) Year 3 lesson

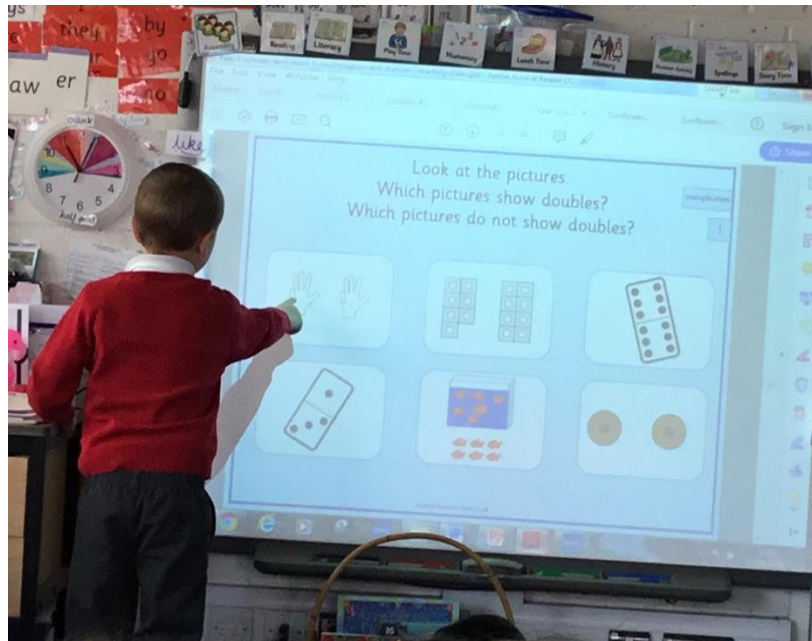
In Nancy's employment of enactive representation, the arguably abstract system of decimals is presented in such a way that pupils are better supported in finding connection between the mathematical concept being taught and the real world. Furthermore, it appeared that enactive representation involved encoding physical action-based information and storing it in one's memory. However, in Year 4 during the data collection period there were no opportunities to capture Ruth's employment of enactive representation, e.g. her use of manipulatives. It would appear that teachers in younger year groups, such as Year 1 and Year 2, employed the use of tactile resources more typically, and given this, enactive representation was more prevalent in younger year groups. Enactive data in older year groups was harder to capture and seemed less instinctive by comparison to younger year groups. However, Bruner's (1966) Iconic (visual and other summarising images) representation was more typical of its use across all year groups. This may be attributed to the fact visual representations can be used in teaching almost all topics in mathematics.

Iconic

Iconic representation, also described as visual representation aims to promote learners' visual perceptions. During a lesson on grouping and doubling in Year 1, visual representations played an important role as an aid for supporting pupils in reflecting upon their understanding and as a means for communicating their mathematical ideas.

Poppy began the Year 1 lesson with a whole-class review of pupils' understanding of doubles. She displayed a selection of images (image 23) some correctly showing doubles and others incorrectly so. Pupils were directed to look at the images and suggest which pictures illustrated doubles and those that did not. Pupils then came to the board, selected their image and provided an explanation as to why it was or was not an iconic representation of a double.

Image 26: Teaching Input- Year 1



This use of iconic representations required children to consider inclusion and exclusion factors related to their conceptual understanding of doubles. Furthermore, the visual images provided the means by which to communicate their mathematical ideas. As previously examined in discussions on mathematical thinking, practitioners cannot assume to understand or know the extent of a pupil's mathematical comprehension unless presented with the means by which for pupils to outwardly convey such understanding. Iconic representation provides the means by which to support pupils' deliberation of concepts. In doing so, Poppy then appeared better informed to address misconceptions and support pupils based on their interactions and responses to iconic representations.

Poppy (Year 1) also appeared to use iconic representation to expose the mathematical structure of concepts being taught. During a whole-class input related to grouping and sharing small quantities, Poppy presented an image of three empty circles beneath fifteen separate counters (image 26). Field notes then describe her use of the pictorial representation:

Poppy: So, I have 15 counters and three circles. If I'm sharing them equally, I take one counter and move it into my circle, and then do that again and again with the last circle [moves a counter into the first circle and then the second circle and third circle]

Poppy: What will I do now?

Andrew: Do back and do the others.

Field notes (19) Year 1 lesson

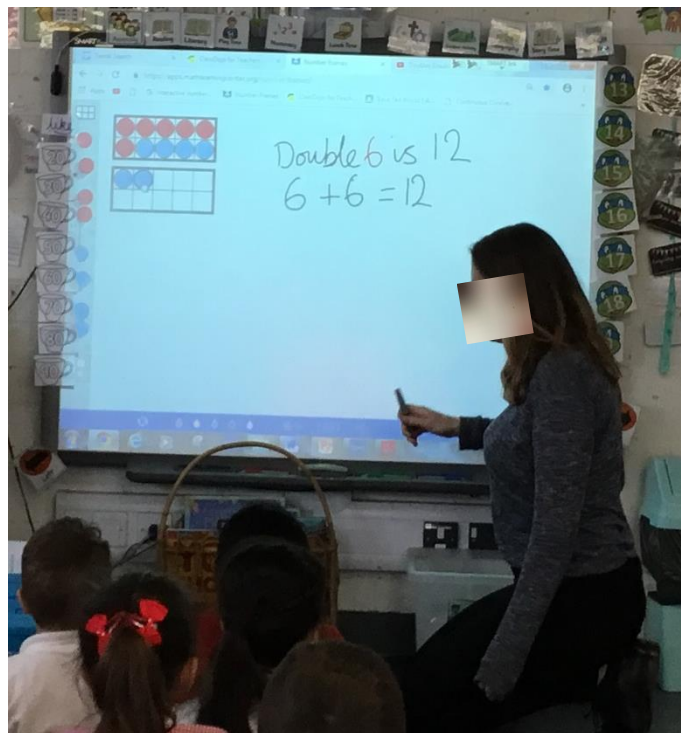
In this exchange, iconic representation was used to expose the process and consequence of sharing and grouping a given quantity. Pupils were supported in understanding groupings and visualising this.

Image 27: Teaching Input- Year 1



Subsequent learning the following day would build upon this as pupils were then supported in making connections with arrays. Poppy (Year 1) began by displaying two ten-frames (image 27).

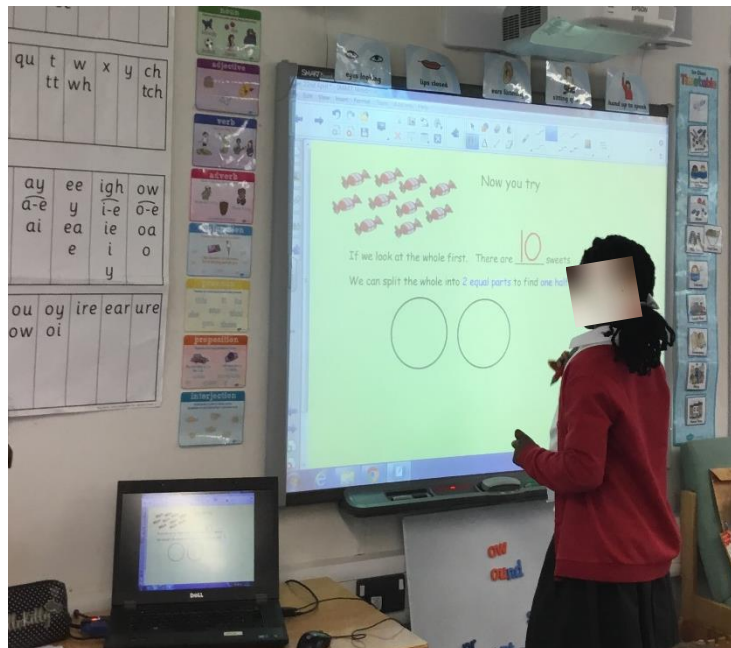
Image 28: Teaching Input- Year 1



Poppy then placed six counters into the tens-frame. Using the horizontal configuration, she encouraged links to the benchmark of five, encouraging pupils to consider how many counters she had placed. In particular, she sought to elicit an appreciation that six had been constructed given that a full row plus one in the frame had been filled. She then utilised the image to encourage pupils to consider how many more were needed to fill the tens-frame. Having taken suggestions from pupils, Poppy then used a different colour counter to fill the tens-frame. Again, she then asked pupils to consider how many counters would be needed to make a total of six. Having filled the tens-frames, Poppy then encouraged pupils to 'see' the total given the complete and partial tens-frame. Pupils were quick to respond to this, suggesting pupils remembered the visual aspects of a concept better than analytical aspects.

Similarly, whilst seeking to support pupil's ability to connect unit fractions to equal sharing and grouping, Helen (Year 2) applied iconic representation to aid this.

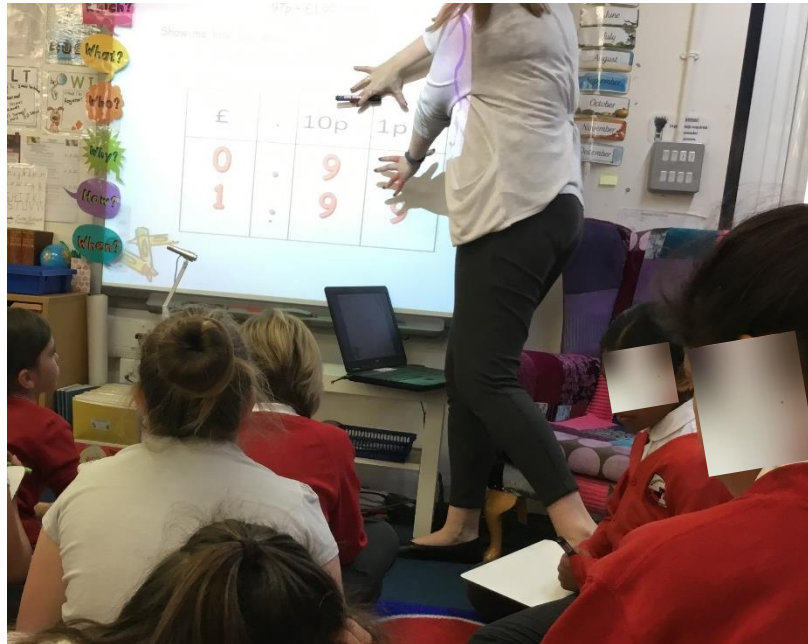
Image 29: Teaching Input- Year 2



Helen began the teaching input by asking pupils to consider how they would share a given number of depicted sweets between two circles (image 28). Initial discussion was directed towards understanding the total number of sweets, followed by how many groups they had been separated into and finally how many sweets were in each set. Throughout the discussion Helen referred to the Iconic representations to translate theory into practice. For example, having counted the individual sweets, Helen asserted this to be the whole and used stem sentences to affirm this (image 28). Pupils then collectively chanted the stem sentence as Helen gestured towards the pictorial representation. Finally, she used the image of equal grouping to expose the correlation with unit fractions.

Similarly, during a teaching input in which pupils were tasked with solving simple money problems involving decimals to two decimal places, Ruth (Year 4) also sought to expose mathematical structure via Iconic representation.

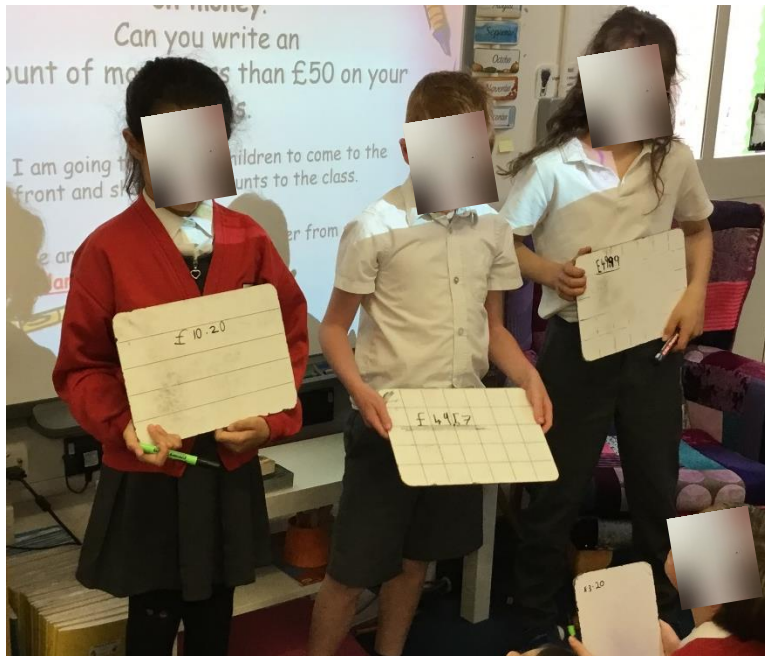
Image 30: Teaching Input- Year 4



Ruth began the whole-class input by displaying a place-value chart illustrating the value of each given digit in a monetary figure (image 29). Unlike other year groups which favoured the use of picture and images for Iconic representation, Ruth appeared to favour the use of tables and charts. Her use of the place-value chart during the lesson on solving simple money problems involving decimals to two decimal places, appeared to be rooted in the desire to provide essential information via an easily accessible medium. Consequently, her use of Iconic representation was helpful in showing the proportional representation of each digit, a concept essential to understanding money and decimal place value. In this way, Iconic representations were utilised as the basic cognitive building block in a broader process of mathematical learning. Thusly, Ruth then extended this Iconic representation with a task to contextualise the key principles. Having discussed the place value and decimal place of each digit using the table, pupils were then challenged to write a monetary value of their choice on their whiteboard. Three pupils were then selected to come to the front of the class displaying their values, whilst a fourth child was selected to arrange the values in ascending order (image 30). In this way, structures are not only that of the concept at hand, but also that which the learner can use by establishing his/her own internal structure of meaning.

Pupils were required to articulate their thoughts and suggestions using established facts and reflecting upon activities related to this use of place-value charts. This gave rise to pupils reconstructing details, rules and conventions when completing their task.

Image 31: Teaching Input- Year 4



Furthermore, the learning sequence of new mathematical concepts followed a progression from pictorial to symbolic. In this way, the learner had not only arrived at a point in which they had acquired a new mathematical notion in its mathematical symbol, but pupils had also developed a means by which to store the concrete image and commit this to memory.

Consequently, given the sequential process of Bruner's (1966) theory of representation and structure, I finally move on to the analysis data related to use of Symbolic (algebraic and mathematical symbols) representation and structure.

Symbolic

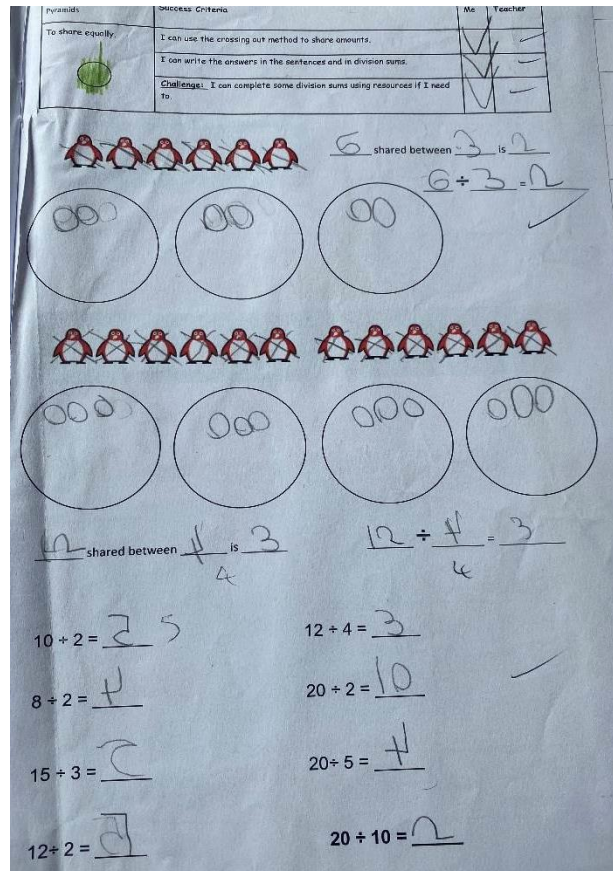
According to Bruner (1966), at the stage of Symbolic representation, language becomes an essential mode of thinking and knowledge development. Learners no longer use concrete objects (enactive) or images (iconic) rather, pupils are able to draw upon these past experiences to imagine a concept abstractly and use symbolic or algebraic notation without dependency on real objects or images. Learning at this stage is presented in the form of abstract symbols both verbally and within learning activities containing the exploration and use of symbols corresponding to a field of mathematics.

Symbolic representation in Year 1 interchanged with that Iconic. Pupils would typically use pictorial representations and imagery initially before undertaking a task which would be focused on symbols and icons. For example, during a lesson on sharing equally, Poppy only introduced Symbolic representation as the final task for pupils in which they were presented with division number sentences to complete (image 31).

Pupils were expected to read the sentences aloud and complete the sum. Video and field notes show all pupils (of all demographics) were competent in 'reading' the divide symbol ($\div$) to accurately assert the

task required, there appeared to be no variances in synthesising the algebraic representation and its meaning. One might suggest that the close proximal use of Iconic representation facilitated such a comprehension.

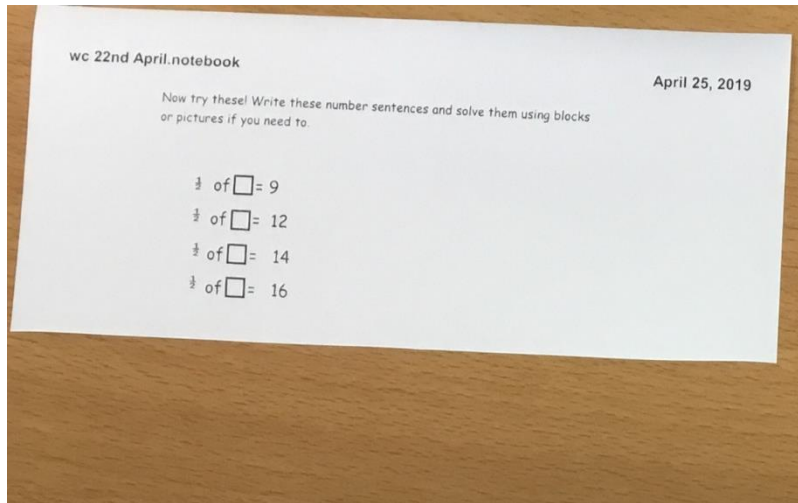
Image 32: Teaching Input- Year 1



However, both Samisoni (new arrival Service child and previously identified as a higher attainer) and Lacey (home-grown Service, previously identified as a higher attainer) reverted back to the use of Iconic representation (such as drawing groups in Samisoni's case) or using fingers for counting (in Lacey's case) to complete the Symbolic structure. This would suggest a difficulty in pupils' ability to work solely within the constraints of Symbolic representation and structure. This was also observed in Year 2.

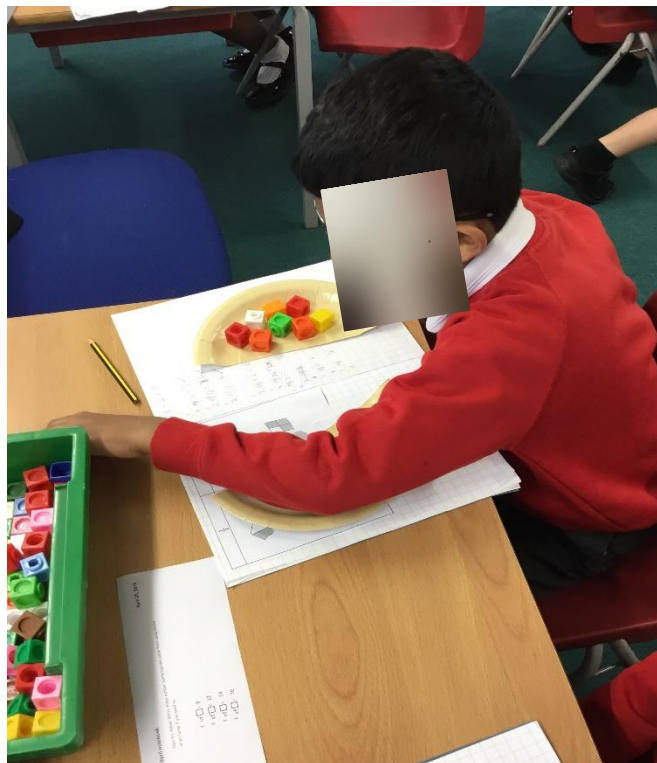
Having delivered a whole-class teaching input on finding fractions of a given quantity, pupils were tasked with solving missing fraction sentences, finding the total having been given the half (image 32). As with Year 1, pupils across all demographics were confident and confident in recognising the remit of the task, reading the missing fraction sentence aloud to either themselves or the adult supporting the group, as with Mostafa (non-Service, lower attainer). However, yet again, pupils struggled to complete the task without reverting back to Enactive or Iconic representation to elicit the required knowledge.

Image 33: Learning Task- Year 2



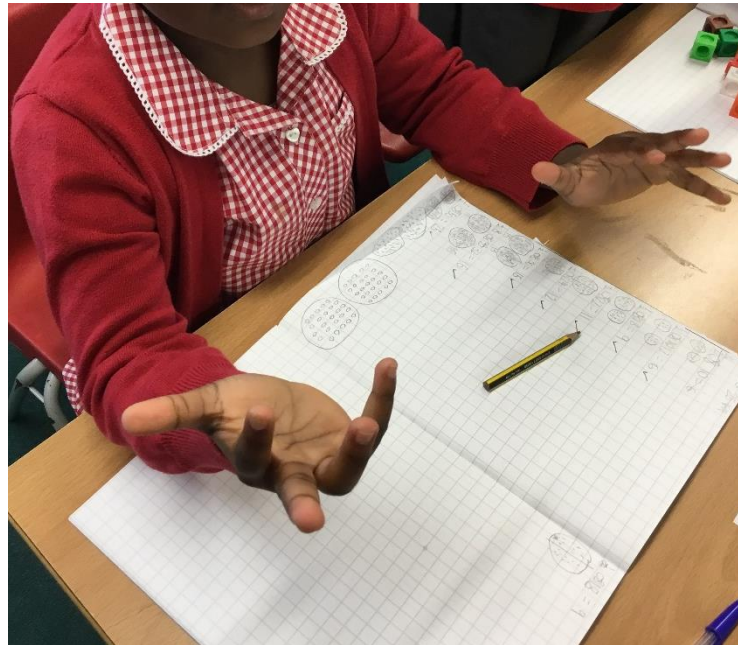
For example, having independently read the Symbolic representation of the task (image 29), without prompting Mostafa (non-Service, lower attainer) got up from his table, located a tray of Multilink cubes and a half template used in the previous lesson the day before, and set about establishing the answer to the Symbolic representation through Enactive actions (image 33).

Image 34: Learning Task- Year 2



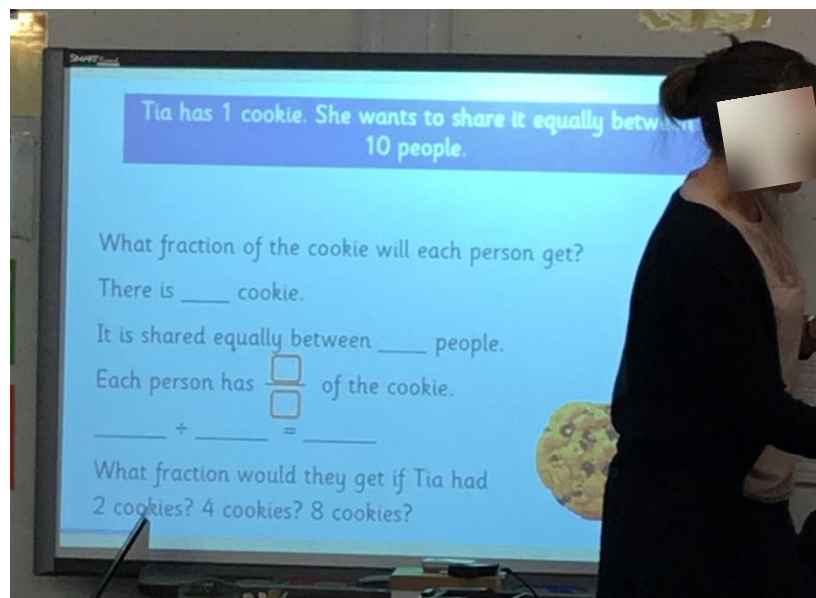
Similarly, Elodie (newly-arrived Service, higher attainer) undertook the same task, equally confident in deciphering the Symbolic representation, yet as with Mostafa, reverted to both Iconic (drawing two halves and sharing dots equally) and Enactive (counting on her fingers) representations (image 34).

Image 35: Learning Task- Year 1



In Year 3, Nancy elected to undertake Symbolic representation in a similar way to Poppy and Helen. During a whole-class input to support pupils in connecting tenths to place value, and division by 10, Nancy presented the subject matter (image 32) not in its final form, rather are encouraged pupils to organise and discover for themselves the relationships that existed amongst items of information.

Image 36: Teaching Input- Year 3



For both Molly (non-Service, higher attainer) and Morad (non-Service, high attainer, EAL) arriving at a plausible but tentative solution began with grasping meaning and the structure of the problem through analytical steps. Both pupils (working separately) displayed an anticipatory attitude in that they expected certain actions and knowledge would be needed or required such as dividing or multiplying to engage with the representation. Field notes captured this:

Molly: [reading question quickly to herself] Ok, so basically, I'm going to be dividing 1 by 10

Field notes (20) Year 3 lesson

Morad: I'm just going to multiply [the answer] by 2 and 4 and 8, its so easy

Field notes (21) Year 3 lesson

From their comments, it can be presumed that the pupils had an attitude of expectancy in knowing what to do. However, data does not capture as to the basis for this expectancy in that we cannot ascertain whether it was prior experience, word cues, preferred learning style etc. However, it would appear that such intuition advanced pupils' ability to 'translate' representations and operate within various structures more freely and successfully. Consequently, Symbolic representation appeared most effective when pupils could reduce ideas to forms that they could grasp. Perhaps then, where pupils had not truly grasped an idea, they equally struggled to grasp the Symbolic representation.

This then reaffirms the notion of readiness. Cited as a key aspect of the NCETM's Five Big Ideas, readiness or coherency is that which permits the progression to higher more advanced forms of knowledge and understanding.

6.9 Representation and Structure: How this relates to the literature

Bruner's (1966) theory of representation and structure in mathematics stresses the importance of how pupils internalise and understand concepts through different modes of representation. Bruner suggested that learning is an active process in which pupils create new ideas or concepts based on their current or past knowledge. He emphasised three modes of representation that are essential for effective learning in mathematics:

- Enactive (representation through action)
- Iconic (visual and other summarising images)
- Symbolic (algebraic and mathematical symbols)

During data analysis, enactive representation (which is action-based) was frequently employed by Key Stage 1 teachers (Poppy- Year 1 and Helen- Year 2) when beginning learning, that is to say at the start of a problem-solving task, when introducing a new concept or when modelling a new concept. In this sense, teachers represented knowledge through physical actions. Pupils of all abilities were observed to use manipulatives (e.g., counters, multilink, or dienes) to initiate their learning by interacting with the materials.

During Poppy's interview, when asked what she considered prior to planning a maths lesson, she made specific reference to her consideration of motor responses and hands-on learning or direct experiences for pupils; this was frequently reflected in her practice in which she used a wide range of tactile resources. In considering the impact of this, in Year 1, previously identified as lower attaining Service children

responded to the use of enactive representation and structure positively. Pupils such as Andrew appeared to benefit from being able to 'see and discover' mathematical concepts through representations and structure. Andrew and others were supported in moving beyond the simple memorisation of procedures or rules, to instead establishing a deeper, conceptual understanding of mathematics. In using the concrete materials Poppy provided (enactive representation), pupils began to manipulate resources and in doing so, begin to formulate mathematical ideas through tangible experiences. For instance, when learning to share equally into different amounts, Polly (Year 1) provided pupils (of all abilities) with a range of items such as empty egg boxes, cake trays and sweet boxes to use when sharing given quantities. Pupils discussed how many groups there were, such as 12 using an egg box, and then set about sharing a given number of dienes ones.

An additional positive impact of representation and structure for Service children previously identified as lower attaining, was that their intuition was better supported. The notion of intuition in mathematical teaching and learning has already been discussed within mathematical thinking. However, in using enactive representation, data captured instances of pupils using and developing their intuition. Intuition, in this context, refers to a learner's ability to understand and reason about mathematical ideas without relying solely on formal rules or procedures. Andrew's discussions and interactions suggest he was able to see patterns and discern relationships which underlay the key concept (equal division). It could be suggested that the visual and concrete structure helped Andrew and his peers to see the consistency in mathematical ideas, supporting them to make intuitive leaps and generalisations. Given this, it would appear creative thoughts and ideas were better facilitated and serviced.

Similarly, in Year 2, Everly, a home-grown Service pupil previously identified as lower attaining, responded to representation and structure positively as demonstrated through her willingness and keenness to test various hypotheses and recall prior knowledge. Learners such as Everly made inferences or predictions about mathematical relationships, patterns, or properties (such as when finding fractions of a given quantity), and then used the various forms of representation provided by the teacher to verify and refine those hypotheses. In doing so, pupils deepened their understanding of concepts (such as equivalent fractions) and promoted higher-order thinking, as they moved between concrete to pictorial and then to abstract levels of reasoning.

The use of representations and structures also appeared to support independent learning in this same pupil group (Service pupils, previously identified as lower attaining). Field notes captured pupils exploring and visualising to solve problems without the reliance of adult intervention. Bruner (1966) strongly urged discovery learning. Learners were encouraged to discover mathematical concepts independently or in groups to actively form their understanding, rather than passively receiving information. Working in this way supports learners to internalise concepts through multiple representations, which leads to deep conceptual understanding and flexible problem-solving skills.

For example, in Year 3, Albert (newly arrived Service pupil, previously identified as lower attaining) was able to utilise visual representations to support his understanding of decimal numbers. In doing so, the otherwise arguably abstract system of decimals was presented in such a way as to better support pupils in finding connection between the mathematical concept being taught and the real world. Furthermore, it appeared that enactive representation involved encoding physical action-based information and storing it in one's memory.

However, it would appear that teachers in younger year groups, such as Year 1 and Year 2, employed the use of tactile resources more typically, and given this, enactive representation was more prevalent in younger year groups. Enactive data in older year groups was harder to capture and seemed less instinctive by comparison to younger year groups. However, Bruner's (1966) Iconic (visual and other summarising images) representation was more typical of its use across all year groups. This may be attributed to the fact visual representations can be used in teaching almost all topics in mathematics.

Bruner's (1966) research has had a profound influence on how mathematics is taught, particularly in primary education, where building a strong foundation of conceptual understanding is key.

6.10 Coherency

An important feature of the teaching for mastery or maths mastery approach is the focus on systematic, thoughtful curriculum design and lesson planning in order to 'foster deep conceptual and procedural knowledge' (NCETM, 2014a). Consequently, lesson planning emerges as a key component in striving to achieve the NCETM's definition of coherency.

Coherency runs through each of the Five Big Ideas: mathematical thinking, fluency, variation, representation and structure alongside coherence. In using this model, the aim is to share a common base for knowledge amongst all pupils. Learners need to share enough common reference points to enable all students to learn steadily, albeit at differing rates and in response to varied approaches. Consequently, coherent mathematics lessons help pupils develop mathematics conceptually; instructional tasks provide pupils the opportunities to learn the concepts embedded in the tasks, and the tasks pupils do in the classroom determine how students think about the content. Given this, I will begin discussions on coherence relating to lesson planning.

Lesson Planning

The NCETM (2014a) describes instructional coherence as the interrelation of all Five Big Ideas, the notion of connectedness from structured content and classroom activities. Given this a coherent mathematics lesson is goal-orientated and content-focused, being delivered via a structured discourse.

During interviews, teachers were asked what considerations they made prior to planning mathematics lessons. Helen (Year 2) and Ruth (Year 4) were particular about considering the children's prior learning experience. In particular, Helen associated this with the unique context of the school's transient military community and the arrival of new Service children.

Ruth: So, what they already know? Yeah, so sort of a baseline where they're coming in from.

Interview with Year 4 Class Teacher

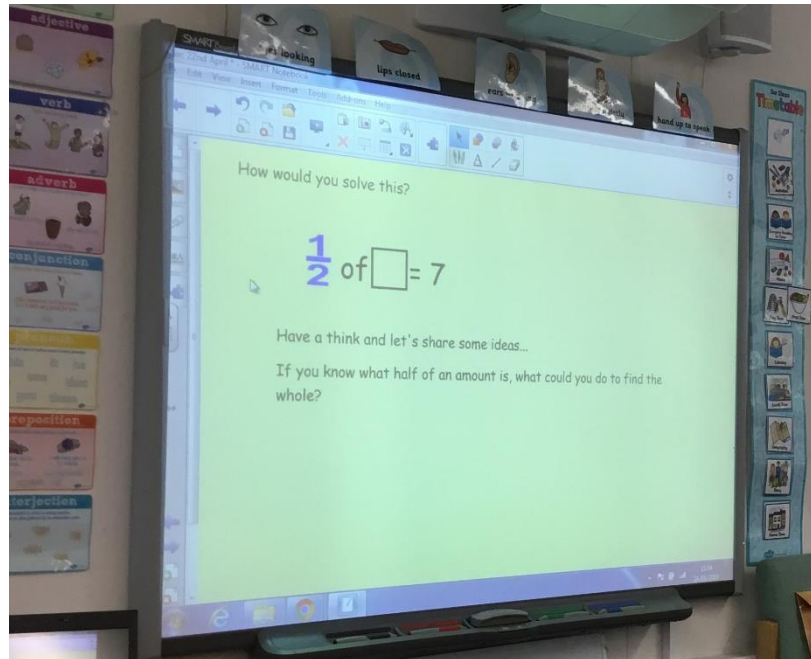
Helen: Currently I take into consideration, first of all, the cohort that were here last year, because I'm...so slightly more aware of their, the current abilities... I find it's necessary to set up activities which allow me to gauge their understanding, particularly when some of the resources that we use maybe they haven't really had a chance to use in their school.

Interview with Year 2 Class Teacher

The desire to ascertain pupils' "baseline" or "current abilities" was frequently captured at the start of teachers lessons in which the first discourse was to assign a task for pupils to think about and discuss as a

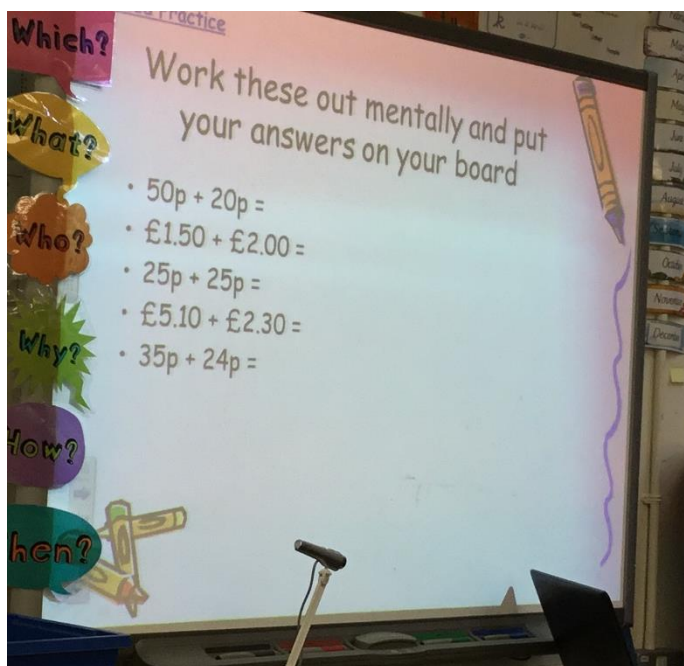
whole-class in order to establish commonly held notions which teachers then either confirmed or readdressed through direct instruction.

Image 37: Teaching Input- Year 2



For example, Helen (Year 2) began a lesson with a missing part activity (image 36). Pupils were presented with an incomplete fraction sentence to which they were challenged to complete. To this effect, the task design appeared to be a means by which for Helen to provoke pupils' understanding related to reading fractions and recognising the function of the numerator and denominator. Additionally, the task also elicited pupils' understanding of known multiplication and division facts. Field notes show Helen then established the topic and purpose of the activity ascribing the goal and aim of the lesson.

Image 38: Teaching Input- Year 4



Similarly, in Year 4, Ruth provided an initial opportunity (image 37) for pupils to recall and use previous knowledge to identify the strengths and needs of the class. Integral to this was the opportunity for pupils to discuss their methods and/or solutions. During this time, Ruth was observed to have waited, walked between pupils or pairs of children, listening to discussions and giving some encouraging comments. Pupils were then asked to report their conclusions, describing verbally the essential features of place value and decimal place when working with money. Leading the discussion, Ruth shifted between individual work to group and then class discussion. In this way, Ruth appeared better positioned to push pupils to think further than solving the problem at hand, instead considering more generalised theories. For example, having discussed $35p + 24p$ Ruth introduced the notion of $35p + £5.10$, taking aspects from previously answered question and creating a new problem. In doing so, she then moved pupils towards considering adding amounts of money using expanded and compact addition. Consequently, Ruth was able to utilise the task to provide more opportunities for pupils to apply their conceptual understanding and deepen learning.

Flowing smoothly from one discourse to another was captured in Poppy's lessons. Poppy routinely began lessons with a problem or consideration which raised a question regarding how this could be solved using new knowledge. Consequently, the rationale of lessons was established via these questions. In order to find the answer, pupils had to go further with Poppy to learn what would come next. For example, during one lesson on sharing equally field notes provide an account of events (however, the absence of some pupils' informed consent means this cannot be included in analysis). Poppy began by posing the problem that some teachers in the school had been gifted a bag of sweets and they wanted to share them fairly. Pupils were attentive as they waited to discover how many teachers and how many sweets had to be considered. Having clarified there were two teachers and twelve sweets, Poppy then presented pupils with an empty egg box and asked the children to consider what iconic representation models the children had previously used (tens-frame) and how this was similar. By posing questions, Poppy then reviewed

pupils' previous knowledge about sharing and connected their previous learning to the current exploration about sharing equally.

After this, Poppy asked pupils to observe her closely as she then modelled taking twelve cubes (representing sweets) and distributed them into the egg box (image 38). Having completed this, she then asked pupils to describe what they had observed her doing. Pupils provided their response and Poppy appeared to be seeking responses which looked at the underlying mathematical idea of sharing equally, I suggest this as Poppy then repeated the task only on this occasion, she deliberately placed two cubes in one egg cup section so that cubes had not been equally shared. Having done so, she then mused as to which of her actions, the first or second, correct sharing. This initiated discussion generalising sharing and grouping quantities. Notably, Poppy did not dominate discussion, rather, she facilitated the opportunity for pupils to think, discuss and generalise based on what they had observed. Pupils were learning through observing, discussing, thinking and communicating with their peers.

Image 39: Teaching Input- Year 1



Providing scaffolding or learning tools (Enactive or Iconic representation) to support pupils' self-exploration, was also captured in Year 2 (Helen), Year 3 (Nancy and Judith) and Year 4 (Ruth). This would suggest a move away from traditional 3-part lessons towards increased parts, in-line with NCETM expectations and coherent lesson design.

However, increased lesson-parts alone are not enough to evoke a coherent mathematical experience, instead anticipating and planning for misconceptions is a key attribute.

Anticipating and planning for misconceptions

Given the NCETMs (2014a) clear parameters for mathematical content that is sequenced in such a way that new ideas are built on previously developed ideas, teachers must have a vision of how learners can build a new idea based on that which has previously been discussed. Consequently, teachers are required

to know and anticipate the barriers to achieving this, be conceptual or in execution. Data collected for Alexander First School suggests teachers approached anticipating and planning for misconceptions in the following areas:

- Anticipating possible solution strategies
- Monitoring pupil responses

Anticipating possible solution strategies

Having good procedural skills, or the ability to carry out procedures to solve problems is arguably a critical component of success in mathematics. However, according to the NCETM (2014a), whilst conceptual and procedural coherency are a continuum, coherency is achieved when procedural skills are grounded in conceptual knowledge.

The ability to correctly encode a problem or perceptually process the important features of the problem and create an internal representation, was cited by teachers as an anticipatory error that would impact possible solution strategies.

During Poppy's (Year 1) interview she describes how she anticipates how children will undertake a task and how she would prepare for this:

Poppy: So I say if you want to solve this problem or this question, this addition sum or something, if you can do it in your head that's fine, if you want to use your hands, if you want to use blocks, if you want to Numicon...so I tend to give them the options but I'll normally model all of them or maybe a handful first and see what works best for them sort of thing.

Interview with Year 1 Class Teacher

This was echoed by Judith (Year 3):

Judith: ...mastery is when they have to choose their methods so using a word problem or an investigation where they have to apply whatever the topic [you've taught] had been.

Interview with Year 3 Class Teacher

Their responses show an anticipation of pupils' procedural actions and in doing so the opportunity to leverage an incorrect idea towards a more productive, or modelled strategy based on conceptual understanding.

Monitoring pupil responses

Self-expression and exploration which promotes observing, thinking and communicating are all cited as essential components in achieving coherency (NCETM, 2014a). Listening to pupils' mathematical conversations provide an insight into their conceptual understanding and identify misconceptions that may be causing more widespread problems. However, further to this is the notion of one of planning pupils' responses through the use of stem sentences. In this way, not only are teachers eavesdropping on conversations, but they are facilitating pupils replies with an emphasis on conceptual responses.

In Ruth's (Year 4) interview she describes her use of instigating and monitoring pupil responses to support coherency.

Ruth: So, if it's something like rounding for instance, if we are figuring out the rules of rounding, so we'll have a sentence on the board and I might not complete that sentence. They've got to tell me the rule. So, I'll put the starting point [stem sentence] on the sentence and key words and key vocabulary that I'm looking for. And then they can tell their talk partner the sentence and it's a sentence we'll keep coming back to and keep repeating so that when they go back to their table, they know what they're doing

Interview with Year 4 Class Teacher

Ruth suggests the need for a strong didactic between teacher and pupil, but also pupil to pupil. Additionally, in her response, Ruth suggests that knowledge is made publicly accountable and reasoning visible through talk. The use of stem sentences and pupil responses to promote coherency was also echoed by Helen (Year 2):

Helen: ...giving the open questions such as 'if you have to pick an odd one out which one would it be? Or, what's the same and what's different? Questions like that I find really useful...So lots of discussion I think is really important...Stem sentences are particularly good.

Interview with Year 2 Class Teacher

In Ruth and Helen's account of monitoring pupil responses to achieve coherency, talk, discussion and interactions becomes cooperative, task-focused, equitable and productive. Furthermore, Ruth suggests the pursuit of precise mathematical language and vocabulary for rounding. If this were applied across all topics of study, one could assume a relational and conceptual understanding far beyond teacher in-put alone.

- Selecting pupil work to share
- Sequencing work for optimal mathematical goals
- Making connections between responses

However, planned tasks and anticipating misconceptions alone are not enough to evoke coherency. Instead, instructional coherency related to the mapping out of the curriculum is equally necessary. Added to this, is instructional coherency.

Curriculum design for coherency

The NCETM have organised mathematics into six themes: structure of the number system, operating on number, multiplicative reasoning, sequences and graphs, statistics and probability, and geometry. Each theme is supported by professional development material 'to develop subject and pedagogical knowledge' (NCETM, 2019b). Added to this is the notion that teaching is underpinned by methodical curriculum design and supported by carefully crafted lessons and resources to foster deep conceptual and procedural knowledge (NCETM, 2014:1). Consequently, planning for small sequential steps means that solid foundations can be secured before establishing deep and sustained learning. According to teacher interviews, it was this deliberate action to take smaller steps towards curriculum coverage that teachers cited as being the most significant shift from previous approaches. When asked what their understanding

of maths mastery was or how their teaching practice had changed since the school's implementation, teachers made comments such as:

Poppy: What really stands out and I think it's the small steps stand out as well because I think when you look at the curriculum, its quite a big...sort of... one sentence [statement] is a big things so its like "counting to a 100 backwards and forwards" that's quite huge, but when it's the small steps its like "counts to 10, counts to 20, counts backwards, uses a number line things like that so that stands out to me as a good thing to use as well.

Interview with Year 1 Class Teacher

Nancy: ...this way you do the small steps...then they should have mastered and be fluent in it and then they can use it rather than going for backing and forth, back and forth [between topics].

Interview with Year 3 Class Teacher

Ruth: So, when we first introduced Math Mastery, it was quite scary, I think, to begin with because it was that Shanghai sort of version and it was quite military. But then when we sort of delved into it a bit more, we realized that actually it was about small step approach to learning and not moving on until they were ready. And that makes complete sense, especially in our school, that they need to have those foundations in place before you can move on and teach 'em anything else...

Interview with Year4 Class Teacher

The response of teachers captures the collective regard for a curriculum design rooted in small-step teaching and learning. Teacher responses suggest an appreciation for this approach in working towards coherency, or as Ruth describes, having the "foundations in place before you can move on." Helen (Year 2) went further in ascribing the importance of small-step teaching and learning:

Helen: I think previously we were, as a school, anymore bound by time. I think we had a maths curriculum which moved on sort of in blocks of 2 to 3 weeks, and the, there was a sense of moving on after two weeks of shape or two weeks of place value had finished. Whereas I feel the maths mastery approach is freeing in that I'm moving at the pace of the class. I'm not, perhaps I should be, but I'm not as concerned or I don't feel as time pressured because I feel that the work that we doing is really ensuring that they're getting to grips with the concepts that they need to be secure [learners]. I feel that I can see, with the class that I've got, the children who were here last year, how it's helping them deal with new concepts in Year 2 and I can see a difference between children who have come in and the children that have been here last year. So, I feel that maths mastery has helped them be really secure with the knowledge that they have.

Interview with Year 2 Class Teacher

The implication from teachers, is that when small-step teaching and learning takes place pupils are able to master a concept, make connections between it and other concepts, can reason with it, and apply it in different contexts. Interestingly, teacher responses suggest this to have been a difference to previously held approaches to curriculum design and delivery.

6.11 Coherence: How this relates to the literature

In considering how coherence was defined within the study, teachers referred to how pupils could make sense of their learning, maintain their joy of, and develop a deep understanding of mathematics. In other words, the study found coherence to be defined as pupils experiencing mathematics as a meaningful, relevant, and consistent subject. However, practitioners also recognised that pupils could not develop such desirable characteristics independently. Coherence appeared to require opportunity initiated by the

teacher. For pupils to experience mathematics as a meaningful endeavour, teachers have to, among many things, create a learning environment that involves inquiry through investigative activities such as experiments, problem solving, and modelling. However, this assumes teachers possess suitable subject knowledge to discern the key aspects of content being taught. Whilst it seems self-evident that any teacher of mathematics should understand the content of what they are teaching, this is not always the case. Findings from this research study would suggest teachers demonstrated extensive knowledge of the *content* of the material they were required to teach. This meant teachers were clear on the coherent sequencing of topics, the material that would be covered within each topic and how learning related to the past and future units of study. Given the high rate of mobility and in-year arrival of pupils, it could be suggested that the context of the school gave rise to such expert knowledge. As teachers adapted to pupils arriving mid-curriculum point, staff were required to consider gaps or missed learning experiences and as a consequence, developed a coherent understanding of sequences of learning. This was evidenced in teacher interviews. When asked: 'To what extent do students' backgrounds influence how they learn mathematics?' all teachers described the impact of Service mobility, particularly the likelihood of gaps in pupils' learning experience. Additionally, staff also described identifying pupils' "baseline" or "current abilities" as a starting point for planning lessons. This would suggest a high-degree of thought and consideration as to the context of learning. Teachers seemed attuned to the notion of understanding what a child may have missed within the curriculum and also what they would be subsequently learning.

Using this knowledge, staff were then prepared to map out and plan activities which provided opportunities for pupils to reflect and make connections between mathematical ideas or representations. This was captured via video footage which frequently and consistently depicted teachers using stem sentences, open-ended questions and problem-solving tasks which prompted pupils to communicate their understanding.

This comprehensive understanding was beneficial to all pupils, but especially Service children, in particular, newly arrived Service children who had previously been identified as lower attaining. Previously lower attaining Service children were better supported in moving from one topic of study to another as their prior learning needs and experience had been identified and in doing so, teachers were better placed to anticipate possible struggles. Additionally, pupils were better supported in connecting aspects of learning and therefore coherency. Teachers could recognise where learning had been missed and act accordingly to support them.

One of the research questions posed: what are the challenges and opportunities for pupils, particularly transient pupils, when 'Teaching for Mastery' is the guiding approach to their mathematics lessons? It would seem that the aspect of coherency according to the NCETM's Big Ideas was of great benefit to all pupils, but especially Service children previously identified as lower attainers. For these pupils, different curricula, teaching methods, and classroom environments can be especially detrimental, as they may already struggle with foundational mathematical concepts.

According to French (2003, p.3) 'a teacher's ability to prepare effective lessons and to respond perceptively and flexibly to the multitude of difficulties that pupils encounter with mathematics is dependent on their own depth of understanding of the topics involved and their own powers of mathematical thinking, as well as their more general pedagogical skills and understandings.' Given that a TfM curriculum design emphasises depth over breadth, that is less subject content but taught with greater precision and depth, it could be argued that TfM better supports teachers in doing this.

However, whilst data suggested secure knowledge of the content of the curriculum, there lacked evidence of the same level of expertise when considering the subject material itself. That is to say, the subject knowledge needed to expose and highlight certain features to ensure coherency as defined by the NCETM's Five Big Ideas, was not always evidential.

Liping Ma's (1999) research on coherency in mathematics teaching and learning, highlights the importance of deep conceptual understanding and pedagogical coherence in mathematics education. Her comparative study between Chinese and American elementary school teachers brought significant insights into how coherence can be achieved in the teaching and learning process.

One of Ma's (1999) fundamental conclusions was that Chinese teachers, despite less formal education compared to their American counterparts, demonstrated a much deeper and more coherent understanding of fundamental mathematical concepts referred to as Profound Understanding of Fundamental Mathematics (PUFM). This deep knowledge enabled them to connect different mathematical ideas seamlessly, fostering coherence in their teaching. Teachers with PUFM could explain not just how to solve a problem but also why certain procedures work, linking concepts across different topics.

Data collected during the study showed when given the opportunity, some pupils asked demanding questions about ideas that were within the school curriculum. Teachers attempted to respond appropriately, offering the benefit of their insight and the interaction between pupil and teacher certainly encouraged pupils to be curious about mathematics. However, in-depth, subject-related responses were generally absent and with that, the opportunity to extend pupils' knowledge and understanding.

Hiebert et al. (2003) described instructional coherence as the unification of all mathematical components within a lesson; whilst Wang and Murphy (2004) interpreted instructional coherence as the connectedness of the structured content and classroom activities. These perspectives on instructional coherence emphasised the importance of interrelated content and activities in a lesson. 'A coherent mathematics lesson is goal-oriented and content-focused, being conducted by a sequence of structured classroom discourse moves' (Liang, 2013, p234). Even though instructional coherence has been brought up as a key factor of effective teaching, few studies have been conducted to explicitly analyse what a coherent lesson looks like and how it works. This study goes some way to provide an insight into coherent practices.

6.12 Conclusion to Results and Analysis

Structural and pedagogical discourses shape school mathematics to facilitate learning in particular ways. The premise by which the model of the NCETM's Five Big Ideas (2017) anchors itself is that of maths mastery model closely associated with Far Eastern practices, such as Shanghai approach.

Data analysis has concentrated on how the NCETM's Five Big Ideas (2017- website) were implemented and responded to by both staff and pupils. To maximise the potential of external representations, selected theoretical lenses have allowed for a better understanding of how data has been included or excluded for analysis and under which aspect of the Five Big Ideas it resonates with.

Summary

This chapter begins with the notion of separating each of the Five Big Ideas in order to better understand how each is enacted and the response of identified pupil groups. Whilst the Five Big Ideas are considered cohesive, in order to truly define TfM it is necessary to analyse each one separately. In doing so, the reader is offered an in-depth understanding of how the NCETM's definition of TfM is enacted and the associated response to this by both practitioners and learners.

The process of analysing the data has been determined and the theoretical lens through which analysis has occurred explained. Analysis showed an awareness from teachers that the NCETM's TfM approach elicited some innovative practices which differed from the status quo, in particular the notion of teaching less but in greater depth and ensuring competency before moving on to a new concept. However, practitioners who had been teaching for longer than 8 years were quick to share the familiar nature of both policy change and 'common sense' teaching and learning approaches. It seems encasing such 'common sense' within a policy endorsed by external agencies (Ofsted, DfE) legitimised that which some were already advocates for. For practitioners newer to teaching, there was a certain assumption that the TfM way was 'normal' practice. Consequently, practitioner willingness to enact policy was consistently high either because teachers simply did not know any other way, or because the approaches resonated with practitioners.

The next chapter considers each Big Idea and the analysis in greater detail.

7 Chapter 7: Discussion

This chapter presents a critical and contextual discussion of the research findings, focusing on how the NCETM's Five Big Ideas are interpreted and enacted in practice within a Service school environment. Teaching for Mastery (TfM), despite its widespread adoption, remains a complex and often contested pedagogical approach. While national policy and professional development programmes provide a broad framework, the day-to-day implementation of TfM depends heavily on teacher agency, school ethos, and pupil context.

The chapter begins by situating the research within current debates surrounding the policy trajectory of mastery mathematics, including tensions between neoliberal standardisation and school-level adaptation. It draws on recent scholarship (e.g. Pratt & Alderton, 2023; Coles & Helme, 2022) to explore how TfM can act simultaneously as both an empowering and constraining force for practitioners. The unique challenges faced by Service children—such as frequent school transitions, disrupted prior learning, and varied curricular experiences—add further complexity to the ways in which mastery is understood and delivered.

Three overarching themes guide the discussion: (1) the influence of practitioner beliefs and values on TfM enactment, (2) the role of teacher content knowledge and confidence in supporting conceptual teaching, and (3) the significance of learner context in shaping pedagogical decision-making. These themes are examined in relation to pupil voice, classroom observation data, and national and international literature.

The chapter also highlights moments of innovation where staff adapted mastery principles in responsive and inclusive ways—particularly through their use of variation, structured talk, and problem-solving strategies. By focusing on these site-specific interpretations of TfM, the study contributes to a broader understanding of how educational reforms are recontextualised in practice.

Ultimately, this discussion reasserts the importance of context-aware, learner-sensitive teaching, positioning the Five Big Ideas not as rigid mandates, but as flexible tools that can be meaningfully adapted to meet the needs of diverse and mobile learners.

7.1 Introduction

The purpose of this chapter is to interpret and critically discuss the findings presented in Chapters 4 to 6, situating them within current academic, policy, and pedagogical debates surrounding Teaching for Mastery (TfM) and the NCETM's Five Big Ideas. The chapter explores how the observed practices in the case study school both align with and diverge from dominant representations of TfM, particularly in the context of educating Service children whose learning is shaped by high mobility, disrupted prior schooling, and varied curricular exposure.

While TfM has become the prevailing orthodoxy in primary mathematics education in England (Boylan et al., 2019; NCETM, 2022), it is not a singular or universally applied model. Instead, as Shearman (2021) argues, mastery carries multiple meanings and is often interpreted differently depending on teachers' values, school culture, and the pressures of accountability. The present study supports this position, revealing that while the NCETM's Five Big Ideas were central to lesson planning and school discourse, their

enactment was contingent on context. In this case, that context was a military school with a high turnover of pupils and a complex demographic profile.

Recent literature has highlighted a tension between the intended aims of TfM—depth, inclusivity, conceptual understanding—and the realities of its implementation in diverse schools (Coles & Helme, 2022; Pratt & Alderton, 2023). This tension was clearly visible in the case study, where teachers negotiated between fidelity to policy and responsive adaptation to pupil needs. In doing so, they demonstrated a form of situated professionalism that combined structured pedagogical approaches with relational, flexible teaching.

Drawing on these findings, this chapter introduces an original theoretical extension to the NCETM’s Five Big Ideas by proposing the addition of two further constructs: Community and Context, forming a conceptual model of the **‘Seven Big Ideas for Teaching for Mastery in Complex School Settings’** (see Figure 9).

- Community, as defined here, relates to the sense of collective belonging that underpins effective teaching and learning. It encompasses children feeling part of the school community, parents feeling accepted and welcomed, and staff demonstrating shared commitment and cultural buy-in. In transient communities such as military schools, where relationships are frequently re-established, this sense of belonging becomes pedagogically significant. It influences not only classroom dynamics but also pupil engagement and teacher motivation. Alternative conceptual terms might include ‘Connection’, ‘Collective Ethos’, or ‘Relational Capital’, but ‘Community’ remains a powerful descriptor grounded in this study’s data.
- Context reflects the structural and operational realities that influence how mastery is implemented. In small schools—particularly those with fluctuating staffing, limited funding, or a narrow leadership structure—context determines access to resources, curriculum planning capacity, and the ability to sustain professional development. Teaching assistants, often Service spouses with no prior educational experience, bring a distinctive dynamic to learning support that may not be accounted for in national TfM frameworks. The inclusion of context as a ‘big idea’ recognises that mastery is not enacted in a vacuum. It invites greater attention to the ecological conditions of school life. Alternative terms might include ‘Conditions for Implementation’, ‘Structural Ecology’, or ‘Pedagogical Infrastructure’—but again, ‘Context’ retains clarity and relevance.

Seven Big Ideas for Teaching for Mastery

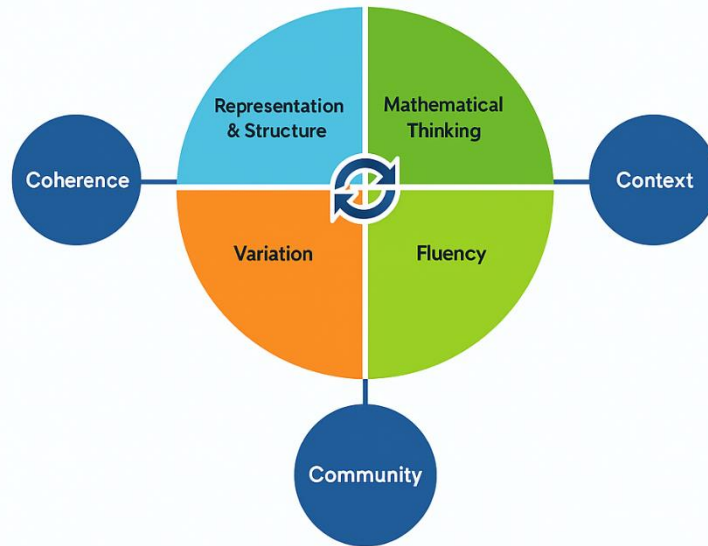


Figure 9: Proposed Seven Big Ideas

By proposing a Seven Big Ideas framework, this study offers a grounded, practice-informed model that expands the conceptual and practical scope of TfM. These additional dimensions are not intended to replace the existing Five Big Ideas but to amplify and support them, particularly in schools where conventional assumptions about stability, staffing, and resources do not hold. This adapted framework has the potential to inform future guidance for schools operating in high-mobility or low-capacity contexts, and to refocus attention on the sociocultural conditions necessary for deep mathematical learning to occur.

7.2 Practitioner Values and Beliefs

The first theme emerging from the analysis is the pivotal role of practitioner values and beliefs in shaping the enactment of Teaching for Mastery (TfM). While national policy and the NCETM offer structured frameworks for delivery, how these are interpreted in day-to-day practice is highly dependent on teacher ideology, professional identity, and their alignment with the ethos of the school. The case study revealed that teachers' beliefs about pupil potential, inclusion, and the purpose of mathematics education significantly informed their use of the Five—and proposed Seven—Big Ideas.

In this context, the introduction of 'Community' as a sixth Big Idea is particularly relevant. Many staff expressed a strong commitment to building a relational and inclusive school culture, seeing this as foundational to learning. They described how Service children's sense of belonging—both to the school and to classroom routines—was often disrupted by frequent moves, changing friendships, and unfamiliar pedagogies. In response, teachers intentionally embedded relational practices into their mathematics teaching. For example, paired problem-solving, mixed-attainment grouping, and dialogic talk were used not just as strategies for mastery, but as vehicles for reintegration and social-emotional connection. These

practices echo the importance of affective belonging within learning communities, a point rarely addressed in TfM literature but fundamental to the lived experience of high-mobility pupils.

The commitment to shared values extended beyond pupils. Staff described their own buy-in to the school's ethos—many citing the unique emotional rewards and responsibilities of working in a military context. For some, this alignment fostered an internalised professionalism that motivated them to innovate beyond prescriptive schemes. For others, however, TfM conflicted with prior pedagogical habits or personal definitions of effective teaching. Shearman's (2021) Q methodology study on the multiple meanings of mastery reinforces this observation, showing that while some teachers embrace mastery as liberatory, others view it as restrictive or overly technical.

The tension between autonomy and compliance was further complicated by the abundance of mastery-aligned materials now available. Several staff voiced concern that schemes and textbooks labelled as 'mastery-based' offered little guidance on implementation and often reinforced procedural teaching. These concerns mirror those identified by Boylan et al. (2018), who note that commercial schemes risk reducing TfM to content coverage rather than conceptual development.

What emerged from the case study, therefore, is a version of mastery rooted in professional discretion, shaped by a shared sense of mission to support Service pupils. This contrasts with a compliance-driven model where fidelity to the framework is prioritised over responsiveness. By adding Community as a core pedagogical idea, this study captures the cultural infrastructure necessary for TfM to take root. In such settings, the affective and ethical dimensions of teaching are not secondary to pedagogy—they are integral to its success.

7.3 Teacher Subject Knowledge and Confidence

The second theme to emerge from the research concerns the confidence and subject knowledge of teachers in delivering mathematics through a Teaching for Mastery (TfM) approach. While the NCETM's Five Big Ideas—particularly Fluency, Variation, and Mathematical Thinking—provide a framework for structured, conceptually rich teaching, their effective delivery relies on a secure understanding of mathematical structures and an ability to interpret and respond to pupil reasoning. The findings of this study indicate that levels of teacher confidence varied significantly, often shaped by prior experience, professional development opportunities, and the realities of the school's staffing profile.

In small schools such as the case study site, structural constraints often shape who leads mathematics teaching. Leaders with multiple roles—such as the Headteacher acting as Maths Coordinator—must navigate competing priorities and limited time for subject-specific CPD. Furthermore, high staff turnover and reliance on early career teachers or teaching assistants (often Service spouses with limited school-based experience) added further layers of complexity. These challenges underscore the importance of adding 'Context' as a sixth pedagogical construct in the Seven Big Ideas framework. As a situated factor, Context helps explain why mastery principles may be adopted unevenly or with adaptations not accounted for in national policy.

This reflects Al-Murani et al.'s (2019) findings on variation theory in practice: where teacher subject knowledge is secure, variation becomes a powerful lens through which pupils are supported to make fine-grained distinctions and generalisations. Where confidence is low, however, variation may be reduced to procedural repetition, or underused entirely. Teachers in this study described this tension explicitly—some felt empowered to explore multiple representations, while others leaned heavily on

schemes to ‘stay safe’, particularly when faced with mixed-attainment classes or newly arrived Service pupils with unknown prior learning.

The NCETM emphasises structured curriculum sequencing and careful progression through small steps, but this assumes a level of subject knowledge that cannot be taken for granted. Coles and Helme (2022) argue that the transition from research to policy to practice is rarely linear, and often fails to account for the pedagogical preparation required for teachers to enact the Five Big Ideas with fidelity and flexibility. The present study supports this assertion. Teachers described CPD that introduced the language of mastery but lacked depth in areas such as generalisation, conceptual reasoning, and the use of stem sentences. As a result, they often relied on pre-written lesson materials without always fully understanding the pedagogical rationale behind them.

Despite these constraints, examples of innovative practice did emerge. Some teachers used video analysis as a tool for reflective planning, focusing on the fine detail of pupil responses. Others developed bespoke activities for children new to the school, using variation principles to diagnose gaps in understanding. These practices suggest that even in contexts with staffing and resource challenges, TfM can be implemented meaningfully when teachers are given space to reflect and supported to build content knowledge over time.

In light of this, the Seven Big Ideas model offers a more ecologically valid representation of what it takes to implement mastery. ‘Context’ is not merely background—it is a pedagogical condition that interacts with content delivery, teacher cognition, and professional development systems. A mastery approach cannot be divorced from the structural and human capacities of the school. When these are recognised and supported, teacher confidence increases, subject knowledge deepens, and pupils benefit from more precise and inclusive mathematics teaching.

7.4 Learner Context: Service Children, Mobility, and Inclusion

The third major theme to emerge from the study relates to learner context, with a specific focus on Service children and the role of mobility in shaping both their learning experiences and teacher responses. The findings revealed that pupil transience was not merely a background factor; rather, it was a defining characteristic that shaped pedagogy, classroom relationships, and curricular continuity. Service children often joined the school mid-year, with unpredictable prior experiences in mathematics, varied curriculum coverage, and in some cases, limited confidence or disrupted learning histories.

This context creates a particular challenge for Teaching for Mastery (TfM), which relies on carefully sequenced, cumulative learning designed to promote depth before acceleration. As noted by Oliver (2024), mastery teaching often assumes stable cohorts who progress through a carefully constructed curriculum together. In high-mobility schools, this is rarely the case. As such, the principles of coherence and fluency must be flexibly interpreted—creating opportunities for consolidation and diagnostic teaching that meets pupils ‘where they are’, rather than expecting uniform progression.

This underscores the value of proposing ‘Context’ as a seventh Big Idea. TfM cannot be implemented effectively in transient, resource-stretched schools without accounting for the discontinuities Service children experience. Teachers described modifying schemes, revisiting earlier content, and creating differentiated entry points to accommodate new arrivals. These pedagogical shifts were often informal, under-recognised, and rooted in a deep understanding of their learners. In this way, adaptation became a professional act of care, not a deviation from the mastery model.

Equally important was the theme of ‘Community’, which appeared critical in supporting Service pupils’ emotional wellbeing, engagement, and mathematical confidence. For many children, their sense of inclusion and belonging directly influenced their willingness to participate in mathematics lessons. Teachers recounted how peer relationships, structured classroom routines, and opportunities for collaborative talk helped create a sense of security—particularly important for pupils navigating frequent relocations. This aligns with the EEF’s (2022) recognition that social-emotional stability underpins effective cognitive engagement in maths learning.

Notably, pupil voice data revealed that older children (particularly in Year 4) were articulate about how mastery practices—such as using representations, solving non-routine problems, or explaining their reasoning—helped them feel capable in maths. These reflections resonate with Oliver’s (2024) argument that mathematical agency is central to deep learning, but often neglected in mastery policy frameworks. In this study, agency was fostered through intentional teaching practices that validated pupil contributions and encouraged metacognition.

However, mastery also presented challenges. Some younger children found stem sentences confusing or repetitive, and newer pupils occasionally expressed anxiety about catching up. These findings suggest that while TfM offers valuable structure, it must be implemented with an awareness of how learners perceive and experience its routines. The NCETM’s Five Big Ideas provide the pedagogical core, but without the additional focus on community and context, mastery may risk becoming technocratic rather than transformative.

The Seven Big Ideas model proposed in this thesis provides a conceptual scaffold for recognising and responding to these complexities. Community and Context do not dilute mastery; rather, they deepen its relevance by foregrounding the human and relational dimensions of teaching. In schools with high levels of mobility, social complexity, and fluctuating resources, these additional dimensions are not optional—they are essential.

7.5 Conclusion to Discussion

This chapter has critically examined the implementation of Teaching for Mastery (TfM) in a Service school context, drawing on practitioner voices, pupil experiences, and lesson observation data. Through the thematic exploration of practitioner beliefs, teacher subject knowledge, and learner context, the discussion has illustrated that the NCETM’s Five Big Ideas—while pedagogically robust—require thoughtful adaptation to meet the needs of dynamic and diverse school environments.

In doing so, the chapter has introduced and justified two new conceptual constructs: Community and Context. These emerged directly from the situated realities of the case study school, where high mobility, structural constraints, and the emotional needs of Service children shaped both the delivery and interpretation of mastery. Together with the original Five Big Ideas, they form a new model—The Seven Big Ideas for Teaching for Mastery in Complex School Contexts.

This expanded framework acknowledges that mastery is not simply a set of strategies or a curriculum model. It is a pedagogical ecosystem in which structural conditions, relational practices, and school culture are as important as variation, fluency, or representation. When teachers are given the professional space to respond to context, and when schools actively nurture belonging and connection, TfM becomes more than a technical solution—it becomes a vehicle for inclusion and empowerment.

The case study findings therefore challenge narrow interpretations of fidelity to policy, calling instead for a responsive, reflective approach to mastery that honours both the academic integrity of the Five Big Ideas and the lived complexities of schools like this one. The following chapter will reflect on the broader implications of these findings, propose areas for future research, and offer a final commentary on the contribution this study makes to the field of mathematics education.

Summary

This chapter critically explored the implementation of Teaching for Mastery (TfM) within a Service school context, drawing on findings from teacher interviews, pupil voice, and classroom observation. It revealed that while the NCETM's Five Big Ideas remain central to mastery pedagogy, their successful enactment is deeply contingent on the school context and the values of its practitioners.

The study identifies three key themes: practitioner beliefs, teacher knowledge, and learner context. Teachers' ideological stances shaped their interpretations of mastery, influencing decisions about grouping, task design, and assessment. Subject knowledge and confidence varied, particularly in small schools with high staff turnover and limited CPD access. Meanwhile, Service children's high mobility and emotional needs posed unique challenges to curriculum continuity, requiring responsive, flexible teaching that often stretched beyond the original TfM model.

In response to these realities, the chapter proposes a new conceptual framework: The Seven Big Ideas for Teaching for Mastery in Complex School Contexts. This model introduces two new constructs—Community and Context—as necessary extensions to the NCETM's Five Big Ideas. 'Community' reflects the affective, relational environment that supports learning, while 'Context' recognises structural conditions such as staffing, funding, and transience that impact enactment.

Rather than prescribing a single model of implementation, this expanded framework honours the complexity of practice in high-mobility schools. It positions mastery not only as a pedagogical toolkit, but as a cultural and contextualised approach to equitable mathematics education.

The Seven Big Ideas model holds promise for informing future policy and CPD, particularly in schools facing instability, transition, or resource constraints. It also contributes to a richer understanding of how mastery principles can be enacted with both academic rigour and human sensitivity.

8 Chapter 8: Conclusions

This final chapter presents a synthesis of the study's main findings and theoretical contributions. It reflects on how Teaching for Mastery (TfM), as framed by the NCETM's Five Big Ideas, is interpreted and enacted in a unique Service school context. Drawing on the lived realities of both teachers and pupils, the chapter revisits the study's research questions and offers a critical overview of the emerging themes.

The case study revealed that while the Five Big Ideas remain pedagogically central, they do not operate in a vacuum. Rather, their successful implementation is shaped by professional judgement, relational dynamics, structural conditions, and school culture. In response, this chapter proposes the Seven Big Ideas for Teaching for Mastery—a new conceptual framework which incorporates two additional dimensions: Community and Context. These ideas emerged directly from the data and respond to the need for more inclusive, contextually grounded models of teaching in diverse and mobile school populations.

The chapter goes on to consider the implications of these findings for schools, policymakers, and teacher educators. It outlines how the Seven Big Ideas might be used to inform practice and influence CPD and curriculum design, particularly in Service schools or similarly complex educational settings. Finally, it highlights the limitations of the study and proposes areas for future research to further explore the intersection between mastery pedagogy, mobility, and equity in mathematics education.

8.1 Drawing Together the Threads

This concluding chapter brings together the key arguments and findings of the thesis and articulates its contributions to the field of mathematics education, curriculum enactment, and pedagogy within the unique context of a Service school. The research set out to explore how the NCETM's Five Big Ideas for Teaching for Mastery (TfM) were understood and enacted in practice, with a particular focus on how contextual and relational dimensions shaped this implementation. While the Five Big Ideas—coherence, variation, fluency, representation and structure, and mathematical thinking—provide a strong conceptual foundation for mastery learning, this study has found that two additional constructs, Community and Context, are critical to making mastery meaningful and sustainable in high-mobility, resource-constrained school environments.

As explored in earlier chapters, the setting of the research—a small primary school serving Service children—offered a rich, situated site in which to examine both the promises and limitations of a standardised national pedagogy when applied to a non-standard school environment. The case study design provided the opportunity to understand TfM as an enacted, lived, and adaptive process. Analysis of lesson footage, practitioner interviews, and pupil reflections revealed a tension between the aspirational consistency promised by TfM and the daily realities faced by teachers navigating shifting cohorts, constrained staffing, and varied pupil prior knowledge.

In response to this, the thesis has developed an extended conceptual framework: the Seven Big Ideas for Teaching for Mastery. While the original Five Big Ideas remain essential for designing cognitively rigorous and coherent mathematical experiences, the additional ideas of Community and Context reflect the importance of belonging, culture, leadership capacity, and institutional realities. They emerge not as

policy supplements but as pedagogical necessities for ensuring that mastery is accessible, inclusive, and meaningful for all learners—especially those who are mobile, vulnerable, or underserved by conventional frameworks.

This chapter begins by revisiting the research questions and aims outlined in Chapter 1 and reflects on how they have been addressed. It then moves to summarise the study's key findings, drawing attention to the three major themes discussed in Chapter 7: practitioner beliefs and values, teacher subject knowledge and confidence, and learner context. It offers a reflection on the significance of the Seven Big Ideas as an original contribution to knowledge and practice, followed by a discussion of the implications for schools, policymakers, and teacher education. The chapter concludes with an acknowledgment of the study's limitations and suggestions for future research.

Overall, this thesis challenges the assumption that fidelity to TFM frameworks alone guarantees pedagogical success. Instead, it positions mastery as an ecological endeavour, dependent on the alignment of curriculum, relationships, professional capacity, and contextually responsive leadership. The Seven Big Ideas model thus provides a more nuanced and inclusive lens through which future scholarship and practice can approach mathematics mastery in diverse school contexts.

8.2 Revisiting the Research Questions

This study was driven by the central question:

- How are the NCETM's Five Big Ideas interpreted and enacted in a primary school serving Service children?

Three sub-questions supported this inquiry:

- How do teachers understand and apply the principles of Teaching for Mastery in their daily practice?
- What is the experience of Service children engaging with mathematics through a mastery framework?
- In what ways do school context and community influence the implementation and adaptation of the Five Big Ideas?

These questions were framed within a case study methodology that recognised the situated nature of pedagogy and the importance of contextually bound professional knowledge. At the time of designing the study, the selected school had only recently begun to embed a Teaching for Mastery approach, guided primarily by the NCETM's Five Big Ideas. As the school's headteacher and mathematics lead, I was deeply involved in promoting this pedagogical shift—an insider position that brought both unique insights and ethical complexity.

Throughout the thesis, the implications of this dual role have been critically examined. My positionality required me to remain reflexively aware of the power dynamics inherent in my relationship with staff, parents, and pupils. This awareness shaped the methodological design, particularly in the interview phase, where I avoided direct questions on leadership efficacy and instead encouraged open reflection through semi-structured prompts. It also influenced how I handled observational data, taking care to foreground pupil responses and teaching practices rather than performance judgments.

As explored in Chapter 5, a key adaptation to the data collection process was the decision to incorporate video recordings of lessons. This method allowed me to step back from the evaluative gaze typical of school observations and instead focus on moments of conceptual development, pupil interaction, and teacher decision-making. The video data also served as a powerful tool for participant debriefing—where teachers were invited to interpret footage themselves, reinforcing co-construction of meaning and allowing their professional voice to guide the analytical lens.

The analysis addressed each of the sub-questions in depth. Chapter 6 identified how teachers internalised and enacted elements of TfM, often aligning with the Five Big Ideas but modifying them in practice based on personal beliefs, available resources, and class-specific demands. This provided a nuanced answer to the first sub-question, demonstrating that TfM is rarely implemented as a rigid model, but rather as a negotiated pedagogical process.

The second sub-question, concerning pupils' experiences, was explored through voice-led analysis in both classroom settings and pupil interviews. Service children described a range of emotional and academic responses to mastery practices. Older children appreciated the clarity and logic of stem sentences, manipulatives, and visual models, while some younger or newly arrived pupils found routines unfamiliar or overwhelming. Importantly, pupil responses highlighted the relational elements of teaching—trust, encouragement, and belonging—as foundational to mathematical confidence. These responses began to point toward the emerging significance of Community.

The third sub-question brought the influence of Context into sharp focus. In a small Service school, subject leadership is often fragmented; resources are stretched; teaching assistants may arrive with limited school experience; and pupils often enter or leave at unpredictable points in the curriculum. These structural conditions directly impacted how mastery was implemented. Coherence and fluency, in particular, became difficult to sustain unless contextual adaptation was permitted. It was through this sub-question that the limitations of the Five Big Ideas were most exposed, and the need for an expanded conceptual model became apparent.

Thus, in revisiting the original research questions, this section confirms that while the Five Big Ideas remain relevant, they are not sufficient to explain or guide effective mastery teaching in all contexts. The data collected, interpreted through reflexive and situated methodology, led directly to the development of the Seven Big Ideas for Teaching for Mastery, which will be further elaborated in the next section.

8.3 Theoretical and Practical Contributions

This section outlines the original contributions of this research to the fields of mathematics education, pedagogy for Service children, and the policy-practice interface. While the NCETM's Five Big Ideas have become a widely endorsed framework for Teaching for Mastery (TfM), this study demonstrates that their implementation and efficacy are significantly shaped by school-level realities. By examining how TfM operates in a Service school, the study provides both theoretical insight and practical guidance—culminating in the proposal of an expanded framework: the Seven Big Ideas for Teaching for Mastery in Complex School Contexts.

8.3.1 *Contextualising the Five Big Ideas for Service Children*

To date, there has been limited curriculum-specific research addressing the needs of Service children, particularly within the mathematics domain. This study is among the first to explore how TfM is experienced and adapted within this demographic. As children of military personnel frequently move

between schools—nationally and internationally—their education is marked by discontinuity. This study found that the Five Big Ideas required re-contextualisation to meet the learning trajectories of such pupils, especially in terms of coherence and variation. The emphasis on sequenced learning and fluency was shown to support pupils transitioning mid-year, particularly when prior gaps could be addressed without reteaching entire topics.

This contribution is significant not only because it recognises the unique barriers faced by Service children, but because it offers practitioner-informed adaptations that could be used to guide policy and practice in similarly transient populations.

8.3.2 Pedagogical Adjustments in Response to Mobility

A clear practical contribution of the study is its documentation of pedagogical strategies that teachers used to manage high levels of pupil turnover. For instance, some teachers emphasised structured routines (e.g. stem sentences, manipulatives, journaling) to provide a sense of familiarity for new arrivals. Others adapted their use of variation to build conceptual bridges across different curricular experiences. These findings highlight the need for TfM guidance that recognises the transitional nature of some learners' educational experiences.

This adaptation sits at the heart of the new “Context” dimension proposed in the Seven Big Ideas model. It emphasises that mastery pedagogy is not simply about consistency or fidelity to design principles—it must also be flexible, responsive, and grounded in the structural realities of schooling.

8.3.3 Teacher Training and Professional Development in Mastery Contexts

The study identified tensions between TfM as a national policy and its classroom-level implementation. Teacher interviews revealed significant variation in both content knowledge and pedagogical confidence—especially in areas such as reasoning, problem-solving, and conceptual generalisation. Some teachers drew on traditional models (e.g. procedural fluency and repetition), while others leaned toward exploratory or constructivist approaches. These differences were strongly shaped by the teachers' own educational values and previous training.

Consequently, this study contributes to professional development discourse by underscoring the need for maths-specific CPD that supports adaptive pedagogy. In high-turnover schools like the one studied, CPD must also account for staff mobility and non-specialist teaching assistants. This ties into the “Community” dimension of the Seven Big Ideas, as a shared professional ethos and trust among staff are essential for sustaining mastery practices.

8.3.4 Policy Enactment in a Military Community Context

A further theoretical contribution lies in the study's exploration of policy enactment within a tightly-knit military community. Unlike more generic school environments, this school's culture was influenced by the rhythms and relational dynamics of military life. Teachers were not simply delivering a curriculum—they were enacting pedagogy within a system shaped by deployment cycles, family separation, and psychosocial pressures on children.

This required leaders and teachers to mediate between national TfM expectations and localised interpretations of what their pupils needed most. In doing so, this study shows how curriculum policy is never enacted in isolation. It is reinterpreted, reshaped, and negotiated within specific communities—

supporting Pratt and Alderton's (2023) view that neoliberal curriculum frameworks often overlook contextual and relational complexities.

8.3.5 Bridging Mastery with Social-Emotional Learning

Another distinctive contribution of this study is its attention to the intersection between mastery teaching and pupils' social-emotional wellbeing. In a school where many pupils had experienced parental deployment or multiple relocations, emotional resilience and psychological safety were not supplementary—they were foundational to academic engagement. Teachers emphasised relationship-building, predictable routines, and inclusive dialogue to help children feel secure enough to participate in mathematical reasoning and collaborative problem-solving.

This study therefore contributes to an emerging conversation about the importance of embedding SEMH awareness within mastery pedagogy. For vulnerable or high-needs populations, academic progress and emotional wellbeing are not separate goals but mutually reinforcing processes. The "Community" dimension of the Seven Big Ideas recognises this explicitly.

8.3.6 Coherence as a Protective Factor in Learning Disruption

Finally, this research offers a significant contribution to the conceptual understanding of coherence within TfM. While the NCETM emphasises coherence as a way to structure knowledge development, this study finds that it also serves a stabilising function for transient pupils. When mathematical structures, models, and routines are consistent, they provide a kind of curricular scaffolding that supports continuity even as external circumstances change.

This insight has both theoretical and practical implications. It reframes coherence not just as an instructional tool, but as a mechanism of inclusion—a way to support pupils whose learning has been fragmented. In this way, coherence becomes not only a cognitive principle, but a pastoral one.

8.4 Study Limitations

While this study has generated important insights into the enactment of Teaching for Mastery (TfM) in a Service school context, several limitations must be acknowledged. These relate to the scope, methodology, positionality, and generalisability of the research.

First, the study was based on a single-case design situated within one small, rural Service school in the United Kingdom. Although this setting was carefully selected for its unique characteristics—such as high pupil mobility, tight-knit community culture, and internal leadership of TfM—findings must be understood as contextually specific rather than universally representative. As Yin (2014) notes, case studies offer depth over breadth. The insights generated here provide analytic generalisability rather than statistical generalisability; they are intended to inform theory and practice, not predict outcomes across all schools.

Second, the study was conducted over a relatively short time span, spanning a pilot and main data collection phase during a single academic year. This timeframe limited the ability to track long-term outcomes of TfM for Service children, particularly those who transitioned in or out of the school during the data period. A longer-term, longitudinal design may have allowed for a richer understanding of how coherence, reasoning, and fluency develop over time in transient pupil populations.

Third, my dual role as Headteacher, Maths Coordinator, and researcher introduced the possibility of bias in both data collection and interpretation. Although great care was taken to maintain ethical boundaries—including the use of participant debriefing, video-stimulated reflections, and reflexive field notes—there

remains a risk that staff responses were influenced by professional relationships or power dynamics. This insider position, however, also enabled access to rich, situated knowledge that may not have been available to an external researcher. As discussed in Chapters 5 and 7, this positionality was both a strength and a methodological challenge.

Fourth, the sample size—particularly in terms of pupil interviews and lesson observations—was limited. While the aim was not to achieve breadth, the small sample means that some themes (especially those related to cognitive impact and long-term attainment) could not be explored in depth. The absence of extensive quantitative data or statistical modelling reflects the qualitative nature of the inquiry. This study privileged voice, interpretation, and professional practice over numerical generalisation, in keeping with its exploratory aims.

Despite these limitations, the study offers transferable insights for educators and policymakers working in similarly complex or mobile school environments. The limitations themselves highlight the need for further research to explore the theoretical and practical viability of the Seven Big Ideas across a broader range of contexts.

8.5 Future Research

This study opens up several avenues for future research into the enactment of Teaching for Mastery (TfM) in diverse educational contexts, particularly those characterised by pupil mobility, limited resources, or atypical staff structures. The proposed Seven Big Ideas for Teaching for Mastery offer a conceptual framework that invites both empirical testing and theoretical elaboration. The subsections below outline key areas for future inquiry.

8.5.1 *Longitudinal Studies on Mastery Learning Across Transitions*

One of the most pressing opportunities for future research lies in the long-term tracking of Service children as they move through successive phases of the TfM curriculum. While this study captured pupil responses and learning snapshots within a single academic year, it did not follow students across multiple settings or year groups. A longitudinal design—possibly spanning Key Stages 1 and 2—would enable researchers to explore whether the benefits of TfM, particularly coherence and fluency, persist over time and across schools.

Such research could also examine how the disruption of learning trajectories (e.g. mid-year moves, international transitions) affects concept retention, reasoning development, and mathematical confidence. It would further support the refinement of TfM principles in transient contexts and strengthen the case for curriculum alignment between military schools and receiving schools nationally and internationally.

8.5.2 *Pedagogical Consistency in Schools with High Staff Turnover*

This study found that teacher positionality, confidence, and personal values shaped their approach to TfM—sometimes enhancing pupil engagement, but occasionally undermining consistency. In schools with frequent staff changes, especially those reliant on short-term contracts or teaching assistants with limited formal training, establishing a shared mastery culture presents unique challenges.

Future research could explore how CPD and induction programmes might be designed to embed the Seven Big Ideas across staff cohorts, including non-specialist educators. Studies might also investigate how internal school structures (e.g. coaching, co-planning, lesson study) can mitigate the effects of staffing

instability. This could have significant implications for leadership practice in small or military-affected schools.

8.5.3 Teaching for Mastery and Teacher Beliefs

An unexpected finding of this research was the degree to which teachers' personal ideologies shaped their interpretation of mastery. Some teachers placed value on scaffolded learning and modelled strategies; others emphasised fluency, speed, and independence. These preferences, in turn, shaped the learning experiences available to pupils.

Future inquiry might explore the relationship between teacher epistemologies and TfM enactment more systematically. Are certain conceptions of learning more compatible with mastery? How can teacher beliefs be surfaced, challenged, or supported in professional learning contexts? Such work could inform the development of CPD that addresses not only technical skill but also the conceptual underpinnings of teaching for mastery.

8.5.4 Evaluating the Seven Big Ideas Framework

The Seven Big Ideas model presented in this thesis introduces Community and Context as integral to effective mastery teaching in real-world settings. However, the framework remains exploratory and grounded in one case study. Future research should aim to test, refine, or adapt this model across different school types, including urban, international, and mainstream state schools with similarly complex populations.

Studies might consider how these additional dimensions interact with the original Five Big Ideas. For example, does a strong school community buffer the effects of low fluency or limited subject expertise? Does contextual awareness moderate how coherence is maintained in multi-year learning sequences? Addressing such questions would strengthen the theoretical basis of the Seven Big Ideas and ensure its practical utility in curriculum design, policy, and CPD.

8.5.5 Clarifying and Exemplifying the Five Big Ideas

One limitation identified in the research was the lack of clear exemplification within the current NCETM guidance. Teachers in the study noted difficulty interpreting what TfM 'looks like' in daily classroom practice, especially when working across multiple schemes, resources, and textbooks.

Future research could focus on developing exemplars of practice—lesson sequences, curriculum maps, and professional reflections—that demonstrate the Five (and now Seven) Big Ideas in action. Particular attention could be paid to variation, which teachers in this study associated with both differentiation and problem-solving challenge, but often struggled to implement effectively. Comparative studies across different textbook-based and scheme-free settings (e.g. Shanghai vs England) would offer valuable cross-cultural perspectives.

8.5.6 Curriculum Fidelity vs Professional Autonomy

Finally, an emerging area of interest lies in the tension between teacher autonomy and curriculum fidelity. In this study, teachers adjusted their practices not only to suit pupils' needs but also to reflect their own professional identities. In contrast, high-performing international jurisdictions such as Singapore and Shanghai use structured textbooks and lesson scripts to deliver uniform mastery instruction.

Future research might examine the impact of scripted versus flexible approaches to TfM on both teacher satisfaction and pupil outcomes. Are there trade-offs between fidelity and responsiveness? Is there an

optimal balance that preserves consistency without constraining teacher agency? Such work would contribute to a more nuanced understanding of how TfM can be scaled without being standardised.

8.6 Final Reflections

This thesis began as an exploration of how the NCETM's Five Big Ideas for Teaching for Mastery could be understood, implemented, and sustained in a primary school shaped by transience, resilience, and complexity. It ends with a deeper, more situated understanding of mastery pedagogy—not as a fixed model to be replicated, but as a responsive, evolving practice rooted in context and community.

As a headteacher-researcher embedded in the day-to-day realities of the school, I was uniquely positioned to observe how teaching for mastery was not just enacted, but negotiated—between policy and practice, between structure and freedom, and between national priorities and local relationships. This insider status brought both privileges and challenges. It enabled me to access nuanced layers of school life often hidden from external observation, yet required continuous reflexivity to minimise bias and respect participant autonomy. As the study progressed, so too did my own understanding of leadership: not as directive, but as enabling—creating the conditions in which teachers and pupils could meaningfully engage with mastery principles.

Perhaps the most powerful insight to emerge from the research was the realisation that the Five Big Ideas, while pedagogically sound, were not sufficient on their own to ensure success in all contexts. It was only through attention to the specific challenges faced by Service children—the emotional toll of deployment, the disruption of frequent moves, the instability of peer networks—that the need for a more expansive model became clear. The addition of Community and Context as Sixth and Seventh Big Ideas was not merely a theoretical gesture, but a grounded response to lived experience.

These findings matter beyond this single case study. Many schools across the UK and globally are grappling with similar complexities: staff shortages, high mobility, shifting demographics, and increasing mental health needs. The Seven Big Ideas offer a framework for these schools to rethink mastery not as a top-down reform, but as a shared pedagogical ethos, responsive to people and place.

As the education landscape continues to evolve in the face of policy pressures, workforce challenges, and growing pupil diversity, the call for inclusive, coherent, and context-sensitive mathematics teaching has never been louder. This research, grounded in one Service school's story, makes a small but meaningful contribution to that call. It is my hope that these ideas—shaped in community, tested through practice, and animated by care—will support educators, leaders, and researchers in building mastery models that not only teach well, but teach wisely.

Summary

This chapter presented the core contributions of the study, highlighting how Teaching for Mastery (TfM) can be adapted to better serve the needs of transient and diverse pupil populations. Central to this is the development of the Seven Big Ideas framework, which extends the NCETM's model by adding Community and Context—two critical elements identified through situated research.

Findings suggest that coherence, fluency, and representation are enhanced when teaching aligns with school culture, pupil background, and staff capacity. The study highlights the role of teacher beliefs and training in shaping mastery pedagogy and emphasises the importance of leadership in supporting consistent implementation in high-mobility environments.

Limitations—such as the single-case design and insider role—were acknowledged, alongside clear directions for future research, including longitudinal tracking and further testing of the Seven Big Ideas in broader settings.

Overall, this study repositions TfM as a responsive, context-aware approach to mathematics education, particularly valuable for schools supporting Service children and similarly mobile communities. Key contributions include the contextualisation of the NCETM's Five Big Ideas for transient Service children, the articulation of Community and Context as essential pedagogical components, and the identification of specific adaptations needed to support continuity and inclusivity in mathematics learning. The thesis also contributes to discourse on teacher agency and curriculum fidelity, showing how pedagogical interpretation is often shaped by personal and cultural values as much as by policy guidance.

The limitations of the study—its scale, timespan, and insider positioning—have been acknowledged, but do not diminish the richness of the insights generated. Rather, they point to a need for wider research exploring the practical enactment of TfM across varied settings.

Future directions include longitudinal studies to understand the sustained impact of TfM on mobile pupils, investigations into teacher induction and CPD in high-turnover schools, and testing the applicability of the Seven Big Ideas framework in broader educational contexts.

Ultimately, the study reframes mastery as a locally negotiated practice—one that gains strength not only from coherence, fluency, and representation, but from its capacity to respond to people, places, and the lived conditions of learning.

9 References

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12.1 Data Coding Sheet

Appendix 1- Coding Sheet

	1. What is your understanding of maths mastery and how has that understanding evolved?	2. What sorts of things are taken into consideration when starting to think about planning mathematics lessons?	3. To what extent does the maths policy influence your practice?	4. How much do you direct student learning in Mathematics ?	5. What methods of teaching and learning do you consider as mastery?	6. What role does your relationship with the pupils play in your mathematics lessons and their mathematical understanding?	7. What are your thoughts on memorised learning and mathematics?	8. What do you feel students respond most effectively to in mathematics?	9. What do you feel students respond least effectively to in mathematics?	10. How do you encourage students to use their creativity in mathematics?	11. To what extent do students' backgrounds influence how they learn mathematics?	12. Should the curriculum emphasise mathematical concepts or application of these concepts?	13. How much do you worry about <u>students</u> attitudes towards mathematics?	14. What have you learnt most from maths mastery training and/or approaches?
Year group	Key words- INTERVIEWS													
Y1 Poppy	small step resources practical				concrete material reasoning small step Stem sentences	approachable calm routine non-directive safe	personal exp. greater depth need to know	practical challenges choice prove-it talk/explain modelled	sheets less practical no variation	teach' modelled	low expectations parental engagement	both	positive parents surprised	time allowance stem sentences
Y2 Helen	small step time allowance number	cohort last year		retention application	open q's discussion variation challenge q's Stem sentences	approachable attitude	reasoning	variation discussion prove it hands on	problem solving listening no concrete	resources self-selection	<u>parents</u> attitude resources streaming mobility gaps	both	positive risk takers	sense of freedom rich experience curious child-centred depth
Y3 Nancy	broaden	prior knowledge fluency									language mobility gaps		life aspirations	
Y3 Judith	breadth depth	curriculum resources	curriculum	topic	methods topic varied		times tables division misconceptions	video visual practical motivation	text book motivation	word problems	parental support movement change order	balance	differences positive attitude	different perspective
Y4 Ruth	fear	prior knowledge misconceptions		practical model teacher talk errors	small step rules vocabulary Stem sentences	safe fun modelling	times tables reasoning understanding	challenge tactical	word problems easy talking at them	artistic drawing pictures variation	gaps diff. approaches diff. schemes	application	engaged accomplishment build skills getting better	not fear no pressure better pace
Year group	Habits observed- LESSON OBSERVATIONS													
	Coherence Connecting new ideas to concepts that have already been understood, and ensuring that, once understood and mastered, new ideas are used again in next steps of learning, all steps being small steps.			Representation and Structure Representations used in lessons expose the mathematical structure being taught, the aim being that students can do the maths without recourse to the representation.			Mathematical Thinking Ideas are worked on by the student: thought about, reasoned with and discussed with others.			Fluency Quick and efficient recall of facts and procedures and the flexibility to move between different contexts and representations of mathematics.		Variation Varying the <u>way</u> a concept is initially presented to students, by giving examples that display a concept as well as those that don't display it. Also, carefully varying practice questions so that mechanical repetition is avoided, and thinking is encouraged.		
	Colour code- teacher observations													
	Colour code- pupil observations													
Y1 Poppy	- Stem sentences - Modelling methods/approach - Use of apparatus			- Modelling- use of worked examples - Closed procedural tasks			- Talking partner discussion 'Think Tank' (Y4) discussion - Missing parts/incomplete models - True/False and Prove it tasks			- Daily counting - Scaffolded examples (minimum detraction from LO) <u>Prove it/ Stem sentences</u>		- Multiple representations - Links to other subject areas (money and place value)		

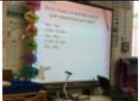
	- Stem sentences - Use of apparatus	Modelling- use of worked examples	- Stem Sentences - Verbal explanations and responses - Whiteboard demonstration of methods - Creating own questions to be answered	Reliance on counting with fingers	
Y2 Helen	Stem sentences	- Equivalents show in various pictorial representations - Asks how many different ways could you divide... - How many different ways can you make...	- Would you rather questions to promote reasoning - Would you rather have...or... (real life context) - How many pieces would you need to make it whole again?		
	Use worked examples to track back through steps taken		- Children respond with "If I had...it would be..." - Repeating key principles in their response (...parts make a whole) - If I had...I would need... - I know that 8/8 makes a whole		
Y3 Nancy	Stem sentences				
Y3 Judith	- Stem sentences - Visual resources and reminders (place value chart) - What does denominator mean? - On this example what is the denominator? - Key facts learnt (how many minutes in an hour?)	- Near doubles used as an example - Semi-completed examples	- What about?...? - Exchange...fraction for... - How many more needed for a whole? - Yesterday we...how will that help with today's lesson?	- Number bond questions - Recalls fraction facts - Commutative Law 30 days have September... - My turn, your turn - Video/songs - Chant it with me	Convert fractions/decimals
	- Answers given in full sentences - Key facts recalled (there are 60 minutes in an hour) - Partitioning for ease and speed	- Pictorial representations - Narratives (stories to work)	- Key vocabulary used during discussions - Ideas based on what they've previously heard "my mum said" - Use strategies such as estimating ("I'm making a clever guess")	- Number bonds used - Heavy preference for addition and subtraction - I know the answer is...because...	Use of part, part whole template
Y4 Ruth	- Stem sentences - Use worked examples modelled by teacher - Modelled steps then independent work - Use w/b then work mentally - First, then, next	- Demonstration of answers and processes used - Links to other aspects of mathematics previously learnt - Children explain actions of teacher "why did it <u>do</u>..." - Formal written methods	- Proving their mathematical theories by explaining actions - Proving their theory by sorting and classifying		Remembering multiple elements to their maths
	First, then, next	Formal written methods	Now I've done this I can do this (making a number x10 smaller)		
Year group	Characteristics- PHOTOS				
	Coherence Connecting new ideas to concepts that have already been understood, and ensuring that, once understood and mastered, new ideas are used again in next steps of learning, all steps being small steps.	Representation and Structure Representations used in lessons expose the mathematical structure being taught, the aim being that students can do the maths without recourse to the representation.	Mathematical Thinking Ideas are worked on by the student: thought about, reasoned with and discussed with others.	Fluency Quick and efficient recall of facts and procedures and the flexibility to move between different contexts and representations of mathematics.	Variation Varying the <u>way</u> a concept is initially presented to students, by giving examples that display a concept as well as those that don't display it. Also, carefully varying practice questions so that mechanical repetition is avoided, and thinking is encouraged.

Y1
Poppy



V2
Helen



Y3 Judith					
Y3 Nancy				 	
Y4 Ruth		 			
Year group	Characteristics- WORK SCRUTINY				
Y1 Poppy	See pupil's books				
Y2 Helen					
Judith					
Y3 Nancy					
Y 4 Ruth					

12.2 Observation Tick Sheet

Teaching for Mastery Data Collection Sheet

Comments to include reference to:

- Frequency of action/interaction
- Length of time
- Gender
- Ability of pupil
- Experience of teacher (years in service)

Clear structure to the lesson including small steps

Opportunities for critical thinking

Speaking in full sentences

Sound subject knowledge

'Ping Pong'

Making connections

12.3 Interview Questions

Interview Questions

1. What is your understanding of maths mastery and how has that understanding evolved?
Focus: Attitudes to mathematics
2. What sorts of things are taken into consideration when starting to think about planning mathematics lessons?
Focus: Teaching strategies
3. To what extent does the maths policy influence your practice?
Focus: Teaching strategies
4. How much do you direct student learning in Mathematics?
Focus: Teaching strategies
5. What methods of teaching and learning do you consider as mastery?
Focus: Cognition development
6. What role does your relationship with the pupils play in your mathematics lessons and their mathematical understanding?
Focus: Classroom climate
7. What are your thoughts on memorised learning and mathematics?
Focus: Memorisation/fluency
8. What do you feel students respond most effectively to in mathematics?
Focus: Application of knowledge
9. What do you feel students respond least effectively to in mathematics?
Focus: Application of knowledge
10. How do you encourage students to use their creativity in mathematics?
Focus: Variation theory
11. To what extent do students' backgrounds influence how they learn mathematics?
Focus: Army cohort
12. Should the curriculum emphasis mathematical concepts or application of these concepts?
Focus: Pure and applied mathematics
13. How much do you worry about students attitudes towards mathematics?
Focus: Attitudes to mathematics
14. What have you learnt most from maths mastery training and/or approaches?
Focus: Informed practice

12.4 Informed Consent Letter- Pupils

Headteacher – Miss Khokar

Thursday 28th March 2019



Parental Notification Letter
Informed Consent

Dear Parent/Carer,

As part of my PhD at Brunel University London, I am conducting a research study in Mathematics, working with Dr Gwen Ineson and Professor Mike Watts. I am looking into the most effective ways to develop children's Mathematical understanding and ability, particularly that of Service children.

I hope that as a school we will be able to use this insight to achieve the best possible progress and attainment for our pupils, especially those who experience frequent school changes.

A normal sequence of Maths lessons will be taught whilst I will be observing the strategies employed by the children, their strengths, areas of development and engagement in activities. I will observe the teacher's instruction methods and take notes. I may collect work samples, but I will remove your child's name.

Your child will not do anything outside of their normal classroom activities, and as such, their participation can only benefit from this activity. If you are happy for your child to participate in the study please and return the slip below. If it is not returned, your child will not be included.

Once the research has been collected and analysed I would be happy to share the findings with you so you have a greater understanding of how your child learns and which methods benefit them.

If you have any questions or concerns about the study, please contact me.

Sincerely,
Miss Khokar

Agreement to Participate:

I have read the above information and had the opportunity to have any questions about this study answered and agree to my child's participation in this study.

Child's name:

Your name- printed:

Signed:

Dated:

12.5 Informed Consent Letter- Teachers

Headteacher – Miss Khokar

Thursday 28th March 2019



Parental Notification Letter
Informed Consent

Dear Miss XXXX,

As part of my PhD at Brunel University London, I am conducting a research study in Mathematics, working with Dr Gwen Ineson and Professor Mike Watts. I am looking into the most effective ways to develop children's Mathematical understanding and ability, particularly that of Service children.

I hope that as a school we will be able to use this insight to achieve the best possible progress and attainment for our pupils, especially those who experience frequent school changes.

A normal sequence of Maths lessons will be taught whilst I will be observing the strategies employed by the children, their strengths, areas of development and engagement in activities. I will observe your instruction methods and take notes. I may collect work samples, but I will remove your child's name.

Your child will not do anything outside of their normal classroom activities, and as such, their participation can only benefit from this activity. If you are happy for your child to participate in the study please and return the slip below. If it is not returned, your child will not be included.

Once the research has been collected and analysed I would be happy to share the findings with you so you have a greater understanding of how your child learns and which methods benefit them.

If you have any questions or concerns about the study, please contact me.

Sincerely,
Miss Khokar

Agreement to Participate:

I have read the above information and had the opportunity to have any questions about this study answered and agree to my child's participation in this study.

Child's name:

Your name- printed:

Signed:

Dated:

12.6 Focus Pupils Synopsis

CASE STUDY PUPILS

Year 1

Pupil	Characteristic	Description
Tahib	Non-Service EAL Higher Attainer	Tahib joined the school in Nursery class coming from a non-Service family. Tahib is identified as being a high achiever and is consistently working above age-related expectations. He speaks English as a second language. Tahib is an eager learner and was very keen to share his love of maths and actively participated in all lessons.
Lacey	Service- Home Grown Higher Attainer	Lacey joined the school in Nursery class. Although she is a Service child, she has been at the school for the last 3 years with no moves in between. Lacey is identified as being a high achiever and is consistently working above age-related expectations in Reading, Writing and Maths. Whilst being reserved, Lacey fully engages in her maths lessons and is keen to participate.
Andrew	SEN Lower Attainer	Andrew is Service child who joined the school in the Summer term of Reception. Andrew's educational experience is broad, including time spent overseas for postings. He has attended 2 previous settings, 1 for Nursery and 1 Reception and now attends Allenby First School. Andrew is identified as having additional learning needs, particularly in relation to retention and recall. Andrew reports finding maths difficult and is often reluctant to participate in lessons.
Samisoni	Service- New arrival Higher Attainer	Samisoni is a Service child who joined Allenby First School in his Reception year. Had previously not attended a Nursery placement. Samisoni has no additional learning needs. Samisoni is keen to learn and engages with adults well, however he can often become distracted and needs reminding not to rush his work in haste.

Year 2

Pupil	Characteristic	Description
Mostafa	Non-Service EAL Lower Attainer	Mostafa joined the school in Nursery class coming from a non-Service family. Mostafa is identified as having undiagnosed learning needs characterised by: - Difficulties in understanding information. - Learning new skills at a slower pace. - Problems with retaining/recalling learnt information. Whilst English is a second language to Mostafa, he is a proficient and capable speaker. Whilst working in a small group with additional adult help, Mostafa actively participated in all lessons.
Warren	Service- Home Grown Higher Attainer	Warren joined the school in Nursery class. Although he is a Service child, he has been at the school for the last 4 years with no moves in between. Warren is identified as being a high achiever and is consistently working above age-related expectations in Maths. Warren has received been diagnosed as dyslexic with writing being a particular struggle. In Reading he is working at age-related expectations.
Everly	Service- Home Grown Lower Attainer	Everly is a Service child who joined the school in Reception and is due to move on to another school at the end of Year 2. Everly is identified as being below age-related expectations but through additional booster groups has been working towards achieving age-related expectations.
Elodie	Service- New arrival Higher Attainer	Allenby School is Elodie's third school with a further school move planned at the end of Year 2. She is consistently working above age related expectations in reading, writing and maths. Elodie is a quiet and more reserved member of the class, yet was still keen to have contributed during lessons.

Year 3

Pupil	Characteristic	Description
Morad	Non-Service EAL Higher Attainer	Morad joined the school in Reception class coming from a non-Service family. Whilst English is a second language to Morad, he is a proficient and capable speaker. He is consistently working at age-related expectations in reading and writing. Maths is a particular strength of Morad's and has potential to be working at depth.
Chris	Service- Home Grown Middle Attainer	Chris joined the school in Nursery class. Although he is a Service child, he has been at the school for the last 5 years with no moves in between. Chris is identified as being a middle attainer in maths and is working towards age-related expectations in reading and writing.
Albert	Service- New arrival LA	Albert is a Service child for whom Allenby is his fourth school. All of Albert's schools have been UK based but across the country (various local authorities). Albert is working below age-related expectations in reading, writing and maths.
Molly	Non-Service HA	Molly is a non-Service child who has been at Allenby since Reception. She is consistently working above age related expectations in reading, writing and maths. Whilst Molly is reported to be a quieter member of the class, she keenly contributed during lessons.

Year 4

Pupil	Characteristic	Description
Nish	Non-Service EAL	Nish joined Allenby School in Year 1. He is a non-Service child who has English as an additional language, although he is a proficient and capable speaker. Nish is working at age related expectations in maths and writing and above age-related expectations in reading.
Freya	Service- Home Grown HA	Freya joined the school in Nursery class. Although she is a Service child, she has been at the school for the last 5 years with no moves in between. Freya is identified as being a high achiever and is consistently working above age-related expectations in reading, writing and maths.
Richard-John (RJ)		RJ is a Service child who joined the school in Reception; he is due to move on to another school at the end of Year 4 and then another school shortly after this owing to a military move. RJ is working at age-related expectations in reading, writing and maths.
Anesha	Service SEN	Owing to military moves, Anesha has moved back and forth between Allenby and other schools over several years. Anesha began Reception at one school, before transferring to Allenby mid-year. She then transferred to another school (Nottingham) at the start of Year 1 before transferring back to Allenby at the end of Year 1. Owing to another military move, Anesha is due to move to another school at the end of Year 4. She is a quiet and more reserved member of the class, yet was still keen to have contributed during lessons. Anesha is consistently working below age-related expectations in reading, writing and maths. She is identified as having undiagnosed learning needs characterised by: - Difficulties in understanding information. - Learning new skills at a slower pace. - Problems with retaining/recalling learnt information.
Alice	Service- New arrival	Allenby School is Alice's third school with a further military move planned at the end of the academic year. Alice has attended schools in a variety of local authorities across the UK. Alice is identified as working at age-related expectations for reading and writing and below age-related expectations in maths.