University of Reading

Beyond a checklist?
A multiple case study exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of the evaluation of primary mathematics teaching.

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Abstract

Whilst evaluation of primary mathematics teaching is a well-embedded element of school improvement practice, the perceptions and experiences of those involved both as evaluators and evaluands are poorly represented and under-researched both empirically and theoretically. Previous research in this field has focused on the evaluation of generic teaching as an essential component of education systems around the world, but consensus on how this is defined, measured and developed is lacking. This study offers new empirical data on current evaluation processes in primary mathematics. Few studies have examined the impact of recent changes in the mathematics curriculum, pedagogy and policy on practice, and none have explored their influence on the evaluative process, evaluators or evaluands. This study also offers a new theorisation of the evaluation of primary mathematics teaching through its use of a conceptual framework that is otherwise absent from recent studies focusing on professional development, professional knowledge, and professional identity. The study therefore aims to offer insight into the perceptions and experiences of evaluating primary mathematics teaching of teachers, mathematics subject leaders and senior leaders and to understand these in the context of the issues outlined above.

15 semi-structured interviews, informed by the completion of reflective timelines, were carried out and documentary evidence in the form of publicly available vision statements for mathematics teaching were collected from each participant's school. Reflexive thematic analysis of interview and documentary data was carried out to identify common themes and these were discussed in relation to an analytical framework formed of three conceptual lenses; professional development, professional knowledge and professional identity.

Key findings highlighted inconsistencies of perception and experience in relation to effective mathematics teaching, knowledge of primary mathematics and evaluation processes, and clarity of purpose and ownership of evaluations. These variations support the conclusion that there is a need for fairer, more coherent, and more useful evaluation processes of primary mathematics teaching and a new model for the provision of these based on mutual engagement, joint enterprise and a shared repertoire of tools is proposed.

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This work is dedicated to Gary and Charlotte, along with a promise that I'm done now.

Declaration: I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Samantha Parkes

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List of Acronyms

ATM	Association of Teachers of Mathematics
BSRLM	British Society for Research into Learning Mathematics
DfE	Department for Education
EEF	Education Endowment Foundations
NCETM	National Centre for Excellence in the Teaching of Mathematics
NC	National Curriculum
Ofsted	Office for Standards in Education
PGCE	Post Graduate Certificate of Education
SATs	Standard Assessment Tests

1. Introduction

The overarching aim of this study was to explore and better understand the evaluation of primary mathematics teaching through the perceptions and experiences of evaluands and evaluators. This chapter will initially problematise the wider context within which this study sits, that of quality of teaching within mathematics education. The origins of the thesis in terms of the personal and professional background of the researcher will also be explained. It then identifies the overarching aims for the study, clarifies the resulting research questions for exploration and outlines the conceptual framework through which the core elements of evaluations and primary mathematics teaching are viewed. It gives a brief overview of the methodology and lastly outlines the significance of the study in terms of its claim to original contributions to knowledge and implications for practice.

1.1 Origins of the thesis – personal and professional background

The origins of this thesis are rooted in three elements of my personal and professional background; my personal relationship with the subject of mathematics, my professional role as a primary school teacher, and my professional roles as a leader in a primary school and subsequently a school advisor with responsibility for evaluating the quality of primary mathematics teaching.

My personal relationship with mathematics as a learner is complicated but, I have come to learn through conversation with many people over time, not unusual. I was competent at school, in terms of passing tests and exams with good enough grades, but I was often frustrated, bored, ashamed of my mistakes and scared of being exposed as someone who was not very good at rapid mental calculation. These feelings led to my 'dropping' of mathematics aged 16 and I did not meet it again in any formal sense until my PGCE training. Further reflections as part of post-graduate studies have enabled me to understand the role that my gender (female) and social class (working class background, first in family to attend university) played in these experiences.

During my PGCE training, I often found the mathematics sessions stressful and again, feelings of inadequacy, frustration and, increasingly, anger often surfaced as my lecturers (perfectly reasonably) expected me to engage with the subject. I often felt that I had 'missed something' and couldn't follow others' reasoning. I needed everything to slow down, to be given the chance to talk through my thinking with someone who would not jump in with the answers or explanations and let me work at my own pace. I cannot recall the evaluations of my mathematics teaching as a student teacher, it must have been considered adequate for me to qualify, but I do wonder if my placements in a Reception class and

then a Y4 class in schools that had planning in place for me to follow were factors that enabled me to mask my fear and consequent avoidance of the subject.

This masking continued into my early career as the first two years were in a Y1 class. Again, I don't know how much of my perceived adequacy in the teaching of maths was relative to the expectations of the curriculum and of the individuals who were assessing it but my perception, looking back and knowing what I know now, is that it was inadequate. I then moved schools and began to teach Year 5. I could no longer mask my lack of confidence and competence when teaching maths, particularly as my teaching assistant was extremely confident in mental calculation and pushed for competence in this with the children on a regular basis. After two years, when I was told I would be moving to Y6 and advised to take on a mathematics subject leadership role as that of mathematics lead became available, it was clear that it was time to face my issues with the subject.

This was a significant turning point for me as it coincided with the nationally funded professional development opportunity to become a Primary Mathematics Specialist Teacher (MaST). This was a two-year, postgraduate course and the influence of it on my teaching career cannot be overstated. I learned that I was, after all, a competent mathematician who had been taught in cultures that prioritised speed, procedural skill and correct answers over connected understanding and mathematical thinking processes, the aspects of mathematical learning that it turned out I was good at.

As I was developing my subject matter, pedagogical content and curriculum knowledge alongside these revelations, I was also required to undertake lesson evaluations of the teachers in my school. This was a complicated experience as I was often evaluating the teaching of colleagues who had considerably more classroom experience than me but had not had the opportunity to consider the mathematics specific knowledge that I was learning. This often led to tensions in feedback as I would attempt to communicate my thoughts on what could be improved in their teaching and be met with responses ranging from polite indifference to outright hostility. This began a long journey in my development of leadership and professional development skills that have resulted in my current values-led position of respect for the relative expertise of individuals, leading to the co-production of professional knowledge, and how a teacher's actions ought to be viewed in the context of their beliefs as influenced by their experiences to this point. These tensions were further exacerbated when I moved into a senior school leadership role, as I began to grapple with the added dimension of an awareness of external pressures on, and a responsibility for, evidencing progress and attainment in mathematics at both Key Stage One

and Two.

1.2 The wider professional context – identifying the problem(s)

Problem 1: A potential lack of shared understanding of the varied purposes and consequences of evaluations

Evaluating teaching quality is securely embedded as an essential component of education systems around the world, but consensus on how this is defined, measured and developed is lacking. As Berliner (2005) argued, "…defining quality in teaching is unusually difficult. Were anyone serious about this issue, they would soon realize that quality is an ineffable concept... Defining quality always requires value judgments about which disagreements abound." (p. 206). In their review of research into 'What makes great teaching?' Coe, Aloisi, Higgins and Major (2014) also acknowledge that reaching a definition is problematic but identify that the cornerstone to which research keeps returning is "...that which leads to improved student progress" (p.2). This seems to be unarguable, however 'improved student progress' is perhaps just as ineffable a concept as 'quality of teaching' when we consider what could be meant by 'improvement' and what could be identified as 'progress'. Indeed Coe et al. (2014) acknowledge that any system for evaluating teacher quality that uses this definition as a guiding principle is only of value if assessments of outcomes reflect the full range of learning that an education system is attempting to secure for its students. This outcome-related definition is reflected in Berliner's (2005) definition of an 'effective' teacher, and Fenstermacher & Richardson's (2005) 'successful' teacher, whilst characterising a 'good' teacher as one who demonstrates the normative logical, psychological and moral dimensions of teaching. To be a 'high-quality' teacher is consequently designed as a combination of being both 'good' and 'effective/successful'.

The processes that schools engage with to identify and develop quality teaching also have a dual purpose. One is to evaluate the current quality of teaching, and the other is to use the information collected to identify developmental points for individual and groups of teachers. These are broadly defined as 'summative' and 'formative' (Firestone & Donaldson, 2019; Paufler & Clark, 2019; Reynolds, Muijs & Trehane, 2003; Tuytens, Devos & Vanblaere, 2020). These categories are defined differently by Hallinger, Heck & Murphy (2014) who use 'teacher performance evaluation' to describe formalised evaluation of teachers' practice by those with responsibility for decision-making, and 'instructional supervision' whose purpose is developmental. The extent to which the purpose of these processes is clearly articulated as either summative or formative, and the outcomes and consequences of these,

strongly influences their perceived value (Liu & Zhao, 2013).

In the publication of the revised Office for Standards in Education (Ofsted) framework (Ofsted, 2022) for school inspections in the United Kingdom (UK) the processes and criteria for inspecting the quality of teaching are outlined, with a separate 'monitoring' handbook (Ofsted, 2022b) to detail the procedures for schools that are judged as 'inadequate' or 'requires improvement' in their most recent inspections. These documents use the words 'evaluate' and 'monitor' relatively interchangeably although 'evaluate' is dominant in the former, and also used in the latter. These two terms are prevalent across education related literature and, although they are not clearly defined by Ofsted, there is broader consensus on their definition which is accurately represented by the following:

> **Monitoring** is the continuous and systematic collection of data on specified indicators in order to provide the main actors of an ongoing development intervention with indications of the extent of progress and achievement of objectives (in relation to allocated resources).
>
> **Evaluation** is the systematic and objective assessment of an ongoing or completed policy, or plan, including its design, implementation and results. It aims to assess the relevance and fulfilment of objectives and strategies with a purpose of informing decision-making.
>
> (Beke, Bird, Sigsgaard & MacEwan, 2015)

Thus, 'monitoring' is akin to the 'formative' purpose of these processes, and 'evaluation' to the 'summative', and this is in agreement with Hallinger et al.'s (2014) use of 'evaluation' to refer to formalised assessment.

Altogether, this provides a context for the evaluative work that is currently undertaken in UK primary schools when attempting to gather information as to the quality of teaching that is evident in each setting. For the purposes of this study, the term 'evaluation', rather than monitoring or assessment, was chosen as an umbrella term for all processes that are undertaken in the pursuit of forming a judgement of teaching quality that is used both summatively and formatively. The use of 'assessment', while free from the nuances of definition described above in relation to 'monitoring' and 'evaluation' above, is too well-embedded as an educational term in reference to leaners' attainment to offer clarity in this study. The use of 'evaluation' also mirrors the predominant language used by Ofsted and thus in schools, and so holds greater shared meaning than other options.

Despite the embedded use of the process of evaluation, the range of terms associated with it and their uncritical use this suggests a lack of shared understanding around the varied purposes and

consequences of evaluations by both evaluators and evaluands is therefore the first problem that this study seeks to address.

Problem 2: The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process

Primary mathematics teaching has undergone seismic shifts in the past decade, beginning with the publication of a revised Primary National Curriculum (DfE, 2013), and continuing with the ever-evolving national implementation of 'Teaching for Mastery' (NCETM, 2023e) beginning in 2014. The revisions to the curriculum foregrounded three core aims for learners of mathematics: that they become fluent, are able to reason mathematically, and problem solve and was "...designed to raise standards..." (NCETM, 2014), largely through the movement of content from the secondary curriculum (e.g. long division, multiplication and division involving fractions) and expectations for end of year attainment moved earlier (e.g. multiplication tables up to 12x expected by the end of Year 4). Internal end of year assessments, and national standardised assessments in the form of end of key stage tests were also changed in line with these expectations. Mastery, in line with Coe et al.'s (2014) most strongly evidenced component of 'great' teaching, '(Pedagogical) content knowledge', moved towards an increased focus on primary teachers' subject-specific knowledge, more comparable to that expected of teachers at KS3 and beyond. This was also reflected in Ofsted's (2022a) introduction of subject-specific 'deep dives' as a mechanism for assessing the quality of a school's curriculum. The current relevance of this is supported by Yee, Rogers, Miller & Galvin (2022) who state, "As we learn more about the teaching and learning of mathematics, it is important that we consider whether the tools we use to measure teaching quality and effectiveness align with current research on evidence-based teaching practices." (p.2).

A lack of understanding about the impact of such significant changes to curriculum, assessment and pedagogy in primary mathematics on the processes employed to evaluate the quality of teaching is therefore the second problem that this study seeks to address.

Problem 3: Under-representation of key stakeholder voices in research and lack of clarity around the relationship between their roles

Multi-academy trusts (MATs) have become increasingly predominant across England since publication of the white paper 'Educational Excellence Everywhere' (DfE, 2016) in which all schools were encouraged to academise and join with other academies to form collaborative groups as part of a school-led system. Within these MATs, school-to-school support was encouraged with "...the best school leaders providing challenge and support for underperforming schools" (p.6). The task of evaluating such 'underperformance' fell to a range of personnel both internally through schools' leadership teams and

externally in the form of privately hired consultants and advisors. Within this system there are consequently a large group of actors who are 'evaluators' as part of their broader role, leading to a wide range of voices attempting to articulate their judgements on the quality of mathematics teaching of both individual teachers and schools. How these voices interact in order to reach agreed judgments to inform actions and decision-making is underrepresented in empirical research to date. Several studies have explored teachers' views (Hopkins et al., 2016; Matsopoulos et al., 2018; Stancic, 2015; Wellington, 2015) and principals' views (Flores & Derrington, 2017; Painter, 2000) of the evaluation process, highlighting professional tensions around a lack of autonomy for teachers and the pressures of accountability for both teachers and senior leaders. However, none have investigated the views of subject (middle) leaders or explored relationships between these within multiple case studies.

This lack of representation of specific stakeholder voices and the relationship between roles is therefore the third problem that this study seeks to address.

Problem 4: The risk of deprofessionalisation of teachers and leaders through the evaluation process

For Fenstermacher (1994), the acquisition of specific technical skill; validation by a collective body and therefore an entitlement to practice such skills; the trust of, and therefore authority over, those who do not possess such skills; a specific institutional setting and a collective ethic rooted in a central ideology and a belief in the necessity of such skills for the betterment of society are all essential factors in defining a 'profession'. These ideas of competence, service, belonging to a community of scholarly practice and perceived credibility encompass the concepts of knowledge and the processes by which they are developed to form criteria by which teachers could identify as 'professional' (Argyris & Schön, 2003; Williams, 2013). Personal autonomy and responsibility and self-governance are also considered to be core components of a 'profession' and here, with its highly regulated service to 'the state', education diverges from classification as a profession, into a 'semi' or 'quasi' profession (Whitty, 2006; Bates, Lewis & Pickard, 2019). Indeed, the absence of teaching from the early lists of male-dominated professions could also be attributed to the diminished status of its largely female workforce, particularly in the primary sector (Bates et al., 2019; Williams, 2013), and the view that a formal education is not necessary in order to carry out the tasks of teaching (Hoyle & John, 1995).

Additionally, when considering the relevance of a collective ethic rooted in a central ideology and a belief in the necessity of such skills for the betterment of society (Fenstermacher, 1994) to education, reaching consensus is a particular challenge. The societal, economic, and political influence of education,

and by extension schooling, is undeniable and coupled with the inherent unpredictability of humans, their interactions, and their environments (Knight, 2020) makes for a system that is fraught with complexities. As Fidan & Balcı (2017, p.13) state;

> *Contemporary educational organizations function in ecosystems that consist of networks with different degrees of connectedness and interdependence. In addition, these organizations are composed of units at different levels including individuals with complex relationship networks and different personal traits. Schools as complex adaptive systems are not capable of shaping the dynamics leading the whole ecosystem independently from others. In other words, they co-evolve together with other schools in the tangled web of mutual interactions.*

Evaluating the quality of teaching is an embedded procedure within schools which itself shares the features of a complex adaptive system and the building of evaluative capacity is a key driver for improvement. A key consequence of this high level of complexity is a corresponding level of uncertainty, a sense of perpetually existing on the edge of chaos (Fidan & Balcı, 2017), and the ways in which teachers and leaders navigate this are directly related to improved student achievement (Kershner & Mcquillan, 2016). The conceptualisation of schools, and the evaluation of teaching, as complex adaptive systems goes some way to supporting the concept of education as a profession. Through establishing and maintaining a common culture expressed through and perpetuated by standardised procedures, schools can allow for adaptations whilst holding to a sense of core purpose (Kershner & Mcquillan, 2016).

Thus, the professional context of this study is that of a complex adaptive system, and the fourth problem it seeks to address is the risk of deprofessionalisation of teachers, mathematics subject leaders and senior leaders as a result of the evaluative processes they engage in.

Problem 5: Tensions and contradictions in the role of the external evaluator

As set out above in section 1.1, concurrently with the changes in primary mathematics curriculum, pedagogy and assessment and the expansion of the academies programme, my career changed as I moved from my post as teacher/mathematics leader/deputy headteacher in a primary school to that of Senior Lecturer & School Improvement Specialist for mathematics in a university. This new role incorporated that of a teacher educator on both undergraduate and postgraduate programmes with work in an advisory and developmental capacity with the university's affiliated MAT. The learning curve was steep, particularly in the latter of these two roles as, although I had undertaken a two-year post-graduate course in becoming a Primary Mathematics Specialist Teacher (MaST) and worked within my school and to a small extent across the local cluster in the evaluation and development of mathematics teaching, working across a larger group of schools amongst several other 'evaluators' was a new

experience. I rapidly became aware that balancing the needs and priorities of teachers, subject leaders and senior leaders alongside navigating the evaluative judgements of other external advisors (namely Academy Improvement Partners (AIPs) and Ofsted inspectors) was a highly complex task. Contradictions and tensions became noticeable, I began to question the efficacy of the evaluative processes that I was involved in and wanted to examine more closely how to increase the validity and useful contribution of external advisors to individuals, schools and the MAT. These tensions particularly manifested in questions about the validity and reliability of methods used to collect and interpret evaluation data and the ways in which unchallenged narratives grew around specific teachers and schools. I have experienced, many times, the polite dismissal of my accumulated expertise by individuals at all levels of this hierarchy. I have also been asked, many times, 'Who are the best maths teachers in the MAT?' by its leadership and management team. These two factors led to a culmination of interest in investigating the phenomenon of the evaluation of primary mathematics teaching. This study was undertaken in the hope that with deeper understanding comes increased professional knowledge and expertise in navigating my role and the ability to articulate and justify potential pathways for school improvement to all interested parties that can affect sustainable positive change.

The fifth and final problem identified by this study is therefore the potential tensions and contradictions related to the role of the external evaluator of primary mathematics teaching. The related insider/outsider nature of my specific role as a researcher is explored further in the methodology chapter.

In summary, the overarching aim of this study was to explore the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of the evaluation of primary mathematics teaching and subsequently aims to better understand how to address the following five problems identified in relation to the context of this research:

1) A potential lack of shared understanding around the varied purposes and consequences of evaluations
2) The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process
3) Under-representation of key stakeholder voices in research on the evaluation of primary

mathematics teaching and a lack of clarity around the relationship between their roles

4) The risk of deprofessionalisation of teachers and leaders through the evaluation process
5) Tensions and contradictions in the role of the external evaluator

1.3 Conceptual framework

Following the articulation of these five problems and the exploration of these within the overarching aim of the study, a conceptual framework was developed to act as a guide for decision and meaning making (Leshem & Trafford, 2007)throughout the study in order to achieve clarity of focus and systematically elucidate deeper understanding. This framework consisted of three inter-related concepts which were chosen to help provide new theoretical insights into evaluating primary mathematics teaching; professional development, professional knowledge and professional identity (Fig.1). The evaluation of teaching is linked to professional development as it is the tool used to identify areas of practice that are effective, and those that need development across the overlapping practice spheres of classroom, school and MAT, as well as the broader context of primary mathematics education within which these sit. The professional knowledge held by each participant, and its connection to the broader context, is also relevant in terms of both knowledge of effective evaluation processes and of the effective teaching of primary mathematics. Equally, the concept of professional identity is useful as a lens through which to better understand the perceptions and experiences of individuals and their roles, again within the broader context of identifying as an evaluator and evaluand.

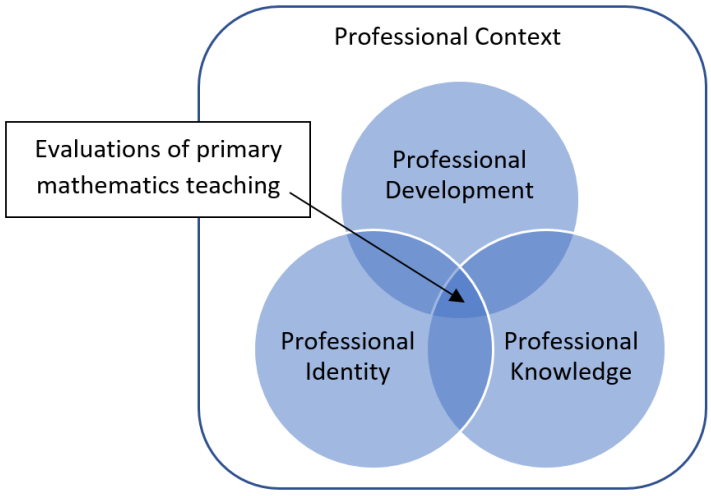


Figure 1: The Conceptual Framework

These concepts are developed further in Chapter 2 to explore the theoretical context of evaluating primary mathematics teaching and were subsequently used as a tool for triangulation during data analysis in Chapters 4, 5 and 6. Consequently, the conceptual framework supported the in-depth

exploration and clarification of issues arising from the data set. The combination of this with the empirical data generated by the study enabled the careful consideration of the implications for professional practice and the creation of a feasible and credible conceptual model to address the identified issues.

1.4 Research questions

Within the overarching research aim to explore the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching, three research questions directly linked to the conceptual framework were used to give clarity and structure to the study:

- What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional development**?
- What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional knowledge**?
- What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional identity**?

Insight gained from exploring these questions was synthesised, discussed and analysed in order to gain deeper understanding of the five problems articulated in section 1.2.

1.5 Methodology

With its intention to explore the subjective perspectives and experiences of individual cases, this study sits within an interpretivist research paradigm and assumes a relative ontological and subjectivist epistemological position. The research design explores bounded case studies and uses 'fortune lines' (Hall & Wall, 2019) and audio recorded semi-structured interviews as methods of narrative enquiry alongside documentary evidence to provide a more formalised framework against which to compare the accounts of each participant. Fifteen participants from five schools were recruited and equally represented the following the roles of senior leaders, mathematics subject leaders and class teachers. All schools were members of the same MAT, and had all worked, to varying degrees, with the researcher. The researcher role was therefore one of 'insider'. Data were analysed using reflexive thematic analysis and according the prior themes identified as key to the study through a review of relevant literature in relation to the conceptual framework.

1.6 Significance and outcomes of the study

This study is important for several reasons. Firstly, given the changes in curriculum, pedagogy and assessment in primary mathematics over the last decade, few studies have examined the impact of

these on practice, and none have explored their influence on the evaluative process, evaluators or evaluands. Secondly, it builds on Almutairi & Shraid's (2021) recommendation that more studies into the perspectives of stakeholders about the combination of evaluation data sources are conducted, and into the perceptions of the evaluation process held by practitioners and considers how gathering these views can inform practice development (Paufler & Clark, 2019). The perspectives and experiences of subject leaders are particularly underrepresented in the field of evaluating teaching practice. Thirdly, whilst existing studies into the evaluation of the quality of mathematics teaching offer insight into the potential use of specific frameworks and rubrics (Charalambous & Litke, 2018; Walkington & Marder, 2018), this study offers new empirical data on the current processes and suggests the application of a previously largely unexamined rubric (Rowland et al., 2009). Fourthly, it offers a new theorisation of the evaluation of primary mathematics teaching through its use of a conceptual framework that is otherwise absent from recent studies (Donaldson & Firestone, 2021). Lastly, the knowledge and understanding acquired through this work led to the development of a new conceptual model which utilises the application of existing theories to support the effective evaluation of primary mathematics teaching.

1.7 Overview of the thesis

Following this introductory chapter, the thesis is organised into seven further chapters.

In chapter 2, the Literature Review reviews relevant literature pertaining to the conceptualisation of the evaluation of primary mathematics teaching through three lenses; professional development, professional knowledge and professional identity. Firstly, within professional development, it considers how evaluations influence the reflection on development of practice, and the methods and tools of data collection. Next, the professional knowledge section explores individual and collective knowledge of primary mathematics teaching, including the Subject Knowledge Quartet (Rowland et al., 2009) rubric and the growing prevalence of a 'mastery' approach, and the development of expertise. Then, professional identity is examined in terms of identifying as a professional, as a primary mathematics teacher, and as a credible evaluator, and the multiple identities and foundational beliefs that might be held within one professional role. Finally, a summary of these and the resulting research questions are articulated.

In chapter 3, the paradigm rationale for the study is explained and the research design outlined. A reflexive account of the context of the study, including details of the selection of participants is given, followed by a summary of the data collection and analysis methods. Finally, issues of quality and ethics,

including consideration of the limitations of the methods and methodology employed are discussed.

In chapter 4, findings, analysis and discussion of the data through the professional development lens are presented, organised into key themes of building a picture of practice, methods and tools of data collection and interpretation, the perceived usefulness of evaluations, and the influence of evaluations on the professional development of both evaluands and evaluators.

Chapter 5 presents the findings, analysis and discussion of the data relating to professional knowledge. It focusses on the subject-specific knowledge for effective mathematics teaching both held and perceived to be necessary by participants, the collective knowledge sources they draw on to inform evaluative knowledge of lesson and curriculum design, and the influence of these on their perceptions of effective mathematics teaching.

In chapter 6, findings, analysis and discussion of the data in relation to the concept of professional identity are presented. The themes explored are participants' perceptions of themselves as 'mathematical' (both as a learner and a teacher), beliefs as a foundation for professional identity, the formation of teacher and evaluator identity as a result of the evaluation process, and identifying as a professional within role(s).

Chapter 7 synthesises the findings, analysis and discussion in Chapters 4, 5 and 6 to identify key findings from each research question which are then combined and synthesised in order to draw conclusions which provide original theoretical insights into the evaluation of primary mathematics teaching. It then outlines further original contributions made by this study to research and methodological knowledge. It also clarifies original contributions to professional knowledge by identifying the implications and recommendations for professional practice, including a suggested model detailing necessary components of the evaluation process and reflections on personal and professional development as a result of participation in the educational doctorate.

2. Literature review

This chapter reviews relevant literature pertaining to the conceptualisation of the evaluation of primary mathematics teaching through three lenses; professional development, professional knowledge and professional identity. Firstly, within professional development, it considers how evaluations influence the reflection on development of practice, and the methods and tools of data collection. Next, the professional knowledge section explores individual and collective knowledge of primary mathematics teaching, including the Subject Knowledge Quartet (Rowland et al., 2009) rubric and the growing prevalence of a 'mastery' approach, and the development of expertise. Finally, professional identity is examined in terms of identifying as a professional, as a primary mathematics teacher, and as a credible evaluator, and the multiple identities and foundational beliefs that might be held within one professional role. These three concepts were initially identified as key to this study through professional experiences that repeatedly pointed to their significance within the evaluation process. They were validated further by Coe, Aloisi, Higgins and Major (2014) whose review of underpinning research which summarised six components of great teaching which clearly align with the concepts of professional development, knowledge and identity, namely, (pedagogical) content knowledge, quality of instruction, classroom climate, classroom management, teacher beliefs and professional behaviours. Additional justification for these choices is contained throughout the review of literature that follows.

Whilst the relationship between each of these concepts is not linear, the exploration of each as separate concepts is helpful for clarification and depth and so they are ordered sequentially from professional development to professional knowledge and then professional identity. The prioritisation of professional development acknowledges the position held by evaluation in the development of practice through both its formative and summative use. This is informed by professional knowledge of both the evaluative process and primary mathematics teaching and so there is logic in exploring this concept second. Professional identity is perhaps the more nebulous concept that both informs and is informed by professional development and knowledge and so is justifiably the last concept to be examined.

The literature review was carried out using professional and academic sources relevant to the evaluation of teaching, and the three conceptual lenses of professional development, professional knowledge and professional identity. Literature was primarily selected from sources within the last ten years, with some

more seminal work cited to contextualise and validate the longevity of key ideas.

2.1 Professional development

In this section, literature on professional development is used as a conceptual lens through which to view the evaluation of teaching. In their framework for professional learning, Coe et.al., (2014) highlight key elements of practice that are directly related to the process of evaluation which include professional behaviours in the form of reflecting on and developing practice, and the triangulation of methods and tools for data collection. In these ways evaluation and the processes used to undertake it are an essential part of professional development, thus justifying the primary use of this conceptual lens as a core component of this study.

Reflecting on and developing practice

Rallis & Militello (2015) offer a definition of evaluation as,

> "... (a) planned, purposeful and systematic process for collecting information, decision-making, and taking action as a means of contributing to improvement of policy and programming for the wellbeing of all within and organisation or community." (p.254).

This encompasses many of the key concepts and ideas found across the literature but does not adequately express the tensions and contradictions inherent within evaluation processes in schools.

The assumption that an evaluation plays a central role in bringing about improvements in practice is rooted in different theories of change that are influenced by both learning processes and organisational context (Rogers & Williams, 2006). Across the literature, there is commonality exploring these processes and contexts that draws a distinction between evaluation's formative and summative purposes (Firestone & Donaldson, 2019; Hallinger et al., 2014; Nevo, 2015; Paufler & Clark, 2019; Reynolds et al., 2003; Tuytens et al., 2020); the former being focussed on the professional learning and development of teachers and schools, the latter on making judgments about the current quality of teaching. Niessen et al. (2015) cite the seminal work of Guba and Lincoln (1989) to further define the formative as 'descriptions' comprised of the characteristics and activity within a specific context, and the summative as 'judgemental' comprised of assessing the quality of teaching against fixed criteria devised by a distinct individual or group of stakeholders.

In line with this, Nevo (2015) asserts that formative/descriptive evaluation is best undertaken internally to an organisation, whereas the summative/judgemental is most usefully carried out by external evaluators. However, as he also acknowledges, in practice the purpose of evaluation is often complex,

serving both formative and summative purposes and including measurements and negotiation generation (Niessen et al., 2015) as a process within pluralistic organisations. In their review of empirical studies into teacher evaluation, Tuytens et al. (2020) acknowledge this complexity as ongoing despite the most recent empirical studies being published in 2015, the issues and recommendations for practice remain the same. The complexities and potential tensions and contradictions arising from these studies can be better understood through two perspectives of evaluation characterised as 'structure' versus 'human agency' (Table 1).

Criteria	*Structure*	*Human Agency*
Function	Control, supervision, accountability	Learning, understanding
Goal	Standardizational/Universality	Looking into variance, differences, and diversity/Particularity
Frame	Structural/Macro perspective	Diagnostic (distinguishing variation among pupil, teacher or school)/Micro perspective
Focus	Products/Conceptual definitions (etic)	Processes/Local meanings (emic)
Benefit	Sorting/Accountability	Strengthening/Autonomy
Outcomes (educational)	Knowledge/Professionalism	Skills/Politics and tensions between different stakeholders and interests
Methodology	Scientific, quantitative (e.g., RCT)	Responsive/diversified
Inquiry	Analytic	Holistic or naturalistic or systemic
Locus[a]	External	Internal

[a] External or internal in almost any aspect: forces, knowledge, evaluators, interveners, culture, needs, and so on.

Table 1: Perspectives of teaching evaluation (Levin-Rozalis et al., 2015, p.202)

For Nevo (2015) a human-agency framed evaluation process, rather than one-off event is key for providing a means for understanding as opposed to judgement, although arguably a 'structure' perspective endures in the UK (Hallinger et al., 2014) alongside an increasing technical-managerial perception of accountability (Ryan & Feller, 2015). This is perhaps reflective of a wider context of accountability and performance management as enforced by Ofsted (2022a) and is aligned with a compliance objective rather than understanding or decision-making (Nevo, 2015).

Accountability and performance management are elements of a 'structure' approach to evaluation and risk creating a culture of 'performativity' "that employs judgements, comparisons and displays as means of control, attrition and change" (Ball, 2017, p.57) where teachers' willingness to engage in honest developmental practice, and the trust between professionals, are greatly reduced (Hopkins et al., 2016). Trust for evaluators and the evaluation process is dependent on perceived validity (Ryan & Feller, 2015) based on methodological and communication practices that enable mutual learning, are fair, and have a clarity of purpose (Nevo, 2015). The development of trust is also related to the interpersonal skills of the evaluator as they acknowledge the validity of localised wisdom, and build relationships that

acknowledge the limitations of their own views (Levin-Rozalis et al., 2015; Nevo, 2015). As Nevo (2006), Levin-Rozalis et al. (2015) and Ryan & Feller (2015) state, issues of politics and power cannot be removed from the evaluation process and examining the values and ideological perspectives of the wider contexts around schools is key, "*Who* is accountable to *whom*, for *what* purpose, for *whose* benefit, by *which* means and with *what* consequences?" (Burke, 2005, in Ryan & Feller, 2015, p.175, original emphasis).

Expanding on theories of learning processes and the institutional context of adult learning, Knowles, Holton, Swanson and Robinson (2020) outline the concept of andragogy as a model that focusses on the characteristics of a learning transaction, not the goals and aims of that transaction. They list six principles of andragogy of which a core common idea is that of adaptation to the unique learner and their context. Whilst critics of this model argue that too much emphasis is placed on the individual without necessary reference to the broader context, there is a validity to the notions of autonomy over the learning experience (Campbell et al., 2009) that are aligned with the 'human agency' perception of evaluation (Levin-Rozalis et al., 2015). Additionally, Kelly & Knight (2019) draw on Deci and Ryan's Self-Determination Theory to frame such learning as coherent with an internal locus of control and a necessary element of professional accountability and responsibility. Within the evaluation process, teachers are often in the role of evaluand, but also act as evaluators of their own and others' practice, and those in leadership positions (both internal and external to specific schools) who, within a 'structure' approach, are often cast in the role of 'evaluator as expert' will have also had experiences as evaluand. These multi-layered experiences increase the complexity of teaching evaluation as the boundaries and spheres of knowledge held by individuals intersect (Nevo, 2015).

The potential benefits of the combined experience and knowledge present in these groups can be maximised through a 'communities of practice' model that frames evaluations as a process of mutual engagement and joint enterprise with a shared repertoire of tools (Wenger, 1999). Christie & Klein (2015) argue that an 'evaluation team' who discuss evaluative practice, reach consensus around foci and methodological approaches, and take collective responsibility for presenting findings within an open and honest environment can result in highly effective evaluations that reflect the values of the situated community. In this way, the process of evaluation is seen as a form of collaborative enquiry (Rallis & Militello, 2015) in which interpretive, analytical and reflective practices are brought to a problem-solving or inquiry-based format (Babione, 2015; Rogers & Williams, 2006). Such a format should be comprised of certain key elements; a problem or question, collection and analysis of information about the focus

issue, and reflection on and sharing of resulting thoughts or actions (Babione, 2015; Knight, 2017; Lofthouse et al., 2010; McNiff, 2013).

In this model, coupled with the principles of andragogy, all participants are valued as equal learners, the process is democratic, and authority is shared (Knowles et al., 2020). This echoes key ideas in work by Argyris & Schön (2003) and Winch (2004) which include fostering a culture that is conducive to mutual, cumulative learning between all stakeholders and professionals and increasing the compatibility of professional practice with self-actualisation. This idea of the importance of 'the whole self' in the development process is echoed by (Korthagen, 2017) who identifies three dimensions that influence teacher behaviour: cognition, emotion and motivation and hence argues "…it is time for research on teacher learning to move beyond a one-sided rational approach to learning." (p.391). The formalisation of reflective/reflexive practice as a core element of professional development and termed 'practitioner research' or 'inquiry' is a key element of the creation of professional 'stories' to make sense of experience and create meaning which help to uncover both dissonance and connection. Through this formative use of evaluation teachers are positioned as knowledge constructors as they "…attempt to discover a new method and create a new incentive for learning; its implications are qualitative, not quantitative." (Lindeman, p.27-28, in Knowles et al., 2020,p.38). Indeed, as stated by (Campbell et al., 2009) this is of higher importance than the selection of specific data collection and analysis tools.

Such andragogical communities of practice can provide an environment in which development can progress from 'single-loop' learning (where feedback from evaluator to evaluand is focussed on correction and the knowledge for this comes from within existing mental maps) to 'double-loop' learning through inquiry-based dialogue which enables deeper reflective and reflexive practice that enables more meaningful and sustainable change (Argyris & Schön, 2003; Cartwright, 2002; Rogers & Williams, 2006). Such practice is aligned with the 'human agency/responsive' perception of evaluation and places the role of the evaluator as one of facilitator or 'consultant teacher' (Firestone & Donaldson, 2019). This also necessitates the development of evaluators' skills for and knowledge of effective evaluation processes, or 'evaluation capacity building' (ECB) (Levin-Rozaliset al., 2015) in order that they can fulfil their professional duty and to avoid circumstances in which the 'blind lead the blind' (Coe et al., 2014). Ryan & Feller (2015) identify three roles into which evaluators can fall, 'measurement technician', 'capacity builder' and 'performance auditor'. The first and last of these are strongly aligned with single-loop learning and the 'structure' perspective of evaluations and is reinforced by the wider dominant ideology of technical rationalist whereby the evaluative process seeks standardisation in order

to predict and control outcomes (Levin-Rozalis et al., 2015). Development for evaluators can be undertaken through direct means in the form of explicit training, and indirectly through reflective participation in the process, but ought to provide opportunities for reflective, technical, situational, management and interpersonal practice (Levin-Rozalis et al., 2015).

Methods and tools of data collection

As part of such development, evaluators need knowledge and skills in the triangulation of data collected through mixed methods including classroom observations, 'value-added' models, pupil perceptions and analysis of classroom artefacts is advocated (Almutairi, Tymms & Kind, 2015; Coe et al., 2014; Nevo, 2006). Inquiry-based practice through the subsequent interpretation and analysis of these data is also a key component of evaluator capacity and credibility in terms of the perceptions and consequences of the evaluation process.

The most common practice discussed in school evaluation literature is that of classroom observations (Almutairi, 2016; Coe et al., 2014; O'Leary, 2020; Schoenfeld et al., 2018). O'Leary (2020) argues that "…observation has become normalized as a performative tool of surveillance and control over teachers." (p.141). As an antithesis to this, and in line with the principles of andragogical communities of practice and acknowledgement of schools as complex adaptive systems, he advocates for a model of observation for which the focus is chosen by the evaluand, or at least decided in negotiation with the evaluator. The role of the evaluator in this model becomes that of the non-judgemental recorder of observable data, to be an 'extra pair of eyes' and avoid subjective or evaluative interpretations of what is seen. Further, he also suggests the use of 'unseen observations' which, seemingly paradoxically, do not involve the direct observation of teaching. Instead, professional dialogue is based on a pre-lesson discussion of the proposed plan, and a post-lesson discussion based on the evaluand's recount. Crucially, the evaluand's perceptions of the lesson are treated as valuable and valid starting points for and contributions to their professional development. Indeed, Almutairi & Shraid (2021) found that there was no significant difference between teachers' self-evaluations and those of internal mathematics subject leaders (Heads of Department) suggesting that these should be treated as equally relevant.

The ways in which a post-observation discussion is conducted also exert a powerful influence over the evaluand's experience and consequently the quality of their professional development. Kelly & Knight (2019) are highly critical of the potentially destructive use of 'feedback' that highlights the evaluator's perceptions of aspects of practice that need improving, usually framed as 'targets' or 'areas for development'. They draw on instructional coaching principles to frame these discussions as

conversations that conducted on the grounds of equality, humility and exploration of a phenomena external to the observer and the observed. (O'Leary, 2020) also states a preference for the term 'professional dialogue' over 'feedback' which is used to collaboratively make sense of events and enhance all participants' understanding and is again in agreement with a model of andragogical communities of practice.

Peer observation, particularly in the form of 'lesson study' (Isoda, 2007), has the potential to remove hierarchical judgements and is aligned with 'Communities of Practice' (Wenger, 1999). According to Isoda (2007) lesson study is formed on the premise that teachers develop best from sharing their knowledge and experiences in the context of seeing others teach with a clear focus on the quality of learning. Teachers participating in lesson study engage in the collaborative planning, delivery, observation and critical reflection of a series of sequential lessons (Murphy et al., 2017). The use of lesson study is not without its potential downfalls, as healthy, effective and efficient collaboration cannot be taken for granted in any group (Mynott, 2020) and the support of a non-participating mediator may be necessary to avoid dysfunctional dynamics related to professional and personal ego (Mynott, 2019). Indeed, (Almutairi & Shraid, 2021) argue that peer evaluation should only be used formatively due to the potentially negative influence of subjectivity and competition. Overall, the impact of all types of observation on student outcomes is limited as few are conducted with a comprehensive understanding of the effective implementation, particularly as even those characterised as formative in nature are not held entirely separately from summative judgements (Coe et al., 2014). The efficacy of concurrent formative and summative uses of evaluation in this regard is in doubt, particularly given the strong case for formative evaluation as beneficial to motivating and sustaining teachers' development (Reynolds, Muijs & Treharne, 2003).

'Value-added' models are those which enable evaluators to measure the progress made by learners towards the desired outcomes and involve regular teacher assessment, usually informed by tests (Coe et al., 2014). This is considered problematic due to the high incidences of variability in both tests and impact factors that are impossible to cohesively measure (Nevo, 2006) and claim causality such as prior experiences, student characteristics and demographic variables (Coe et al., 2014). Pupil perceptions collected through low stakes (for the children and the teachers) purposefully designed questionnaires as part of a wider range of data collection tools can be both valid and reliable (Coe et al., 2014) although bias and immaturity need to be considered (Nevo, 2006). Lastly, the use of classroom artefacts such as lesson plans, class-based assessments, children's work, again according to specific evaluative protocols is

also beneficial (Coe et al., 2014; Nevo, 2006).

In conclusion, so that children's mathematical achievement can be positively influenced by the evaluation process, the individuals and organisations involved need to be knowledgeable of and skilful in the implementation of evaluations, particularly regarding data collection methods and interpretation, and have a clear shared understanding of the purpose of the evaluations. Both evaluators and evaluands need to have equal autonomy in an inquiry-based, dialogic process that accepts the context-specific factors operating on individual schools, classrooms, teachers and learners and use this knowledge to make decisions about the ways in which to frame, conduct, design and support meaningful evaluation for professional development (Knowles et al., 2020). In this way, teaching can progress towards a more expansive model of professionalism that takes account of the humanity of all involved by acknowledging that "…excellence can only be motivated, it cannot be coerced." (O'Leary, 2020, p.146).

To summarise, this review of literature related to evaluation as an essential element of professional development highlights key areas for exploration pertinent to this study. Firstly, into evaluator and evaluand's experiences of the evaluation process and their perceptions of its utility as a form of professional development in primary mathematics teaching. Secondly, into the specific methods and tools used to collect data on the quality of teaching and learning and the implications of these choices on the perceptions and experiences of evaluators and evaluands.

2.2 Professional knowledge

Definitions of teacher knowledge are distinct from other fundamentally theory-based professional fields such as medicine or law, as *practice* and its related acts and reflections are a core component of knowledge acquisition (Ellis, 2009). The use of theory as part of active criticality in practice, or 'praxis', contributes to the professionalisation of knowledge (Zimmerman, 2009) and can be defined as a framework or set of guiding principles that support consistent and coherent understanding of specific educational phenomena (Knowles et al., 2020). Individual teachers draw on personally constructed theories, and both theoretical and practical sources of collective knowledge to form a basis for their decisions, this can be termed 'theory-in-action' (Argyris & Schön, 2003) or 'strategic knowledge' (Shulman, 1985). These decisions and the knowledge upon which they are based can be conscious or more unconscious and attributed to 'instinct' or 'gut feeling' where what is *known* is not easily articulated or justified (Argyris & Schön, 2003). Such tacit knowledge and the resultant decisions and actions are heavily context-dependent and subjective and as such can be seen to sit predominantly within the individual teacher, whereas more general disciplinary knowledge, perceived to be more

objective sits at a broader collective level (Christianakis, 2010; Groundwater-Smith et al., 2013). New knowledge is therefore developed both through experiential analysis and experimental investigation, both 'artistic' and 'scientific' methods of inquiry (Knowles et al., 2020). The formation and persistence of a false dichotomy between theoretical and practical knowledge is unhelpful but relative limitations of each are identifiable, therefore it is most useful when they are combined in order that practical knowledge avoids falling into unexamined idiosyncratic habit, and theoretical knowledge avoids becoming disjointed from and irrelevant to practice (Hiebert et al., 2002).

The reliability of a teacher's claim to professional knowledge is related to tensions around epistemological credibility (Fenstermacher, 1994). Situated hypotheses can be analyses, tested and refined in practice and therefore have the potential to contribute to a theoretical knowledge base (Christianakis, 2010; Ernest, 1991). This resonates with a social constructivist view of knowledge formation that rejects the 'myth' that knowledge exists elsewhere 'in an ultimate form' but, individual knowledge claims need to be justifiable beyond singular context-specific experiences (Fenstermacher, 1994). For this localised formation of knowledge to be included as part of professional knowledge, it needs to be made public with the intention that it is to be examined, therefore clear intellectually honest communication of readily accessible records of experience and resultant theories are necessary (Hiebert et al., 2002). This formalisation of experiential knowledge can result in a fertile interrelationship between theoretical and practical knowledge as 'knowing that' and 'knowing how', and individual and collective professional knowledge become interdependent (Fenstermacher, 1994).

> *"For apart from inquiry, apart from the praxis, individuals cannot be truly human. Knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world, and with each other."*
>
> (Freire, 1996, p.72)

It is apparent that the concept of professional knowledge overlaps with that of professional development regarding evaluating primary mathematics teaching in terms of what evaluators and evaluands need to know to ensure that evaluations are fair, coherent and useful for improving practice (Campbell, Gilroy & McNamara, 2009). The identification of knowledge for evaluating that is already held by individual teachers, as well as that which is not, (known-knowns, known-unknowns and perhaps most challenging, the unknown-unknowns) is the space in which professional development in the implementation of evaluations and the improvement of individuals' mathematics teaching occurs

(Lofthouse et al., 2010).

Due to this overlap, much of the knowledge needed for conducting evaluations of any teaching has been articulated in the previous section. We now turn to the subject-specific knowledge base for the teaching of primary mathematics which is held in both formal educational research and in the less formalised practical wisdom built through practice (Chen, Watson & Ollerton, 2021). Each of these contribute to theoretical knowledge held by both individuals and the collective professional body (Argyris & Schön, 2003). The intersection of individual(s) and collective knowledge can be a site of both agreement and conflict as differing views of what is or can be known meet (Ernest, 1991; Hoyle & John, 1995).

Individual Professional Knowledge of Mathematics Teaching

Whether adopting a 'structure' or 'human-agency' perspective on evaluations, an understanding of how teaching quality might be defined is useful. Primarily this is related to that which leads to improvements in students' outcomes (Coe et al., 2014; Reynolds et al., 2003).

Individual teachers actively construct their knowledge for teaching mathematics through testing hypotheses based on their accumulated experience of the subject, both as learners and educators, and by observing the effects of their decisions in practice. In this way, their professional knowledge evolves as what is known is reformed to make sense of what is experienced (Ernest, 1991). Distinguishing mathematics-specific knowledge from more generic knowledge for teaching can be best understood through categorisation into subject-matter content knowledge, pedagogical content knowledge and curriculum knowledge (Shulman, 1985).

Subject-matter content knowledge in mathematics comprises of both substantive and syntactic knowledge (Rowland, Turner, Thwaites & Huckstep, 2009). Substantive knowledge refers to the links between the facts, concepts and processes of mathematics whereas syntactic knowledge are the 'skills' of working mathematically such as the ability to reason about, prove or disprove mathematical concepts. Subject-matter content is 'background' knowledge of mathematics and an understanding of the connectivity of concepts and procedures inherent within it is key (Turner, 2013). This duality of procedure and concept is prevalent and explicitly referenced in a mastery approach to the subject (NCETM, 2023e).

Although it has been found that no direct relationship exists between the level of academic mathematical qualification held by a teacher and their effectiveness in the primary classroom (Askew, Rhodes, Brown, Wiliam & Johnson 1997; Rowland et al., 2009; Turner, 2013) the level of substantive and

syntactic knowledge of mathematics that such qualifications might denote is arguably beneficial. However, such qualifications are by no means the only indicator that an individual possesses deep content knowledge of the subject-matter they are required to teach in terms of the stage of their learners, or that they have sufficient awareness of the connections between different parts of this knowledge (Askew et al., 1997; Rowland et al., 2009; Skemp, 2006). Indeed, the Department for Education (2010) asserted that to be a mathematics specialist in a primary school, the initial requirement is an enthusiasm for the subject to be harnessed through a Mathematics Specialist Teachers programmes (MaST) into the development of 'deep' subject knowledge. However, more recently, a further increased focus on subject-specificity at a primary level is evident following a renewed inspection framework for schools (Ofsted, 2022a) and the introduction of subject and curriculum focussed 'deep dives' (Ofsted, 2023).

The term pedagogical content knowledge (PCK) is used to describe awareness of the ways in which mathematics can be made accessible to learners (Rowland et al., 2009; Turner, 2013). Even more so than subject-matter content knowledge, this is unrelated to the level of mathematical qualification held by the teacher and is harder to measure or prove than substantive or syntactic knowledge as testing can only provide evidence of theoretical pedagogical content knowledge (Alexander, 2013; Rowland et al., 2009). It is also difficult to distinguish from more general pedagogical knowledge, particularly in the primary phase as most teachers have a generalist role (Turner, 2013). However, knowledge of the ways in which mathematics can be learned, including knowledge of the specific learners and of the challenges of different aspects of mathematics, and knowledge of a range of strategies for communicating mathematical ideas are distinct from general pedagogy (Alexander et al., 1992; Askew et al., 1997). More recently, these have been characterised as 'signature pedagogies', (Shulman, 2005) and PCK can

be expanded and understood through three different structures; surface, deep and implicit (Fig.2).

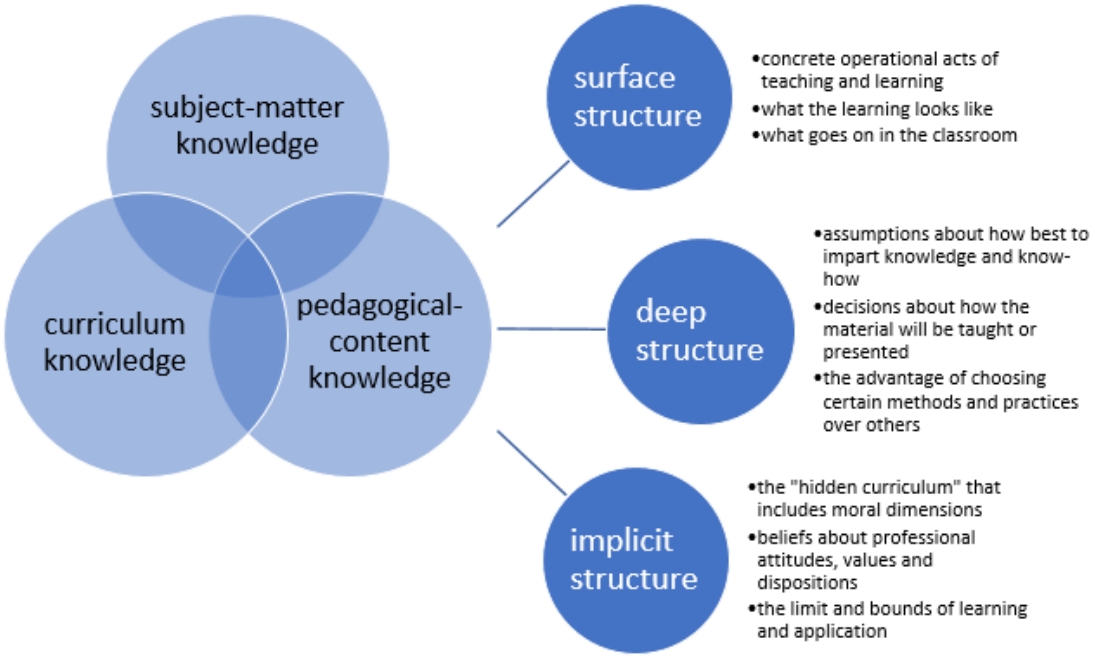


Figure 2: Subject-Specific Knowledge (adapted from Shulman 1985; 2005)

Underpinning each of these structures in relation to mathematics are three pedagogical orientations that are worthy of consideration; transmission, discovery and connectionist (Askew et al., 1997). The transmission orientation prioritises the application of abstractly learned routine calculation procedures, usually written, to contextualised calculations (word problems) and could be seen to contain echoes of behaviourism where control of the learning experience sits with the *teacher*. Transmissionist teachers emphasise verbal explanation and the discrete treatment of areas of mathematics. Teachers who favour a *discovery* approach also view the mathematics curriculum as comprising of separate parts and, when learning these, children are encouraged to develop their own methods, preferably supported using practical equipment. Learners move on to new mathematical ideas when they are ready and understanding develops organically, thus the locus of control of the learning sits in the *learner*. Arguably sitting between these two 'ends' of a spectrum, a connectionist attitude to the teaching of mathematics emphasises methods that increase a learner's ability to make efficient and effective calculation choices and to connect knowledge and understanding of number across different contexts and applications. For the connectionist teacher, the ability to reason, justify and prove is equally important and, in relation to this, mistakes are seen as opportunities for developing understanding which is achieved through dialogue. A connectionist disposition is therefore strongly linked to social constructivist learning theories

(Pritchard & Woollard, 2010) and is also identified as a first order factor of teacher effectiveness (Reynolds et al., 2003).

Individual teachers might show a majority of characteristics from any one of these models, but equally may draw on a range from across all three that will influence their choice of pedagogies. Indeed, in places, cited beliefs and practices displayed contrasting orientations e.g. connectionist in belief, transmissionist in practice but highly effective teachers of mathematics are predominantly connectionist in practice (Askew et al., 1997). Features of less effective teaching included prioritising the performance of standard algorithms over understanding and connection, using practical equipment and/or the most comfortable method for the learner to solve individual calculations, separating areas of mathematics to avoid confusion, and a delay in moving to the abstract. The significance of an individual's pedagogical-content knowledge cannot be underestimated as it has the most influence on teaching practice, regardless of the curriculum materials used (Askew et al., 1997; Williams, 2008).

Curriculum knowledge refers to knowledge of the requirements and expectations of set curricula within which schools work and the range of materials available to support the effective delivery of this (Rowland et al., 2009). However, to follow such guidance without complementary knowledge of subject-matter and subject-specific pedagogy could result in a thin and procedural diet of mathematical teaching and learning (Turner, 2013) whereby the teacher becomes technically proficient without an interrogated professional knowledge base from which to make independent pedagogical choices (Argyris & Schön 2003). Thus, there is a need for a dynamic relationship between subject-matter content, pedagogical content and curriculum knowledges that combine to determine an individual's knowledge of the teaching of primary mathematics.

Mathematical subject-matter, pedagogical-content and curriculum knowledge (Shulman, 1985) and surface, deep and implicit structures of a mathematical signature pedagogy (Shulman, 2005) are refined further in Rowland et al.'s (2009) 'Subject Knowledge Quartet' which synthesises theoretical and practical knowledge from both individual teachers and an established collective knowledge base to offer a rubric for the evaluation and development of primary mathematics teaching. Through the codification of the core components of primary mathematics teaching generated through inquiry into a large sample of practicing primary teachers' work it provides a credible and distinctive knowledge base (Fenstermacher, 1994) as follows. Foundation knowledge refers to that which is known about the teaching of mathematics from a teacher's own experiences as a learner that forms the bedrock for their beliefs and 'theories' about the subject. Transformation, connection and contingency knowledges are

focused on 'knowledge-in-action' and as such, can be seen to simultaneously draw on elements from a teacher's subject-matter, pedagogical content and curriculum knowledge (Shulman, 1985). *Transformation* refers to the ability to represent stage appropriate mathematical content in such a way as to be understood by the learner, *connection* refers to the level of coherence across a sequence of learning, and *contingency* to the flexibility to respond to the arising needs of the learner (Table 2).

Foundation Knowledge (Including beliefs)	Overt subject knowledge Use of terminology Concentration on procedures Identifying errors Theoretical underpinning Awareness of purpose Adheres to textbook
Transformation	Choice of examples Choice of representations Demonstration
Connection	Anticipation of complexity Decisions about sequencing Making connections between procedures Making connections between concepts Recognition of conceptual appropriateness
Contingency	Deviation from agenda Responding to children's ideas Use of opportunities

Table 2: Mathematics Subject Knowledge Quartet (Rowland et al., 2009, p.29)

Whilst there is clearly an intention to support the development of primary teachers' knowledge for teaching mathematics in the devising of the 'knowledge quartet', it could be argued that the translation of the four categories into an evaluative framework begins to subscribe to a technical model which could be used to control and limit knowledge development (Argyris & Schön, 2003). The same can be said of the Mathematical Quality of Instruction Framework' (Charalambous & Litke, 2018), another content-specific lens through which to view and evaluate teaching. However, if used as a supportive tool for evaluators and evaluands to use to identify their known-unknowns, or unknown-unknowns (Lofthouse et al., 2010), hypothesise and experiment, and develop shared and scrutinised theories of practice (Hiebert et al., 2002), the use of such rubrics has the potential to support a shared repertoire of tools and criteria for evaluating primary mathematics teaching (Coe et al., 2014; Wenger, 1999).

Collective Professional Knowledge of Mathematics Teaching

Collective knowledge is formed across a broad range of inter-related institutions and professional bodies. It can be seen as more objective than the knowledge held by an individual as it exists externally

to the spheres it influences (Ernest, 1991) and, certainly in terms of subject-matter content knowledge, this can be seen to be true of mathematics. However, for such an objective body of knowledge to exist for pedagogical-content knowledge and curriculum knowledge, there needs to be collective agreement on the purpose of primary mathematics teaching (Chen et al., 2021). An examination of the collective pedagogical and curricular knowledge that a teacher has access to, and that which is considered valid, is therefore necessary (Ernest, 1996).

Since the publication of the revised National Curriculum (DfE, 2013), the espoused purpose of studying mathematics has included reference to its utility, for participation in society and employment; its inherent beauty and interrelatedness to many other fields, such as science, engineering and technology; and the value of the thinking skills that it promotes such as reasoning and problem-solving. These purposes are strongly aligned with the interests of authoritarian, industrial and pure mathematics groups and, to a lesser extent, of child-centred and social justice groups (Ernest, 2014). The National Curriculum (DfE, 2013) identifies three main aims for the teaching of mathematics; for learners to be mathematically fluent, be able to reason mathematically, and to solve problems using their mathematical skills and knowledge. Corresponding standardised end of key stage tests to assess the extent to which these aims have been met, along with Programmes of Study that lay out the expected content and attainment for each primary year group on their way to these end points were also published. The translation of this curriculum into lesson design in terms of structure, content and pedagogy was initially left to individual schools to navigate.

However, since 2014, following a governmental focus on mathematics teaching practice in countries such as Singapore who performed consistently highly in global PISA rankings the adoption and prevalence of a 'mastery approach' has grown (Boylan, 2019; NCETM, 2023e; Tidbury, 2019). The use of 'mastery' as a term in its current England based context originates form work undertaken by Drury (2015) as part of the ARK academies chain and supported by funding from the Education Endowment Fund (EEF) and pivots around the idea that mathematical knowledge and skills are to be 'mastered' before progression to new learning. The National Centre for Excellence in Teaching Mathematics (2023) adopted the term and became the official professional subject body tasked with leading the development of a mastery approach in schools (Boylan, 2019). Two commercial schemes were initially published to support the approach, 'Maths - no problem!'(Maths - No Problem!, 2023) and 'Mathematics Mastery' (Ark Curriculum Plus, 2023), with more recent schemes of learning and professional development materials being produced by the NCETM and its affiliated 'maths hubs'

(NCETM, 2023c). Most notable of these are the 'White Rose Primary Maths Resources' materials (White Rose Education, 2023) and their subsequent published scheme and textbooks, 'Power Maths' (Pearson, 2023). All these schemes of work are aligned with the Primary National Curriculum and provide short term planning materials, support for teacher subject knowledge and within year assessments for progress tracking.

Pedagogically, 'mastery' draws on a collective body of professional knowledge about the effective teaching of mathematics from a range of sources of thinking (Askew, 2016; Bloom, 1968; Bruner, 1982; Cockcroft, 1986; Drury, 2015). It prioritises the importance of representation and structure within a Concrete-Pictorial-Abstract heuristic, and an awareness of the importance of connected mathematical thinking for relational understanding (Breakell, 2002; Skemp, 2006; Tidbury, 2019). These along with variation (ATM, 2018; Lo et al., 2011), fluency and coherence form the 'Five Big Ideas' of teaching for mastery (NCETM, 2023b) and, as such, makes a positive contribution to the effective teaching of mathematics by drawing on philosophy, theory and research that has shown repeated and longitudinal value in the field. Increasingly, the application of elements of cognitive science and its applications to learning are being amalgamated into a 'mastery' pedagogy, particularly in terms of strategies designed to reduce cognitive load (NCETM, 2023d) and 'spacing' or 'distributed practice' that refers to the ways in which ideas are met, and re-met over time, alongside 'interleaving' that draw heavily on variation theory (ATM, 2018). The technically proficient use of cognitive science based techniques in a primary classroom may well lead to the effective development of certain mathematical knowledge and skills but limit the scope and potential of what it means to learn mathematics (Ollerton et al., 2020). The programme's professional development model owes much to the Cockcroft missionaries' model (Brown, 2014), the subject specialist model espoused by Alexander et al. (1992) and the Williams (2008) advocated lesson study model in its aims "…to train mastery specialists, support for the specialists to work with groups of teachers from local schools (called mastery advocates), a subsidy to buy textbooks (and)…further exchanges with Shanghai teachers" (Boylan, 2019, p.15), and is the primary government subsidised programme for the development of knowledge for teaching mathematics.

The subject-specific knowledge for the evaluation of primary mathematics teaching is therefore taking place in a context which has altered significantly over the past decade, but it has not happened wholesale or coherently across local or national contexts. Whilst increasing numbers of primary schools are adopting a mastery approach, there is a wide discrepancy between those who adopted these principles through the purchase of an affiliated scheme or participation in their local 'maths hub' early in

the establishment of the national programme, and schools that have not yet started. Therefore, within the complexity of schools as adaptive systems, there are also layers of complexity within the specificity of mathematics teaching. Due to the allocation of significant funding to and public endorsement of 'mastery' specific organisations and materials, high levels of professional knowledge and confidence are needed to justify, and articulate a defence of, any alternative. Whilst mastery principles are built on a broad and well-established knowledge base for the effective teaching of mathematics, setting them within the parameters of specific materials and guidelines implies an emphasis on technical ability (Winch, 2004) over the rigorous professional use of a collective body of knowledge. For evaluations to be built upon strong professional knowledge to increase their fairness, coherence and usefulness, evaluators and evaluands need to be able to access and assimilate a vast body of knowledge to exercise professional judgement in their contexts. The extent to which the deep and implicit structures of this subject-specific pedagogy (Shulman, 2005) can be understood so that knowledge is not limited to the surface structure and leads to the potentially deprofessionalisation of both teachers and leaders.

Expertise

The use of a framework such as the 'subject knowledge quartet' (Rowland et al., 2009) to guide and develop mathematical knowledge for teaching and an approach such as mastery has the potential to support the development of subject expertise by providing 'quality control' to evaluation practices for both the evaluator and evaluand and guard against insular thinking or habitual practice (Hiebert et al., 2002).To identify expertise, the epistemological scrutiny of individual and collective knowledge can be explored via four questions: 'What is known about the effective teaching of primary mathematics?', 'What do teachers know about the effective teaching of primary mathematics?', 'What knowledge is essential for teaching?' and 'Who produces knowledge about teaching?' (Fenstermacher, 1994). The degree to which those involved in the evaluation of primary mathematics teaching can engage with the first three of these questions impacts upon the level of expertise they are perceived to hold, the status in which their relative knowledge is held and the credibility of their resulting decisions or judgements about practice (Ernest, 1991; Fenstermacher, 1994).

Regarding the fourth question of knowledge production, it could be argued that the broader context of primary mathematics within which teachers' professional knowledge is currently operating could be seen as an example of second-order technical knowledge whereby the environment around the teacher is constructed so as to ensure that the prescribed techniques will be perceived as effective (Argyris & Schön, 2003). The power dynamics implicit within this view of teachers' professional knowledge as such

technical knowledge are linked to manipulation of behaviour to serve educational ideologies (Palmer, 1973, in Argyris & Schön, 2003). Thus, those who are observed to conform most closely to the prevalent dominant ideology become viewed as experts, such as the NCETM's mastery specialists (NCETM, 2023a). To develop authentic expertise, a partnership model for knowledge development between university-based researchers/educators and teachers that is reciprocal, rather than transactional and allows for dialogue and mutual benefit could be one way to avoid insular recycling of established, and potentially outdated, knowledges (Groundwater-Smith et al., 2013).

To summarise, a review of the literature relating to the concept of professional knowledge as relevant to the teaching of primary mathematics has highlighted further key areas for exploration pertinent to this study. The first of these regards the individual knowledge held by teachers, mathematics subject leaders and school leaders and the influence that this has on their perceptions and experiences of the evaluation process. The second is the interrelationship between individually held knowledge and the collective knowledge base which this both informs and sits within, and the influence of this on the perceptions and experiences of both evaluators and evaluands. Lastly, the influence of teachers', mathematics subject leaders' and school leaders' perception of expertise and the influence of this on the evaluation process is also worthy of exploration.

2.3 Professional identity

Criteria under which to be identified as a professional includes the acquisition of specific technical skill; validation by a collective body and therefore an entitlement to practice such skills; the trust of, and therefore authority over, those who do not possess such skills; a specific institutional setting and a collective ethic rooted in a central ideology and a belief in the necessity of such skills for the betterment of society (Fenstermacher, 1994). These ideas of competence, service, a community of scholarly practice and perceived credibility encompass the concepts of knowledge and the processes by which they are developed to form criteria by which teachers could identify as 'professional' (Argyris & Schön, 2003; Williams, 2013). However, such characteristics were originally derived from an analysis of the common features of occupations perceived as 'professions'; medicine, the law, the church, architecture, engineering and the military and consequently, such definitions are arguably self-fulfilling (Williams, 2013). Based on these fields, personal autonomy and responsibility and self-governance are also considered to be core components of a 'profession' and here, with its highly regulated service to 'the state', teaching diverges from classification as a profession, into a 'semi' or 'quasi' profession (Whitty, 2006, in Bates, Lewis & Pickard, 2019). Indeed, the absence of teaching from the early lists of male-

dominated professions could be attributed to the diminished status of its largely female workforce, particularly in the primary sector (Bates et al., 2019; Williams, 2013), and the view that a formal education is not necessary in order to carry out the tasks of teaching (Hoyle & John, 1995).

The de/reprofessionalisation of teachers is under constant debate (Winch, 2004) therefore the claim to identify as a 'profession/professional' made by education/teachers can be seen part of an ideological approach in itself to enhance status and power through seeking to increase autonomous control, which can be clearly seen in the 'human agency' perception of evaluations as defined by Levin-Rozalis et al. (2015), and as a counterpoint to assertions that teachers' claims to special knowledge and skills are exaggerated (Hoyle & John, 1995). The concept of autonomy plays a key role in the formation and flux of a primary mathematics teacher's professional identity. If autonomy is defined as the relative freedom teachers have to make and act upon decisions, (the latter sometimes termed 'agency') about their practice then such freedoms are constrained to a great or lesser extent given the organisational and institutional cultures within which they exist (Hoyle & John, 1995). This perception of autonomy as a factor in the degree to which an individual can identify as a 'professional' contrasts with broader definitions of professionalism which refer to efficient compliance to external expectations and full personal accountability for actions (Bates et al., 2019; Brown & McNamara, 2011). The level of perceived autonomy that an individual, or school, has contributes to a professional culture which is comprised of three values; independence (freedom to construct a personal pedagogy balancing personality, training, experience and the requirements of the educational context), individualism (teacher has sufficient autonomy to make decisions in the interest of the needs of individual learners), and pragmatism (the freedom to make context bound decisions – i.e. to act in accordance with theory only when it is practically useful to do so) (Hoyle & John, 1995). Thus, identifying as an autonomous individual is correlated with notions of trust and credibility, and linked to self-esteem and value; am I trusted, am I valued, am I a 'good' teacher?, and therefore alongside this for many, am I a 'good' evaluator?

Views of teacher identity, which is a part of the professional identity of all evaluators and evaluands, are woven across the personal and public spheres of an individual's life and as such are complex, varied and changeable and inextricably linked to the wider contexts in which they are situated (Day & Gu, 2010; Tomo & de Gennaro, 2019; Williams, 2013). These two co-existing aspects of identity formation fluctuate in terms of harmony and tension as a teacher may consider themselves to be a 'professional' in so far as they recognise similarities between their own ways of being and doing and those of established members of the professional group, and when the group recognises this and their 'belonging', either

through formal accreditation or informal validation (Jones & McEwan, 2000, Williams, 2013). Macro-areas for the process of forming a teacher identity include organisational practices, group identity practices and institutional practices (Tomo & de Gennaro, 2019), indeed the multi-faceted nature and influence of the professional context calls into question the existence of any stable identity as an individual's sense of self is formed through identification with different ways of making sense of their world (Brown & McNamara, 2011).

Identifying as 'a primary mathematics teacher'

The 'primary' aspect of this identity label is key when exploring teacher's interactions with the subject of mathematics, as many train as 'generalists' and often bring to their teacher identity a largely negative, anxiety fuelled personal perception of the subject (Brown & McNamara, 2011). The discomfort felt by many primary teachers when faced with incorporating 'mathematics teacher' into their professional identity is rooted in a threat to self-esteem (Breakwell, 1986, in Tomo & de Gennaro, 2019). In all cases, whether mathematics is viewed positively or negatively, the influence of a teacher's unique experiences and consequent perceptions of the subject on the choices they make when teaching are profound (Babione, 2015; Hargreaves, 1982 in Campbell et al., 2009). This subjectivity is brought to bear on perceptions of the extent to which someone is a 'good' mathematics teacher; in self-assessment, in collegiate evaluations of practice, and by the extent to which an individual complies with a broader view of the role (Brown & McNamara, 2011). What is valued, and who it is valued by, are rooted in personal beliefs about the nature of mathematics and how it is best taught and learned (Askew et al., 1997; Day & Gu, 2010).

As a result of such beliefs, primary teachers of mathematics may enact certain characteristics in their teaching that occupy two ends of a spectrum, *phenomenological* (learner-centred and inquiry-led) and *official* (towards measurable outcomes against external pre-determined criteria) (Brown & McNamara, 2011); the former shares parallels with a 'discovery' orientation, the latter with 'transmissionist' principles (Askew et al., 1997). Teachers who identify as professionals with a broad societal function (Argyris & Schön, 2003) and who believe that the purpose of learning mathematics transcends narrow, testable criteria are likely to prioritise talk, reasoning and problem solving in the pursuit of democratic and socially just long-term outcomes (Sachs, 2003 in Day & Gu, 2010; Ollerton et al., 2020). However, teachers who subscribe to such beliefs but who lack a confident personal relationship with the subject are likely to gravitate towards transmission-oriented practice which utilises risk-averse adherence to the delivery of tightly controlled content, although attempts to soften this through empathy with learners

may be present as such approaches are often held responsible for the development of their own negative relationship with the subject (Brown & McNamara, 2011). In this way, teachers' subject-matter and pedagogical content knowledge cannot be separated from their professional moral purpose and identity (Day, 1999 in Campbell et al., 2009).

Autonomy and agency (Levin-Rozalis et al., 2015) cannot be separated from more fundamental questions about the goals and purpose of primary mathematics; meta-goals will shape perspectives and consequently influence the evaluation of practice and identity (Brown & McNamara, 2011; Hoyle & John, 1995). A teacher may identify, and be identified, as a 'good' mathematics teacher if their learners obtain high test scores that show quantifiable 'progress' if the purpose for learning mathematics is aligned with the obtaining of qualifications such as a GCSE. However, such a focus leads to a reduction in autonomy as such measurement inevitably leads to the use of highly detailed specifications for success and increased surveillance of practice (Ball, 2003; Hoyle & John, 1995). Adherence to such regulatory criteria may be viewed by teachers and schools as beneficial insofar as it removes uncertainty and risk, prioritises pragmatic solutions to complex problems and provides a perception of professional success that many may enjoy (Brown & McNamara, 2011). This view obfuscates issues of power and control over teachers' practice whereby the work is simplified to such an extent that no specific professional capability is required to enact it, and those that comply with this do not present challenge to the dominant ideology (Argyris & Schön, 2003). The extent to which an individual is prepared to define their professional identity to that of a proficient technocratic (Babione, 2015) is closely aligned to their personal and professional core values and their view of their professional identity (Sachs, 2003, in Day & Gu, 2010).

Identifying as a credible evaluator

If one purpose of professional identity is to justify, explain and make sense of teaching decisions and actions then recognising oneself, and being recognised, as an 'expert' strengthens an individual's argument for autonomy, trust and credibility (Campbell et al., 2009). Such expertise might be identified as *constitutive*, in possession of a certain knowledge of how to do something, and *relative*, being 'more expert' than others at a specific activity (Addis & Winch, 2018). Routes to developing such relative expertise might be informal or formalised and accredited but could encompass role transition and therefore have implications for teacher identity (Tomo & de Gennaro, 2019). Such role transitions, such as to mathematics subject leader, 'Mastery Specialist' (NCETM, 2023a) or post-graduate qualifications that can be focussed on mathematics teaching such as a Master's degree can provoke identity struggle

when core features of the new identity contrast with the old, or when there are social expectations of the role (Tomo & de Gennaro, 2019). However, although roles play a part in the construction of an individual's identity, they do not define it (Day & Gu, 2010) and autonomy, again, plays an important role in the extent one feels able to relate developing beliefs and goals to evaluative tasks to give them personal meaning and authenticity (Addis & Winch, 2018). To be viewed as credible by others is dependent on interpersonal skills and mathematical content knowledge (Donaldson & Firestone, 2021; Firestone & Donaldson, 2019) and yet several studies have found that personal beliefs, particularly of those in senior leadership positions, influence the viewpoints and practices adopted by evaluators (Oeberst & Imhoff, 2023; Paufler & Clark, 2019). Firestone & Donaldson (2019) advocate for 'consultant teachers' in place of senior leaders in formative evaluations as their higher levels of content knowledge and capacity offer the opportunity to elevate discussion and create sustainable change.

Multiple identities, roles and beliefs

All individuals experience the evaluation process through different roles depending on the context, they may be evaluators, the objects of evaluation and have varying levels of stakes in the evaluative process (Nevo, 2015). It is widely accepted that teacher identities are varied and variable, that beliefs about what constitutes a 'good' teacher are formed from all experiences with teachers and teaching, and that these beliefs are the foundations upon which individual teacher identities are built (Steadman, 2023). High levels of uncertainty and risk present ongoing challenges to beliefs and values, as situational feedback provokes teachers to question the kind of teacher they are, and the kind of teacher they want to be (Bates et al., 2019). Growth is unlikely to be linear and identity is constantly formed and re-formed *if* an individual remains open to such challenges, which can be discomfiting (Steadman, 2023). Without a commitment to engage in self-reflective practice, the tendency to process information in a way which is consistent with prior beliefs is heightened as is the risk of invalidating the evaluation process due to confirmation bias (Oeberst & Imhoff, 2023). Cultures of performativity which prioritise that which can be measured against clear criteria and a focus on observable evidence that targets have been met reduce the capacity for such awareness and therefore potentially reduce the fairness, coherence and utility of evaluations (Argyris & Schön, 2003; Ball, 2003; O'Leary & Savage, 2020). Within this culture, the potential for unchallenged belief-consistent judgements is increased (Oeberst & Imhoff, 2023). If evaluation methods are meaning rather than action oriented, aligned to double rather than single-loop learning, then the threat to professional identity is reduced and change is more profound and sustainable (Korthagen, 2017). Such prioritising of individual growth does not have to come at the expense of technical competence (Day & Gu, 2010), whereas prioritisation of technical competence can

result in the stymying of growth.

Ultimately, a strong reflection-based approach to teacher evaluation which supports the idiosyncratic development of individuals, although potentially inconvenient in its complexity and long-term investment, necessitates the acceptance that 'good teaching' will mean different things to different people (Korthagen, 2017). A fundamental facet of this is the extent to which evaluator and evaluand perceptions and judgements of the quality of practice are influenced by the beliefs they hold that form core aspects of their professional identity (Berger & Van, 2019; Oeberst & Imhoff, 2023). This runs counter to an increasingly homogenising culture of accountability and faith in the objective truth of test results to ascertain a teacher's effectiveness (Gardner, 2007; Wragg et al., 1999). The extent to which individuals are accepting of such difference is linked to their own level of comfort with the idea that meaningful education always involves an element of risk (Biesta, 2016). Collaboration is key to creating a harmony between individual and organisational identities, in order that sustained commitment can flourish, where an investment in the maintenance and enhancement of the self and the profession through joint reflection occurs (Bates et al., 2019; Knowles et al., 2020; Tomo & de Gennaro, 2019). In this culture, evaluators and evaluands identify as wholly present, with a synergy between their identity and that of their organisation, able to challenge assumptions in a supportive culture in which professional humility, trust and respect allow all to thrive (Freire, 1998).

In summary, a review of the literature relating to the conceptual lens of professional identity has highlighted key areas for exploration relevant to this study. Firstly, the ways in which professional identity is perceived and experienced and how this influences, and is influenced by, participation in the evaluation process. Secondly, the extent to which teachers, mathematics subject leaders and senior leaders identify as primary mathematics teachers and whether this strengthens or inhibits their professional identity when evaluating teaching or having their teaching evaluated. Thirdly, and similarly, the extent to which they identify as credible evaluators. And lastly, how the holding of multiple identities within each role, and the underpinning beliefs held by each individual influence their perceptions and experiences of the evaluation process, whether as evaluators or evaluands.

2.4 Summary of key concepts and related theories

This review of the literature has illuminated several relevant theories, frameworks and models that, when combined, can be seen to influence, inform and underpin key processes and practices related to fair, coherent and useful evaluations of primary mathematics teaching. This relationship is multi-layered as not only do each of the conceptual lenses provide relevant knowledge and understanding pertaining

to the evaluation of teaching in and of themselves, but the interplay between them has the potential to enhance and refine evaluative practices to increase effectiveness. For example, applying principles of andragogy (Knowles et.al., 2020) with an understanding of belief-consistent information processing (Oeberst and Imhoff, 2023) to the development of mathematical knowledge (Rowland et.al., 2009) has greater potential to result in evaluative practices which embrace and harness the complexity of individual and collective professional development, knowledge and identity. Thus, it can be said that the conceptual framework provides a triple focused lens through which to view evaluations of mathematics teaching, giving rise to the identification of effective practice, and that fair, coherent and useful evaluations also sit at their intersection. (Fig.3).

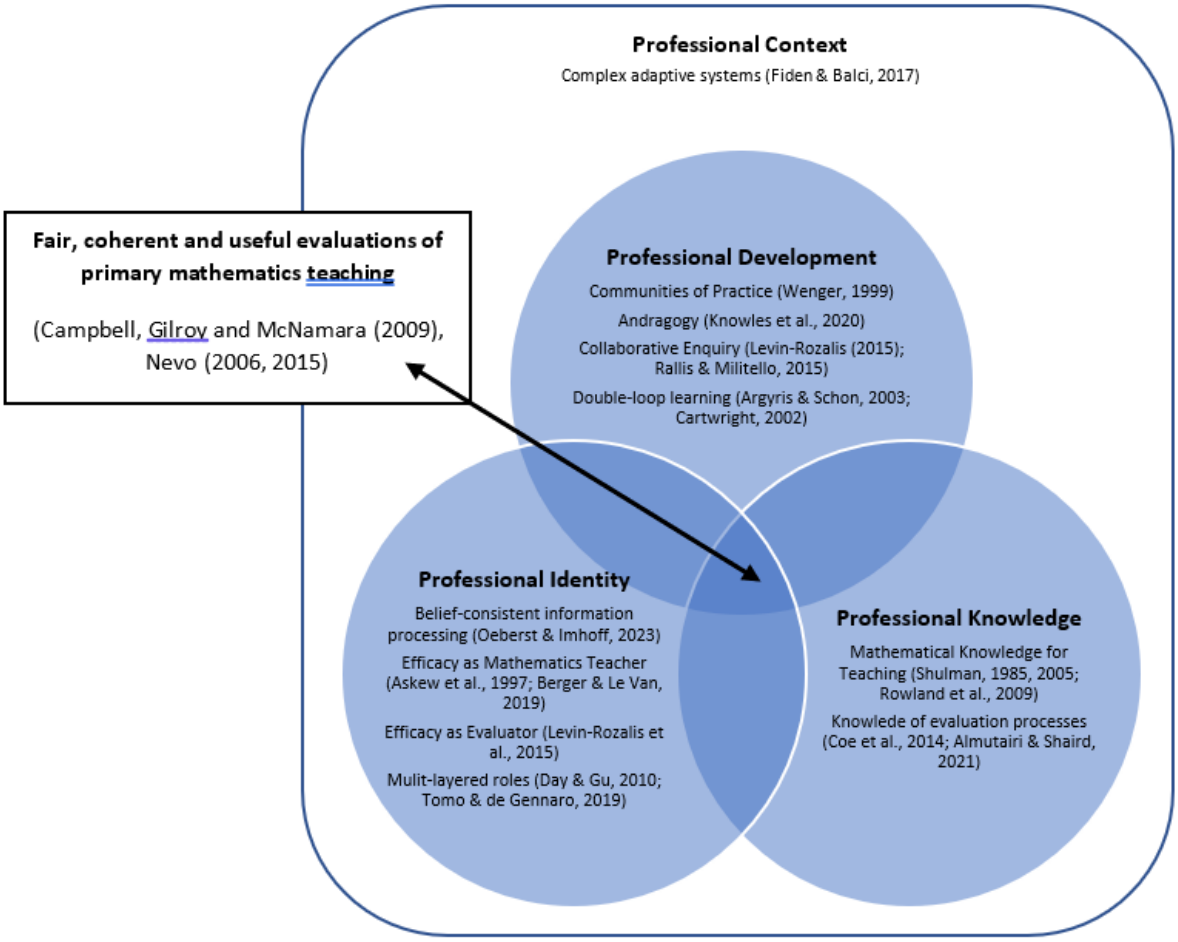


Figure 3: Relevant literature within the conceptual framework

The relevance and influence of each of the conceptual lenses to the process and practices of effective evaluation can be explained further as follows.

When applying a professional development lens, and therefore prioritising a formative purpose for evaluations to reflect on and develop practice, the culture and systems that surround the process and individuals involved are influential. Adopting a 'structure' or 'human-agency' perspective to evaluations influences the experiences of those involved and the latter is aligned with collaborative enquiry, principles of andragogy and double-loop learning that can be facilitated within communities of practice to support the development of both evaluator and evaluand. The ways that methods and tools of data collection are chosen and used can contribute to this, particularly regarding observations and feedback, value-added models such as tests, pupil perceptions and classroom artefacts.

Professional knowledge for the evaluative process is related to both primary mathematics and of evaluative processes and methods themselves. The use of rubrics to evaluate mathematical subject knowledge for teaching is important, as is awareness of the wider context of the National Curriculum, national assessments and 'mastery' within which primary mathematics teaching is situated to critique and adapt the utility of such rubrics. These also contribute to the conceptualisation of expertise in both mathematics teaching and evaluating the quality of teaching. Regarding expertise in mathematics teaching, the extent to which adherence to the predominant views and practices of the wider body of knowledge influences perceptions of quality is key. Expertise in carrying out evaluations of the quality of teaching is both related to this, and further refined through knowledge of inquiry-based methods of evaluation to ascertain the validity of the process.

The lens of professional identity offers a view of evaluations of primary mathematics teaching that highlights the extent to which an individual identifies as an autonomous professional, a mathematics teacher, and as a credible evaluator. It also supports the understanding of the multiple identities held by individuals with their role, the impact of their varied experiences on their beliefs, and the influence of these beliefs on the evaluative process. Underpinning this are perceptions of what it means to be a professional and how this is perceived and experienced through the evaluation process. The tensions between individual conceptions of this and collective ideas of professional practice contextualise evaluations as a core component of professional behaviour, particularly in terms of accountability and autonomy. This tension is heightened in the teaching of primary mathematics within the nested complex adaptive systems of classrooms, schools, MATs, the DfE, Ofsted and subject associations wherein exist

high levels of unpredictability, uncertainty and contradictory purposes.

As a result, this study seeks to better understand the extent to which evaluations are perceived to be and experienced as fair, coherent and useful for all involved and identify components necessary for their successful implementation by asking 'What are teachers', mathematics subject leaders' and senior leaders' experiences and perceptions of (1) professional development, (2) professional knowledge and (3) professional identity in relation to the evaluation of primary mathematics teaching?'. These three research questions will be explored in depth in chapters 4, 5 and 6 with reference to the key areas for exploration identified and summarised in this literature review. These conceptualised findings will then be considered in relation to their contribution to a better understanding of each of the five problems that this study aimed to explore, as previously articulated in Chapter 1:

1) A potential lack of shared understanding around the varied purposes and consequences of evaluations
2) The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process
3) Under-representation of key stakeholder voices in research on the evaluation of primary mathematics teaching and a lack of clarity around the relationship between their roles
4) The risk of deprofessionalisation of teachers and leaders through the evaluation process
5) Tensions and contradictions in the insider/outsider role of the evaluator

The next chapter sets out the methodology employed to explore the three research questions and gain insight into the implications for the wider problematised context of participants' perceptions and experiences.

3. Methodology

This chapter sets out the paradigm rationale for this study, including an exploration of the ontological and epistemological positions taken and the potential limitations of these, before outlining the research design. A reflexive account of the context of the study, including details of the selection of participants is outlined, followed by a summary of the data collection and analysis methods. Finally, issues of quality and ethics, including consideration of the limitations of the methods and methodology employed are discussed.

3.1 Paradigm Rationale

As this study seeks to explore in detail the subjective experiences and perceptions of a small number of individual cases within a particular context, it sits firmly within the interpretivist research paradigm (Hammersley, 2013; Waring et al., 2021; Willis, 2007). In order to develop a clearer understanding of the actions taken in primary schools regarding the teaching of primary mathematics, it is necessary to gather information about the underpinning world views that drive both individual and collective decision-making (Hammersley, 2008). The paradigm in which this research sits is further refined as 'constructivist', in that it assumes an ontological position that recognises multiple realities, allows for the co-creation of understanding through a subjectivist epistemology and utilises a naturalistic methodology (Cohen et al., 2017; Denzin & Lincoln, 2017; Lincoln & Guba, 1985).

A relativist ontological perspective takes account of both local and specific realities of individuals and groups as wholly interwoven with each other and their context, and asserts that the process of knowing, knowledge and values are inextricably linked (Cohen et al., 2017; Waring et al., 2021). The attribution of meaning to these realities to understand them is therefore constructed by the people involved and strongly influences action, often based on historical and biographical experiences (Cohen et al., 2017; Gillham, 2000). Inquiry into these realities is likely to be dynamic and divergent, and therefore be difficult to predict or control, but understanding can be achieved when they are studied holistically (Lincoln & Guba, 1985).

This linking of realities also includes that of the researcher and a subjectivist epistemology is assumed which allows for the co-creation of knowledge as the study evolves (Waring et al., 2021). Extensive experience on the part of the researcher of the context in which the participants exist is desirable in order to develop a rich picture of their situation, behaviours and perspectives, thus enabling the development of both detailed and holistic knowledge and understanding to evolve (Cohen et al., 2017). Indeed, Lincoln and Guba (1985) state that "…it is essential that the human instrument *be* permitted to

use his or her tacit knowledge at full strength in a most explicit fashion. Anything else simply dulls the instrument and reduces the value of the inquiry" (p.198). Multiple 'truths' can co-exist and hold equal validity in the creation of knowledge (Earthy & Cronin, in Gilbert, 2008) and the relationship of knower to known cannot be separated as tacit knowledge held by both the research and the participants constantly counter-interacts and influences (Lincoln & Guba, 1985). This study therefore constitutes an emic approach to the construction of knowledge whereby validity and truth are agreed upon by members of the culture being studied, which includes the researcher (Willis, 2007).

In its attempts to understand the professional knowledge and professional identity of participants who hold different hierarchical roles, this study also draws on some elements of the critical educational research paradigm, most notably through anticipated discussion around "…the social construction of knowledge and curricula, who defines worthwhile knowledge; what ideological interests schools serve and how this reproduces inequality in society; how power is produced and reproduced through education; whose interests are served by education and how legitimate these are" (Cohen et al., 2017). As such, there is the potential for broader exploration of power relationships and possible inequities within school cultures with an emancipatory hope for those involved (Willis, 2007). Again, the details pertaining to this are explored in more depth in 'Participants' in the section 3.2 of this chapter.

3.2 Research Design

The research design of this study, based on a relativist ontology and subjectivist epistemology is rooted in the need for interactions between the research and participants that 'tell stories' of interconnected realities to "distil a more sophisticated and informed consensus construction" (Waring et al., 2021). It therefore draws on case study and narrative inquiry as its key methodologies.

Case study

A case study approach offers the opportunity to interrogate alternative interpretations and the potential to identify congruent and conflicting viewpoints (Adelman et.al, 1980, in Bassey, 1999) on previously identified theoretical propositions (Yin, 2014). In order to provide the opportunity for pattern spotting across similar context, a collective case study will be carried out where a number of cases will be studied in detail to develop as full an understanding as possible (Bassey, 1999; Denzin & Lincoln, 2017; Punch, 1998). The findings of this study provide both information for the development of knowledge and understanding of judgements and decisions that are made with regard to primary mathematics teaching, and offer some explanations of cause and effect and therefore it is both evaluative

(Stenhouse, 1985, in Bassey, 1999) and explanatory (Yin, 2017) in its aims.

Multiple cases were examined, in terms of both the roles held by individuals and of different primary schools, are part of bounded, coherent systems (Stake, 1995) within which the key themes are studied to gain as full an understanding as possible providing data at individual, group, institution and community levels (Gillham, 2000). These multiple cases can be seen to represent both horizontal bounded coherent systems in the form of the parallel roles held by participants in different schools, and vertical bounded coherent systems within one school setting. For example, one mathematics subject leader's experiences and perceptions hold relevance both in comparison to those who hold the same role in a different school (horizontal), and in relation to those of the class teacher and headteacher in their own school (vertical). This use of multiple cases increases the potential for claims of both literal and theoretical replication, and therefore increased robustness of findings, as data is collected which supports the same theories of meaning (Yin, 2017).

Narrative inquiry

In order to capture as rich and authentic a picture as possible of the experiences and perceptions of each participant, some principles of narrative enquiry were drawn on and incorporated into the research design. Earthy and Cronin (in Gilbert, 2008) argue that the collection and analysis of all qualitative data can be classified as forms of 'story-telling' whereby participants engage in producing narrative accounts. These accounts may take the form of a plot structure as they talk about their perceptions and experiences of key topics and provide the opportunity for a researcher to consider the purpose of and reasons for the presentation of their story, "Fiction is the lie that tells us the truth" (Gaiman, 2021, p.30). As such, a narrative inquiry approach "…is particularly suited to studies whose research questions are based around exploring perceived, subjective experiences of individuals or groups of individuals." (Floyd, 2012, p.224). The role of the inquirer becomes part of the 'storytelling' as they use various methods to actively 'coax' the participant into telling their story, and their questions, prompts and signals during its telling to co-produce the narrative (Earthy & Cronin, in Gilbert, 2008). The key method chosen to support this 'storytelling' was that of 'fortune lines', this is explained further in section 3.3. The researcher is acting in the moment, sensitive to the implications of what is being said, and how the story is being told (Conle, in Fleming & Murphy, 2010) and tacit approval or encouragement on certain elements may influence how the narrative emerges (Earthy & Cronin, in Gilbert, 2008). Other sources of evidence, such as key documents used within the participants' contexts,

can also provide valuable texture and richness to the verbal story that is told (Newby, 2014).

Participants

As previously stated, a multiple case study approach provides an opportunity for increased validity of the study as both literal and theoretical replication are possible. Participation from five schools was gained, with requests for participation from one teacher, the mathematics leader, and one senior leader from each, fifteen participants in total. Whilst it could be argued that fifteen is a relatively small sample size, it was intended that the material under investigation will be covered in depth (Floyd, 2012). Purposive sampling (Floyd, 2012; Lincoln & Guba, 1985) of schools from one MAT was utilised, and as far as possible priority was given to those with children aged 4-11 years on role (through primaries) as opposed to Infant (4-7 years) or Junior (7-11 years) schools. It is prudent to note that, although these schools are all part of the same MAT, the nature of this organisation is to encourage and support the comparative independence of individual schools in matters of curriculum and pedagogy. Therefore pen portraits to provide a layer of 'thick description' (Cohen et al., 2017) of each of the case study schools are outlined below (Table 3). The key information demonstrates the similarities and differences across the schools regarding the classification, age range taught, demographic, most recent Ofsted rating, the published admission number (PAN), and the most recent available maths progress scores (MPS) (publicly available at https://www.gov.uk/school-performance-tables). It also encapsulates the key words from each school's vision for mathematics as shared on their websites in line with DfE expectations. For the purposes of anonymity and succinctness, these are presented as word clouds to give a sense of the priorities and coverage in each school. The range of key words coupled with the word cloud convention of an increased text size for words that are used more frequently offers a succinct visual summary.

Case Study	Key information	Vision for mathematics
School A	Primary School (Academy) Ages 4 to 11 Mixed gender PAN (to nearest 50) 400 MPS (2019) - Above average (+2.0)	

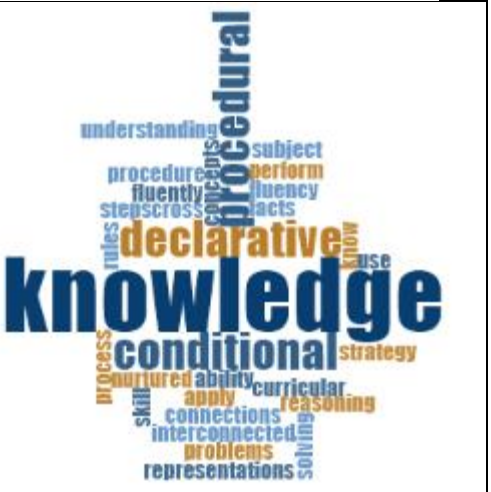
School B	Primary School (Academy) Ages 5 to 11 Mixed gender PAN (to nearest 50) 300 MPS (2019) - Well below average (–4.4)	
School C	Infant School (Academy) Ages 4 to 7 Mixed gender PAN (to nearest 50) 300 MPS - unavailable	
School D	Junior School (Academy) Ages 7 to 11 Mixed gender PAN (to nearest 50) 300 MPS - unavailable	
School E	Primary School (Academy) Ages 4 to 11 Mixed gender PAN (to nearest 50) 200 MPS (2019) - Well below average (–3.4)	

Table 3: Pen portraits of each case study school

A combination of typical case sampling and convenience sampling (Lincoln & Guba, 1985; Waring et al., 2021) was utilised to select the individual participants. This was to increase the likelihood of gaining teacher participants from a range of year groups/key stages, and to ensure that the issues faced by all

participants were comparable in terms of curriculum scope and testing requirements. As Gillham (2005) states, "…one may seek informants who come from different 'strata' within the group – in terms of status, occupational category…But this is more to do with trawling for a *range* of information than trying to establish a representative sample" (p.43). In the event, participation from five primary schools was not achieved due to a lack of response, although three out of the six approached did agree to take part, and agreement from two others, affiliated Infant and Junior schools, was gained, thereby fulfilling the requirement for a parity of contributions from the primary range.

A key point regarding the choice to investigate the perceptions and experiences of three members of staff who hold differing hierarchical roles, relates to the overt intention to explore the views of those who hold a more influential or powerful position within the context of the evaluation of teaching (Hammersley, 2008). This is intended to address any potential bias in the researcher's increased empathy with the role of the teacher or mathematics leader over those that hold a senior leadership position and increase the potential for understanding of the rational justification behind all participants' beliefs and actions. Participants were classed as 'teachers' of mathematics if they have responsibility for the planning, teaching and assessing of whole class mathematics lessons in any primary phase year group. They were classed as 'evaluators' if their role includes the monitoring and evaluation of mathematics teaching including the form of observations, monitoring of planning, children's work and data analysis. Due to the nature of career progression in primary schools, it was likely that all 'evaluators' will have past and potentially current experience of 'teaching' and so they were asked to state their current role at the time of interview. As for each case study school, pen portraits of each participant are provided below (Table 4), including pseudonyms (ethical consideration of these is detailed later in this chapter), to provide further 'thick description' (Cohen et al., 2017). Recruitment of a teacher in School E was unsuccessful, but two teachers in School B had expressed an interest and so they were both included in order to retain equal group sizes according to role. Although this resulted in a gap in opportunity to explore the relationship between perceptions and experiences according to role in School E, it was decided that the richness of data offered by both teachers in School B compensated for the lack of teacher voice from School E and therefore offered a valuable contribution to the overall dataset. It was also decided to retain the middle and senior leader voices from School E for the same reason. In order to connect each participant to their school, their pseudonym begins with the same letter as designated to their school i.e. Anna, Alice and Amanda are all from School A. The following table is organised by role to aid easier reading and comprehension of similarities and differences in

individuals' career experiences.

Participant (psuedonym + intial code)	Current Role	Training	Teaching experience	Leadership experience
Anna, class teacher CT2	Class teacher	Undergraduate teaching degree with QTS (or equivalent)	Early Years, KS1, LKS2 Student mentor 30+ years	
Becca, class teacher CT3a	Class teacher	Primary PGCE	Reception, UKS2 (Supply across primary range) Approx. 5 years	
Beth, class teacher CT3b	Class teacher	Undergraduate teaching degree with QTS (or equivalent)	Predominantly KS2, 2 years KS1 Student mentor 26 years	Deputy Head
Claire, class teacher CT4	Class teacher	Undergraduate degree (Childhood Studies) Primary PGCE with Early Years	Early Years, Reception, Y1 13 years Student mentor	
Donna, class teacher CT5	Class teacher	Information not provided	Student mentor 13 years	Maths leader
Emily, subject leader MSL1	Mathematics Subject Leader Class teacher	Primary PGCE	Reception, KS1, LKS2 Approx. 10 years, some time as 'specialist' English teacher	Deputy Head
Alice, subject leader MSL2	Mathematics Subject Leader Class teacher	Primary SCITT	KS2 (Y6, Y4, Y3), KS1 Approx. 20 years	
Brooke, subject leader MSL3	Mathematics Subject Leader Class teacher	Undergraduate teaching degree with QTS (or equivalent)	LKS2 4 years	
Caroline, subject leader MSL4	Mathematics Subject Leader Class teacher	Information not provided	KS1 (predominantly Y2) Approx. 20 years	
Daniel, subject leader MSL5	Mathematics Subject Leader Class teacher	Information not provided	UKS2 (predominantly Y6) 10+ years	
Elaine, senior leader SLT1	Headteacher	Primary PGCE	KS2 MaST Approx. 15 years	Maths leader County Advisor
Amanda, senior leader SLT2	Assistant Headteacher	Undergraduate teaching degree with QTS (or equivalent)	KS1 and KS2 Approx. 10 years	Phase leader Curriculum Lead
Brett, senior leader SLT3	Headteacher	Information not provided	UKS2 Approx. 20 years	Maths leader Deputy Head

Christina, senior leader SLT4	Deputy Headteacher	Undergraduate teaching degree with QTS (or equivalent)	KS2 Approx. 30 years	
Dominic, senior leader SLT5	Headteacher	Undergraduate teaching degree with QTS (or equivalent)	KS2, predominantly Y6, (supply across primary range) Approx. 30 years	Deputy Head

Table 4: Pen portraits of participants

Participants were approached via email, initially to secure gatekeeper consent from the individual headteachers, and then to approach individuals and include participant information details and request consent (Floyd, 2012). The mathematics subject leaders were easily identifiable by role, and the teachers/senior leaders were, in some cases, emailed 'en masse' to recruit those individuals who were interested and willing to give their time, and in others, emailed individually following recommendations by the headteacher after they sought interest from the staff. In no cases was the sampling of participants influenced by researcher preference or choice, and there were not more offers for participation than required so no individuals were rejected from the sample.

3.3 Data Collection

Before conducting data collection with participants in the field, pilot methods were trialled to support the selection of the most appropriate tools. Three pilot interviews were carried out with colleagues who had varying professional experience as primary mathematics teachers, mathematics subject leaders and senior leaders. These were 'fortune lines', 'semi-structured interviews' and a 'focus group'. The latter of these was found to be difficult to organise and disproportionately time consuming relative to the quality of data collected, it replicated much of what was provided in the interviews, and so this tool was rejected. Therefore, in line with the tenets of narrative inquiry, fortune lines and semi-structured interviews were employed with each participant. Completion of the fortune line prior to the interview asked them to reflect on their professional life from a starting point at the beginning of teacher training, through to their current role, focusing on the recording of key moments in their career. They were asked to focus on three lines; mathematical subject knowledge; experiences as a teacher of mathematics; and experiences of evaluating the mathematics teaching of others and graph these according to a positive/negative scale (Appendix 1). The interview was mediated by these 'reflective timelines' and a list of questions and prompts to initially standardise the interviews according to key themes from the research aims and sub-questions were used (Appendix 2). The interviews were recorded using audio software. All participants were also asked to provide examples of any policies or proformas used as part of the evaluative process of mathematics teaching and explicit consent was sought from the gatekeeper

and participants regarding the sharing of these.

Throughout the data collection process, to increase reflexivity, provide a secondary data source and retain a focus on the scholarly pursuit of this study, a research diary (Appendix 3) was kept by the researcher in order to document thoughts and reflections immediately that the interview had ended (Etherington, 2004; Gillham, 2000; O'Reilly, 2009).

Fortune Lines

As outlined in section 3.2 'Narrative inquiry', fortune lines were selected as one method of data collection. Originally used by Rush (1988, in White & Gunstone, 1992) as a tool for eliciting understanding of stories with a range of learners, fortune lines are used to estimate and graph specific literary themes over the course of a narrative or sequence of scenes. This method of visualisation is recognised as useful when trying to express more abstract or changing elements of a story such as feelings of confidence, enjoyment, interest and motivation (White & Gunstone, 1992). The inclusion of this method in this study where elicitation of individual perceptions and experiences over time were key the advantages of which included, but were not limited to, an aid to recall and focus on important events over a long period of time, support to identify and analyse relationships, and a simple, quick and detailed basis for further discussion. To increase accessibility to this method of data collection, they were re-named 'reflective timelines' as these are more conceptually in line with terms and ideas that educators are familiar with as elicitation tools for professional development. In order to understand the fluctuations in a person's lines, and the justification for what is included (and excluded), a follow up interview was necessary (Earthy & Cronin, in Gilbert, 2008; White & Gunstone, 1992). in which these reflective timelines were used by the participants to support their responses, and by the researcher to probe potentially rich events or experiences during the interviews. The data they generated is therefore implicit within these responses and not explicitly discussed as part of data analysis.

Semi-structured interviews

The use of the 'reflective timeline' as a source of data on which to base an interview lent itself to an flexible dialogic framework which, coupled with a semi-structured interview gave each participant the opportunity to tell their 'story' whilst simultaneously ensuring that data would be collected that could give rise to the comparison of beliefs and opinions with reference to the main research themes (Denzin & Lincoln, 2017; Floyd, 2012; Earthy and Cronin in Gilbert, 2008; Gillham, 2005). The starting point for each interview was to invite the participant to talk about their timeline, this had the benefit of allowing

them to settle into sharing their story, and also provided an opportunity for the interviewer to not if any of the questions or topics on the interview schedule were mentioned and could be probed at a later point in the dialogue (Floyd, 2012). Whilst, in narrative inquiry, it can be beneficial to conduct more than one interview with each participant to establish rapport and then probe key points later as the research evolves (Floyd, 2012; Earthy & Cronin in Gilbert, 2008), the researcher's prior relationship with many of the participants, coupled with the time pressures on all concerned, made this less relevant in this study. This is a potential limitation of this study as it cannot take account of changes in people's views over time and cannot therefore be taken as indicative of anything more than a data point at one moment in time (Hammersley, 2008).

The interview schedule was rehearsed during the 'piloting' stage as detailed above with individuals with a professional history that mirrored those of the participants, but who were not currently working in a school. It was developed from themes emanating from the literature review. This rehearsal led to an awareness that it would be beneficial for the participant to have access to the interview schedule, alongside the 'reflective timeline' activity, in advance of the interview to allow for more considered responses. The schedule was constructed to allow a logical flow from one question to the next, whilst also allowing scope for the order to be rearranged should the participant's responses indicate a more relevant direction (Gillham, 2005). This led to the need for high levels of balanced attention to be paid by the researcher to both the content of the participant's responses, and the coverage of the interview schedule (Floyd, 2012; Kvale & Brinkmann, 2009). The questions utilised a range of broad, open-ended linguistic questions, e.g. 'Please tell me the story of your professional life in primary maths education…' to those that encouraged more specific, detailed examples, e.g. 'Can you tell me about your experience of being evaluated/evaluating others as a maths teacher? Who was involved? What happened? How did you feel?' (Earthy & Cronin in Gilbert, 2008; Kvale & Brinkmann, 2009) (Appendix 2). Throughout the interviews, further follow-up, probing, structuring and interpreting questions and statements were used as deemed necessary to elicit the most accurate expression of the participant's views and experiences as possible (Kvale & Brinkmann, 2009).

Documentary evidence

All participants were asked to provide examples of any policies or proformas used as part of the evaluative process of mathematics teaching to gain a sense of espoused practice in order that these could be compared to participants' perceptions and experiences. Two schools provided these and, they were useful for prompting discussion and gaining a richer understanding of those cases, although they

could not be explicitly described or provided as appendices as several identifying features would have compromised the anonymity of the participants. Additionally, schools' visions for mathematics, which are publicly available via their websites, were also examined to ascertain the espoused values that underpin the mathematics teaching in each school and offer opportunities for analysis of the relationship between these and individual values. These documents provided a wider picture against which to compare the informal accounts of each participant and helped to develop a more thorough understanding of the context in which they were situated (Gillham, 2000).

3.4 Data Analysis

In accordance with the constructivist approach taken throughout this study, reflexive thematic data analysis was conducted allowing for the knowledge of the researcher to be brought to the dataset to develop a deep and meaningful understanding of the data (Braun & Clarke, 2022). Reflexive thematic analysis differs from other forms of thematic analysis within a qualitative paradigm as it openly acknowledges and seeks to value "a subjective, situated, aware and questioning researcher" (Braun & Clarke, 2022, p.5). Crucially, in reflexive thematic analysis the subjectivity of the researcher as an 'insider/outsider' (explored in more depth in section 3.5) is viewed as a resource that enables greater depth of analysis of data rather than a source of bias that needs to be eliminated. This study does not seek accurate or objective analysis and interpretation, rather that which is compelling, rich and nuanced and embraces complexity. These values and assumptions underpinned an analytical process that

consisted of five stages as shown in the flow diagram below (Fig.4) and then outlined in more detail.

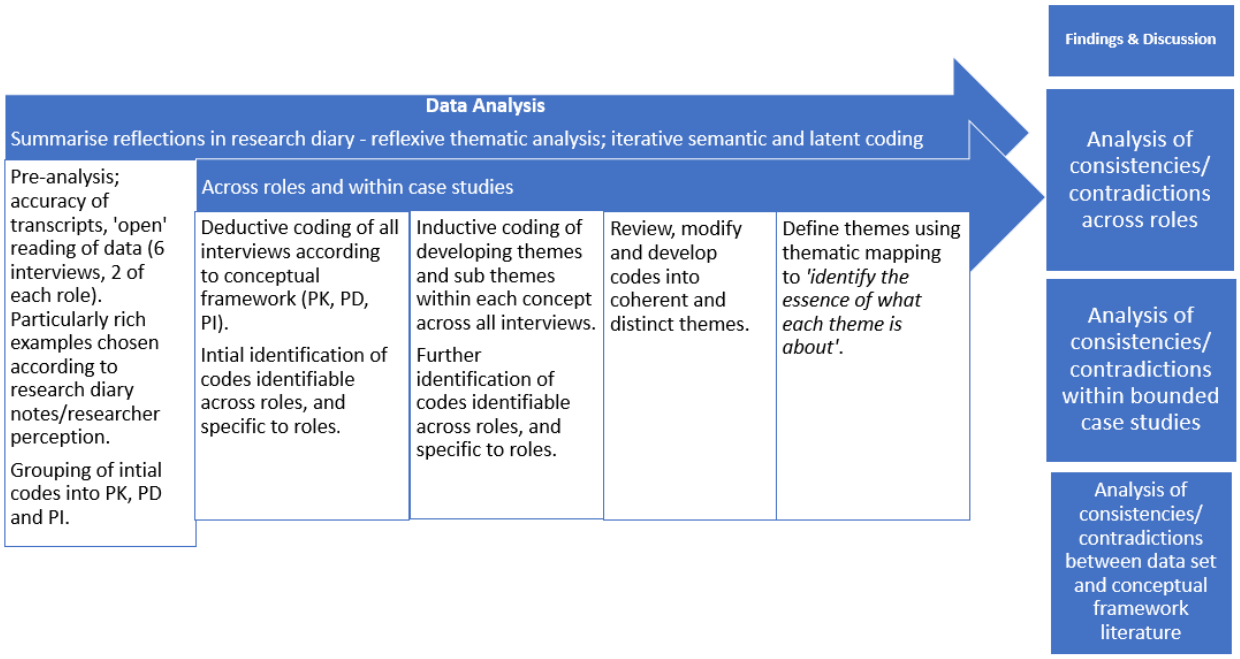


Figure 4: Flow diagram of data analysis process

The audio recorded interviews were downloaded into Nvivo, a software program used for qualitative and the analysis of transcribed interview data and the text found in the documentary evidence. During the initial 'open' reading of data conducted with six interviews (two of each role) early generation of ideas that were of interest or relevance to the conceptual framework themes of professional identity, knowledge and development were noted, along with any points relevant to the study as judged by the researcher, and the beginning of organic codes as relevant to each participant were developed (Table 5).

MSL3	**MSL5**
English *or* maths person	Conceptual and procedural
Importance of sequencing (LT/MT/ST)	Mastery
Role of schemes of work in supporting sequencing	Differentiation
	Ability
Misconceptions knowledge	Girls and maths
Steps/gaps/prior knowledge	Learner anxiety
Mathematical vocabulary	Assessment levels
CPA	Beliefs about maths and maths teaching
Mastery	Maths hubs
Assessment labels	University (SP) support
Adapting schemes	Why and how
Influence of school Ofsted grading	Numerical attainment data
Being observed	'Seeing it' to make sense of it (scheme espousing mastery principles)
Evaluation foci	

Observation feedback Pupil views Book look Reflective/reflexive process for development Reducing complexity, 'bits' of maths Valuing in others practice/experience what is valued in own Performance Ongoing, developmental conversations Usefullness of examples/models from others' practice What 'it' looks like Trust Perceptions of self-efficacy Usefullness of evaluation tools Beliefs about where (and when) learning can be *seen* Depth of analysis of data collected about teaching and learning Intent Implementation Impact Whole staff vision Defintions of autonomy 'they' homogenising groups vs meeting individual needs Timetabliing and coverage Autonomy of individual aligning with collective aims/goals/expectations	Resistance to change – challenge to personal 'success' What is 'success' in maths? Connections Steps Progression Variation theory/intelligent practice Doing/thinking Representation Context Application Pace Homogenisation of children Open-minded view of children's capability Gaining buy-in (from staff and children) Others' perception of competence/level of expertise Target/goal setting for teachers Use of teacher identity/expertise to inform leadership Awareness of own developmental journey Responsibility for development Dilution of knowledge in dissemination Differentiating teacher support Experience levels of individuals Definitions of subject knowledge Compliance/fidelity

Table 5: Inductive codes generated by open reading of data

These initial 'open' codes were then grouped using the conceptual lenses; professional development, professional knowledge and professional identity, as a framework (Fig.5) to identify patterns and

produce themes to support the deductive coding of all interviews.

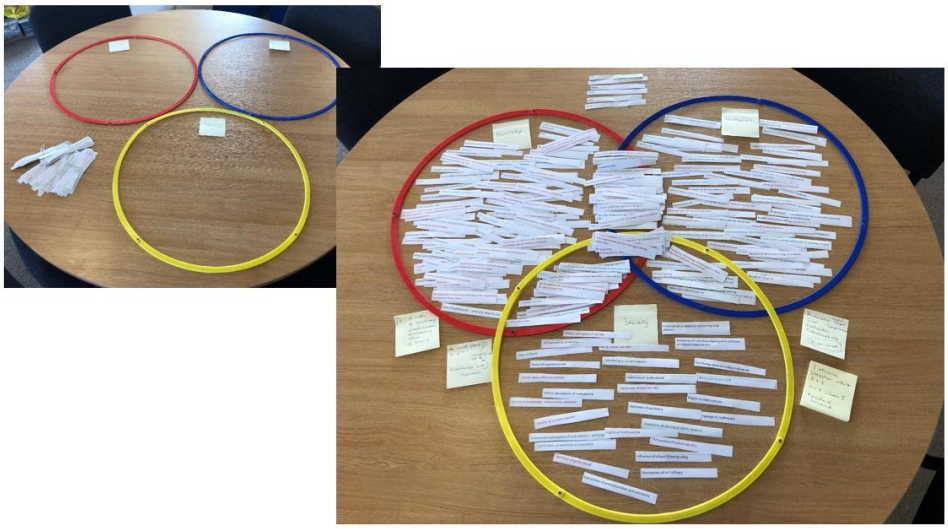


Figure 5: Generation of themes through conceptual lenses

Thematic mapping and inductive coding were then carried out across all interviews using Nvivo to refine and deepen the analysis and interpret key themes and sub-themes across the data set (Earthy & Cronin, in Gilbert, 2008; Nowell et al., 2017) (Fig.6).

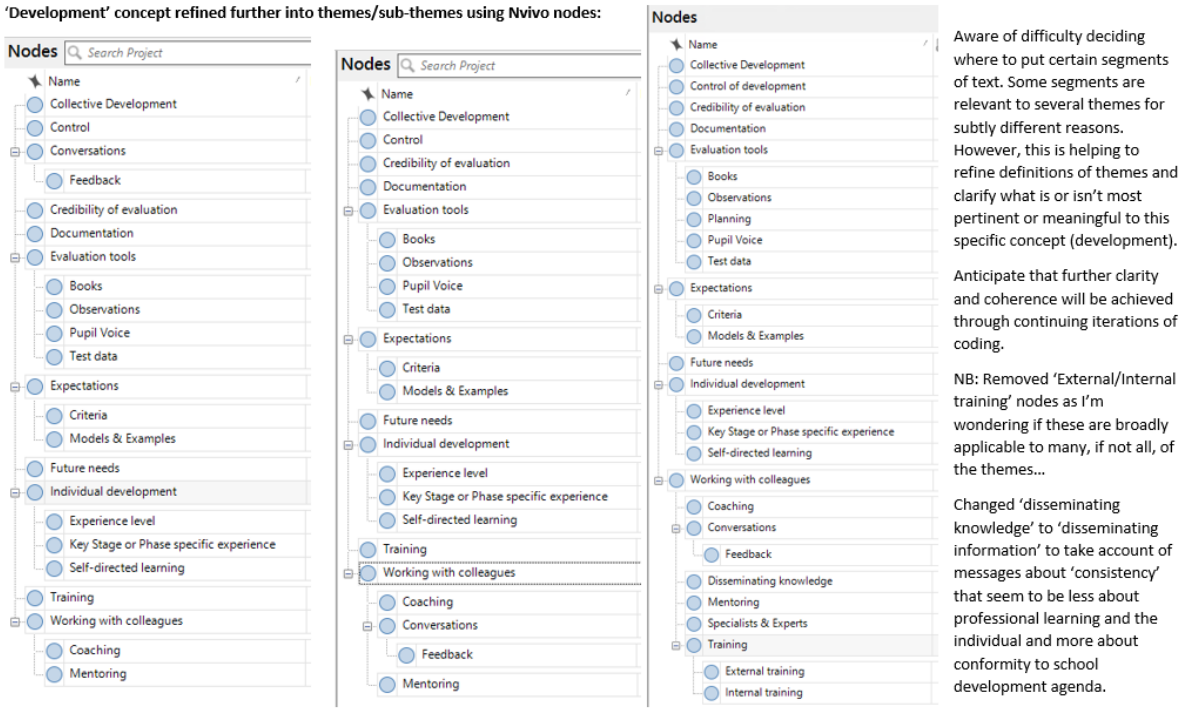


Figure 6: Refinement of themes and subthemes within each conceptual lens

Through these stages, themes and sub-themes were developed around shared central organising

concepts (Braun & Clarke, 2022). This iterative process that included both deductive and inductive coding enabled the gradual condensing of codes without a loss of data richness (Fig. 7).

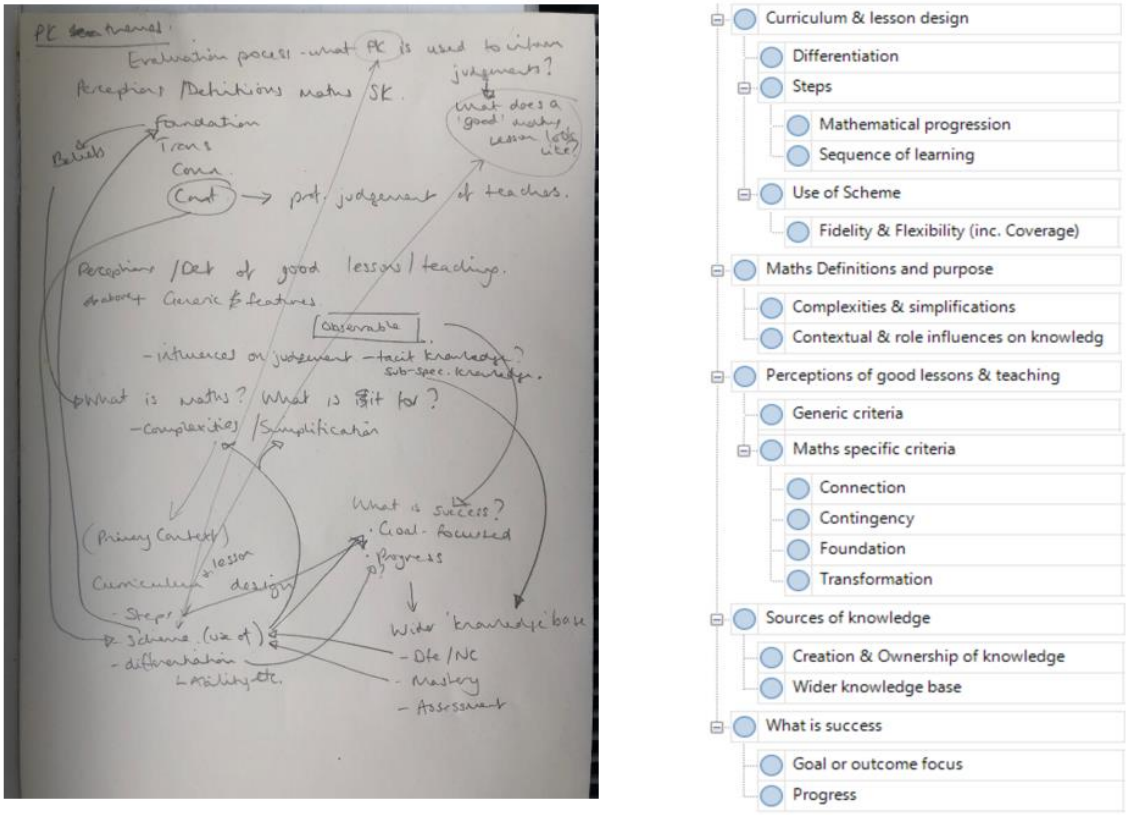


Figure 7: Iterative process leading to condensing and organisation of codes

Across all iterations of the data analysis process, both semantic and latent coding were used. Whilst semantic coding captured meaning from participants' language and statements that demonstrated overt descriptions of their perceptions and experiences. A focus on the semantics of the interview data allowed for explicit links to be made across and between responses and a surface level of themes to be identified (Braun & Clarke, 2023). Alongside this, and supported by an 'insider' positionality (more on this is section 3.5), latent coding identified more implicit levels of meaning and allowed for insight and connections to be made that went beyond the merely descriptive into the conceptual. Both were appropriate for this study as semantic coding ensured that analysis stayed rooted in the participants' voices, whilst latent coding utilised the perceptions and knowledge of the researcher to explore potential meaning and connections that might otherwise have been lost. Analysis of the documentary materials explored synthesis of and/or contradictions in espoused and enacted practices, also through

latent and semantic coding.

Analysis of interview data was conducted alongside the development of a research diary which documented both the data collection and data analysis processes in order that an audit trail was created (Nowell et al., 2017) and that elements of narrative analysis were made possible in terms of how each individual's story was co-constructed with the researcher (Floyd, 2012; Earthy & Cronin in Gilbert, 2008). Empirical data was triangulated with theoretical knowledge related to each of the conceptual lenses to deepen understanding and analysis of participants' perceptions and experiences. The subject-knowledge quartet framework as developed by Rowland et al. (2009) was used to support developing template analysis of the evaluation of mathematical knowledge for teaching (King in Symon & Cassell, 2004) according to prior identification of themes in literature.

Identified themes, sub-themes and organisation of data analysis

The process of combined deductive and inductive iterative coding led to identification of key themes and sub-themes as relevant to each conceptual lens (Table 6). These overarching themes were used to inform the organisational structure of the findings, analysis and discussion in chapters 4, 5 and 6, the themes formed section headings under which the sub-themes were discussed and analysed. These gave rise to summarised key findings at the end of each chapter, which are clarified and synthesised in

chapter 7.

Findings, Analysis and Discussion Chapter	**Key Themes**
4. Professional Development	4.1 Building a picture of practice 4.2 Methods and tools of data collection and interpretation 4.3 Usefulness of evaluation 4.4 Influence of evaluations on development of evaluands' practice 4.5 Influence of evaluations on development of evaluators' practice
5. Professional Knowledge	5.1 Evaluating subject-specific knowledge for effective mathematics teaching 5.2 Collective knowledge for evaluating lesson and curriculum design 5.3 Influence of knowledge on perceptions of effective mathematics teaching
6. Professional Identity	6.1 Perceptions of mathematical self (learner and teacher) 6.2 Identity formation through evaluation 6.3 Identifying as 'a professional'

Table 6: Key themes identified for analysis and discussion

To support the identification of sub-themes within the professional knowledge lens, and analysis of how subject-specific knowledge was understood and evaluated by participants, a further layer of theory was applied throughout the data analysis process in the form of Rowland et.al.'s (2009) rubric for effective primary mathematics teaching. This was to increase the trustworthiness of the data analysis by avoiding researcher subjectivity in the perception of what might be considered effective practice. The use of the rubric enables increased clarity of analysis and as a consequence, increased the credibility of the findings.

Trustworthiness

Lincoln and Guba (1985) suggest that, contrary to the quest for 'validity' in a positivist paradigm, work within a relativist ontology as part of a constructivist approach to inquiry needs to concern itself with 'trustworthiness'. Further to the use of additional theory as part of analysis in chapter 5, the multiple case study approach coupled with the selection of participants holding parallel roles in different contexts supports this study's claim to transferability in terms of applicability (relevance of findings to other contexts) and consistency (replication with similar subjects in similar contexts) (Lincoln & Guba,

1985). The credibility, dependability and confirmability, of the researcher's interpretations of the data collected was rooted in prolonged engagement and persistent observations of the contexts under investigation, the provision of an explicit audit trail of the data collection and analysis processes, and in triangulation with theoretical knowledge presented in the conceptual framework (Lincoln & Guba, 1985; Nowell et al., 2017; Waring et al., 2021). Credibility was also enhanced through environmental triangulation (Stahl & King, 2020) insofar as several cases of similar types were studied to corroborate themes and findings. In these ways, the trustworthiness and authenticity of this study was ensured (Denzin & Lincoln, 2017). Relatedly, issues of the insider/outsider position of the researcher are explored in more detail next.

3.5 Ethical Issues

A core element of the aim of this study is to, through better understanding of the subjective views and experiences of the participants, and a reflexive approach to data collection and analysis, to develop my efficacy in my role so that I can support beneficial improvements within my professional context. There is, therefore, a moral and ethical dimension to these overlapping aims that seeks to understand "what person I am or can be; what is good for me; what is good or bad in a particular practice or situation; or what underlying values shape a practice" (Conle, in Fleming & Murphy, 2010, p. 156) and questions of personal and social 'good' are the driving force of the inquiry. As a result, the potential for the data collection process to prompt uncomfortable recollections, probe complex and nuanced connections between experiences, thoughts and actions, and prompt reflection or even affect change is significant, and therefore was approached with sensitivity, humility and respect (Floyd, 2012). Here, an 'insider/outsider' researcher role supported ethical practice as the investment of time and energy into the study is part of an authentic membership of and vested interest in benefitting the individuals, schools and wider MAT community in which the study is situated (O'Reilly, 2009). All participants were given control of when and where to hold their interview, provided with the option of additional contact to talk through any questions or guidance about the process before the interviews took place, and provided with the option to redact or withdraw any of their data within a specified time frame (Appendix 4). Gatekeeper consent was also sought from the Headteacher for each school (Appendix 5) and ethical approval given by the University of Reading Ethics committee following due ethical application processes (Appendix 6).

In addition, careful ethical consideration was given to the 'insider' element of the researcher role. As a known outsider with established professional relationships with each participant, although this varied as

the closeness and frequency of my work with each individual and school was not equal, the boundary between my role based as an external colleague with that of my work as part of the internal team of each school was blurred. In addition to this 'insider' role specific to each context, I also have ten years' experience as a primary class teacher, five of which were also spent as mathematics subject leader and three of which as assistant headteacher. As a result, my own professional identity overlaps with that of each of the participants, and the need to acknowledge potential influence of bias in my interactions during data collection and interpretation of data during analysis is clear. As Etherington (2004) states, "Our personal history, when it is known to us and processed in ways that allow us to remain in contact emotionally and bodily with others whose stories remind us of our own, can enrich our role as researcher" (p.180) and given my professional background, an increased level of empathy with participants could be identifiable. However, this also opens the possibility for 'over-rapport' (O'Reilly, 2009), the risk of bias, and unethical practice that could harm participants (Etherington, 2004). The use of my research diary (Appendix 3) as a space in which to articulate my honest responses and reflections on each interview was an important element of reflexivity in my role as researcher and demonstrates sincere efforts to own my perspective (Braun & Clarke, 2023). This demonstrates an open communication of my position and role and an acknowledgement that all interactions were viewed through the lens of prior experiences and the provision of a detached voice of authority was avoided (O'Reilly, 2009).

With this mitigation in pace, the 'insider' perspective was ultimately useful as the professional tacit knowledge gained through my previous roles, in addition to continued post-graduate study and attainment of MA(Ed) and MaST (Mathematics Specialist Teacher), increased the validity of a subjectivist epistemology (Bassey, 1999; Cohen et al., 2017; Lincoln & Guba, 1985). As it is an explicit aim of this study to collect the perspectives of those 'inside' the situation being investigated, an insider role within the community is arguably beneficial (O'Reilly, 2009) and the personal involvement between and interaction of the researcher and the researched is, whilst always unavoidable, both overt and crucial in this case (Conle, in Fleming & Murphy, 2010; Floyd, 2012). It can also be argued that, as someone whose work is based in a separate institution and has contact with each school as a 'visitor', there was also a dimension of the 'outside' that helped to avoid overfamiliarity that might impair the interpretation of unconscious communication, and increases the potential for the disclosure of information that would be otherwise withheld to a fully partisan member of the school community (O'Reilly, 2009).

To balance this 'outsider' distance whilst utilising the capacity for deeper 'insider' understanding, high

levels of reflexivity were necessary (O'Reilly, 2009), particularly regarding potential power issues as part of ethical consideration. My 'outsider' role was characterised by schools as one of 'expert' or 'specialist', not least due to the latter of these labels forming part of my job title. Ongoing work with many of the participants has earned perceptions of my credibility as a colleague that can make useful contributions due to an extended breadth and depth of knowledge of primary mathematics that is difficult to attain whilst working in a school setting. For some participants, with whom I did not have an established working relationship, this perception was more by reputation than first-hand experience but, in these cases, it seemed rapport was lessened due to a wariness that this produced (see MSL2 entry in Appendix 3). To encourage the empowerment of each participant assurances were given that their voice was valued and valuable, and I made every effort to behave in both a professional and warm manner with encouraging body language, eye contact and tone of voice to give an authentic demonstration of an inquiring mindset.

Careful consideration was also given to confidentiality and anonymity in the reporting of this study as there are several features of the context that could give rise to the identification of participants, should that be pursued. School names were anonymised with a code, and all identifying geographical features were omitted, including any reference to my place of work. Participants were initially given a code in the data collection and early analysis stages that enabled me to keep track of their school and role but these were changed to pseudonyms during the development of the findings and discussion chapters as the codes were dehumanising and created a distance between the richness of the participants' lived experiences and the reader. Providing the participants with the opportunity to select their own pseudonym was considered, but it was not deemed appropriate to demand this of their already limited time and energy and so the onus for balancing the preservation of the richness of the data with the protection of identity was assumed by the researcher (Allen & Wiles, 2016). This was particularly challenging when paying due respect to the demographic features of ethnicity as the anglicisation of names denied important aspects of heritage from specific participants stories, whereas the use of a more ethnically identifiable name would be too distinguishing a feature. In these cases, care was taken to choose a pseudonym that could appropriate to the participants' cultural heritage whilst also anglicising in line with most participants' names. In making this process and the justification for decisions transparent, this study maintains appropriate standards of ethical conduct and

trustworthiness (BERA, 2018; Denzin & Lincoln, 2017).

3.6 Limitations

Limitations to the methodologies that arise from these ontological and epistemological positions are related to the risk of bias and a lack of generalisability of findings. To avoid bias which could result in a lack of validity, it is often recommended that researchers 'triangulate' data sources to increase this, however it can be argued that to attempt to claim any sense of objective 'truth' in such studies runs counter to the core tenets of a relativist ontology and subjectivist epistemology (Newby, 2014). Alternatively, a reflexive approach which explicitly and transparently acknowledges the researcher's position supports the production of credible work (Floyd, 2012) and all efforts to adhere to this approach have been acknowledged and articulated throughout this chapter. Due to the inability to recruit a teacher form School E, the bounded case studies are not consistent across the whole dataset, and so this school's story is lacking a teacher voice and therefore not as complete as it otherwise would have been. However, this study seeks to be recognised by and useful for the specific setting and subject in which it is located (primary school mathematics) and therefore generalisability is achieved through pattern spotting across similar contexts (Cohen et al., 2017).

In summary, the methodology of this multiple case study was conducted in a constructivist paradigm rooted in a relativist ontology and subjectivist epistemology. It employed naturalistic methods of data collection and analysis in the use of reflective timelines, narrative semi-structured interviews, a reflexive research diary and reflexive thematic analysis stemming from a core conceptual framework. Issues of trustworthiness have been considered throughout this chapter and ethical practices observed throughout.

4. Findings, Analysis and Discussion – Professional Development

This chapter explores participants' responses that relate to their perceptions and experiences of professional development in relation to the evaluation of primary mathematics teaching. Four key themes were constructed during analysis as follows; building a picture of practice, methods and tools of data collection and interpretation, the perceived usefulness of evaluations, and the influence of evaluations on the professional development of both evaluands and evaluators. These themes were identified through the reflexive thematic analysis using iterative inductive and deductive coding based on patterns of commonality between participants' responses. The chapter is organised into the analysis and discussion of each of the themes in relation to literature on professional development with data presented as direct quotations in italics. The acronyms CT (class teacher), MSL (mathematics subject leader) and SL (senior leader) are used throughout to indicate the current role of each participant as outlined in Chapter 3. This chapter ends with a summary of the findings pertinent to the research question, 'What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to professional development?' and uses these findings to gain insight into the five identified problems that this study seeks to address.

4.1 Building a picture of practice.

A consistency across the data set is the participants' views that the fundamental purpose of the evaluation process is to 'build a picture' of the teaching and learning of primary mathematics. The phrase 'big picture' was used by participants in two different ways dependent on context; one refers to a coherent and accurate view of mathematics teaching and learning across a school (*Beth, CT; Donna, CT; Emily, MSL; Alice, MSL; Brooke, MSL; Elaine, SL; Amanda, SL; Brett, SL; Christina, SL; Dominic, SL*) and the other refers to a coherent and accurate perception of an individual's practice (*Anna, CT; Becca, CT; Beth, CT; Donna, CT; Emily, MSL; Alice, MSL; Brooke, MSL; Daniel, MSL; Elaine, SL; Brett, SL; Christina, SL; Dominic, SL*). These 'big pictures' are used both to evaluate the quality of teaching and to initiate school improvement through professional development (Hill & Grossman, 2013; Toch, 2008) and therefore the formative and summative purposes of evaluation are amalgamated into one:

> *So you have a picture of what you are watching this teacher. How does she add to the mathematical group that you have in your school of mathematicians? (Anna, CT)*
>
> *…my teaching in maths has just been evaluated as part of the, um, you know, yearly kind of thinking about your appraisals and things like that as part of the school monitoring… (Beth, CT)*
>
> *…from that I'm really, I know what we need to do as a subject team. Yeah, so we were looking about, uh, how it was being delivered and whether it was being delivered in the way it needed to be delivered. (Alice,*

MSL)

The perceived need for this 'big picture' also seems to be motivated by a desire to ensure that the evaluation process is perceived to be in alignment with aspirations for a fair system (Paufler & Clark, 2019).

> *I'm just wary of saying a snapshot isn't that doesn't happen. That didn't happen when I was in their room, but that doesn't mean that it's not happening. And that's why, I guess we try and take a bigger picture with the children, with the children's work in. (Brett, SL)*

Participants described a range of ways in which a 'big picture' might be built. The predominant method referred to was through the collection of data from different sources of information (*Anna, CT; Beth, CT; Alice, MSL; Brooke, MSL; Elaine, SL; Amanda, SL; Brett, SL; Dominic, SL*) as advocated by Nevo (2006) and Coe et al. (2014), with further reference to the use of a series of 'snapshots' of practice over time (*Beth, CT, Donna, CT, Emily, MSL, Elaine, SL, Brett, SL*), and lastly through contextualising conversations between those involved in the process (*Anna, CT, Beth, CT, Donna, Christina, SL*).

> *… so I think the bigger picture is looking at the books, looking at learning, looking at teaching, um, talking to the children, um, and actually talking and actually almost talking to staff about how they feel it's going maybe before you actually teach it, sort of say you have an evaluation beforehand to know. So you've got a background… (Beth, CT)*

There is a sense here of the importance of dialogue in order that evaluators have a coherent sense of context, but whether this is conducted in ways that frame evaluations through a 'structure' or 'human-agency' perspective (Levin-Rozalis et al., 2015), or as part of collaborative enquiry (Rallis & Militello, 2015) or a community of practice (Wenger, 1999) is unclear. This acknowledgement of the influence of context is however reminiscent of O'Leary's (2020) advocacy for greater teacher involvement in the evaluation experience, but does not go as far as to allow them to set the focus or purpose of observations as he suggests. The 'bigger picture' as described by this participant is consistent with the findings of Almutairi, Tymms and Kind, 2015) who state that teachers value the utilisation of a range of data collection tools to evaluate their practice. The extent to which this was used formatively or summatively was not clear. Therefore, the formative and summative purposes for evaluation were not understood as separate by participants as recommended by Firestone & Donaldson (2019),Hallinger et al. (2014), (Nevo, 2015), (Paufler & Clark, 2019), Reynolds et al. (2003) and Tuytens et al. (2020) but combined within any evaluative episode.

4.2 Methods and tools of data collection and interpretation

The data collection tools referred to across the dataset were observations, pupil voice, children's books,

attainment and progress data, moderation, and planning and as such align with the categories of classroom observations, 'value-added' models, pupil perceptions and classroom artefacts (Almutairi et al., 2015; Coe et al., 2014; Nevo, 2006). Figure 8 below shows the proportion of participants who spoke about each data collection method in reference to formalised evaluation processes in their schools. 'Pupil voice' was largely commented on by those in leadership positions and used summatively, although class teachers also took account of the views of the children they teach as part of their own informal self-evaluation and use these formatively (Almutairi, 2016). These methods were also used by external evaluators as part of 'specialist' or 'advisory' support for individual schools, or as part of moderation across a group of schools.

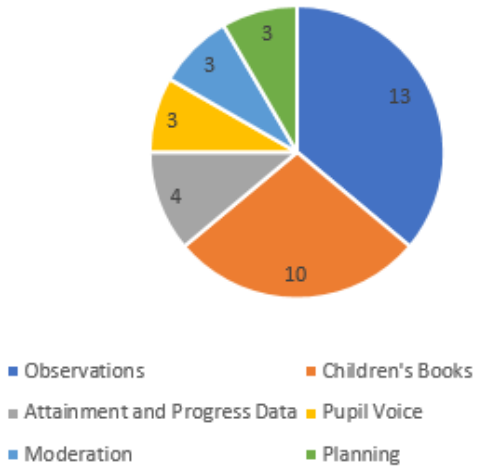


Figure 8: Data collection methods referred to by participants

The range of data collection tools utilised and the role of both internal and external evaluators in evaluation can be seen as indicative of effective practice (Almutairi, 2016; Almutairi et al., 2015; Coe et al., 2014; Nevo, 2006). According to the experiences of the participants, 'observations' and 'children's books' were the sources of information predominantly used to evaluate the quality of mathematics teaching. This is consistent with the two key methods utilised by Ofsted for inspecting the quality of education (Ofsted, 2022a) and as such, could be seen as an example of localised monitoring within schools mirroring that of the wider macro-system within which they sit. Schools, therefore, become part of the established policy discourse, as enacted through the inspectorate, whereby certain sources of information are perceived to have value and reveal 'truth' more than others (Ball, 2017).

> *Um, and at that point that kind of coincided with, um, Ofsted saying that they weren't going to grade lessons anymore. So I remember a huge amount of discussion there about is that, should we do that? You know, um, so Ofsted, weren't going to ask for planning. Well, just cause Ofsted don't, don't do it, should*

we, you know, is that the appropriate thing to do? (Brett, SL)

Observations as experienced by all of the participants tended to be categorised as either formal or informal. The former related to a scheduled focus on a specific lesson carried out by others in either a subject and/or school leadership role, or external visitors (mathematics advisors, Academy Improvement Partners (AIPs) and/or Ofsted inspectors) and involving a formalised individual feedback process. The latter related to relatively unscheduled visits to a teacher's classroom by one or more of the colleagues (excluding Ofsted inspectors) with more general or informal feedback, characterised by participants as "learning walks" (*Beth, CT, Emily, MSL, Caroline, MSL*), "open-door" (*Donna, CT*), "pop-ins" (*Becca, CT*), and "drop-ins" (*Christina, SL*). Formal observations were particularly remembered as an aspect of training or early career development (*Becca, CT, Beth, CT, Claire, CT, Brooke, MSL, Elaine, SL, Brett, SL*), and as part of the ongoing monitoring of their own and others' practice throughout participants' careers (*Anna, CT, Emily, MSL, Elaine, SL*). Neither formal or informal observations, as part of a school's usual evaluation process for mathematics, were cited as happening as part of an ongoing evaluative process as opposed to one-off events and are therefore misaligned with practice advocated by Nevo (2015).

Participants' experiences of these observations when in the role of the evaluand varied. Some attributed the word "positive" to the experience (*Claire, CT, Emily, MSL, Christina, SL*), with others describing both specific and general instances as "interesting" (*Beth, CT*), "constructive" (*Caroline, MSL*), and "I really liked the challenge…I like to show what I'm doing" (*Donna, CT*). Feelings of nervousness (*Becca, CT*) and an awareness of "pressure" (*Becca, CT, Beth, CT*) were also cited.

> *I've always valued people coming in because then I've, um, they've pointed things out to me that I may not have noticed about, uh, or resources that we could have used that I hadn't thought of. I've always valued being observed in maths. (Emily, MSL)*
>
> *I always get nervous when people come and watch me. Cause I just, I go back to being that child thinking like, oh, I'm not good at this. (Becca, CT)*
>
> *I feel on days where I'm having an observation or something, even though I try and relax, I feel more pressurised and yeah, less natural as a teacher. (Beth, CT)*

These perceptions and experiences demonstrated a range of responses to being observed that relate to the culture surrounding the evaluand and the extent to which the locus is perceived as external (a structural approach), or internal (a human agency approach) (Levin-Rozalis et al., 2015). Those that characterised the locus as internal felt safer to engage in honest developmental practice (Hopkins et al., 2016), whereas those who experienced the locus of observations as external were more likely to be

wary of judgements and comparisons with others (Ball, 2017). The use of observations to provide formative feedback on teaching was particularly valued by some evaluands (*Becca, CT, Beth, CT, Donna, CT*).

As the 'observer' when in the evaluator role participants also spoke of an awareness of pressure, particularly in relation to a lack of experience and the potential consequences of giving a summative judgement of an evaluand's practice in the form of a grading.

> *It's, it's more tricky. I find personally that might be from my inexperience of leading, I've only been a teacher for three years, um, and sort of thrown into the deep end with the maths anyway. (Brooke, MSL)*
>
> *Um, I think I just tried to give off that impression that I knew what I was talking about, even though actually I was still getting my head around it. (Daniel, MSL)*
>
> *…there was this more jeopardy in a decision then… because if you are going into observe or be observed, you couldn't be required improvement before you could be satisfactory, but you couldn't be requires improvement. So a judgment of requires improvement was really significant because it meant that you had to go back in and be observed again. (Brett, SL)*

These data showed an insecurity in the evaluator role in terms of their awareness of consequential validity (Paufler & Clark, 2019) due to a lack of both direct and indirect training for the role of an internal evaluator (Levin-Rozalis et al., 2015). However, in line with the perceptions of evaluands, they did perceive that the opportunity to gain a first-hand experience of what is happening in classrooms so that they could provide formative feedback was beneficial (*Beth, CT, Emily, MSL, Brooke, MSL, Brett, SL*). Those in leadership roles also spoke of benefits in terms of the monitoring of practice as observations contributed to their view of the quality of mathematics teaching across their school (*Beth, CT, Donna, CT, Emily, MSL, Brooke, MSL, Amanda, SL, Brett, SL*) and the identification of strategic areas for development. However, one limitation to the use of observations as an evaluation tool was identified as the need to set these 'snapshots' into context over time, this was largely identified by participants speaking in, or showing consideration of, the role of class teacher (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Brooke, MSL, Brett, SL*) and aligns with practice advocated by Nevo (2015) and Coe et al. (2014).

> *An observer of a maths lesson should watch a series of that lesson, not just one lesson. It does not work at all because you can only judge that moment in time. But if you were to just go back, take a few steps back and looked at and discuss, have a discussion with the teacher of what she's taught with her, with her books, with her children, talk through what she's done, and then come and observe a lesson you'll see a different result coming out of it. (Anna, CT)*

Connected to this was a further limitation relating to the potential for single observations to be an

accurate representation of ongoing teaching and of their performative nature (Ball, 2003).

> *I think, um, you know, when you go to another school, you know, when Ofsted come in, inspectors come in, you, you are projecting a, the, you know, a facade sometimes. It's the same when I go to, I'm invited to go to another school to see they're showing me what they want me to see. (Donna, CT)*

The use of children's books (or their recorded work as a product of their learning) as a source of information in the evaluation process was experienced primarily as part of a summative monitoring of practice but with some influence on the identification of formative areas for development. Additionally, these classroom artefacts could also be understood as part of a 'value-added model' when used as evidence of progress (Coe et al., 2014). Samples focussed on children as representatives of a certain level of attainment (*Becca, CT*), or a randomised group (*Amanda, SL*) and varied in size, with a perception that a larger sample offered was beneficial (*Elaine, SL*). When the books were viewed, various foci were evaluated; presentation (*Becca, CT, Alice, MSL*), curriculum coverage and progression (*Becca, CT, Beth, CT, Brooke, MSL, Amanda, SL, Christina, SL*), fidelity to school policy or scheme (*Beth, CT, Donna, CT*) and evidence of progress and attainment (*Becca, CT, Beth, CT, Alice, MSL, Amanda, SL, Christina, SL, Dominic, SL*). Again, a mirroring of the foci adopted by the inspectorate was evident, as these elements were considered key to the process of a 'deep dive' in any subject (Ofsted, 2023).

Some limitations with the use of books for formal monitoring were raised in relation to the nature of mathematical teaching and learning and how feasible it is that a full and accurate picture can be presented in written form (*Becca, CT, Alice, MSL, Brooke, MSL*), particularly when much of what is recorded is standardised meaning that evaluative judgements are based on the interpretation of superficial observable differences such as the quantity of right or wrong answers (*Becca, CT, Brooke, MSL*) (Toch, 2008).

> *…and that's not picked up on because I can write VF in the margin, but you are never going to know what I've actually said to that child to make them understand that concept. So I feel like there are so many aspects that are important in maths that are missed out on, because if we just look at books, it's just not enough. (Brooke, MSL)*

Despite this, the use of books as a source of information was prevalent and considered of high value in some cases.

> *…she will have to come and show me the outcome tomorrow, because that's the bit I'm interested in, always this bit… I want to see what the outcome is there tomorrow. She'll come and show me the books. (Dominic, SL)*

Consequently, the range of foci that could be looked for in the books, coupled with their perceived status as sources of evidence, was again a source of pressure in some cases. This is consistent with the

assertion of Harris, Ingle & Rutledge (2014) and Levin-Rozalis et al. (2015) that the choice and status given to a specific data source influences the performative aspects of teaching that teachers will demonstrably prioritise.

> *…they were just so worried about books and not, having to prove things in books like, it has to go in the book. (Becca, CT)*

Similarly to the use of observations, 'pupil voice' was perceived to take place both formally and informally. The use of this term is consistent with Robinson's, (2018) definition of "working with pupils to elicit their perspectives" (p.2). As a tool within a formal evaluation of mathematics teaching, participants spoke of conducting interviews with groups of children to gather their views on their experiences, although this was not a consistently applied element of each school's practice. When it was referred to, the children chosen and the questions they were asked were spoken about in general terms (*Beth, CT, Brooke, MSL, Elaine, SL, Brett, SL, Dominic, SL*) although School B offered more detail on the nature of the conversation:

> *So we, um, we called in some children with their books and had a book look with the children and said to them, okay, what's your favourite lesson that you've done? Tell me a lesson where you were really challenged. Tell me which part you found really easy. (Brooke, MSL)*

> *…what we do is we speak to the children in conjunction with their books. So we don't just look cold at their books. Um, you know, show me the best piece of work. Why, you know, why for you is this piece of work good? How do you know this has been an effective piece of work? How do you know you're doing well? Um, often, um, how do, how do, how do we know we're doing well? (Brett, SL)*

Within these comments there were elements of dialogue that could be interpreted as an aspiration to a democratic community of practice in which all stakeholder voices are valued (Robinson, 2018; Wenger, 1999). The examples given by school B were largely designed to elicit a pupil's evaluation of their own work and were retrospective in their focus and so were inconsistent with a full definition of 'pupil voice', although the use of broader questions about enjoyment and their perceptions of their learning is beneficial and in line with low stakes data collection (Coe et al., 2014). However, the relative lack of data regarding the formal use of 'pupil voice' in evaluations could be seen as evidence of tokenistic inclusion (Thomson, 2011).

Participants from school B also offered some differing thoughts as to the credibility of the information gained from formal 'pupil voice' interviews which aligned with Nevo's (2006) concerns regarding bias and immaturity and of content-related validity (Paufler & Clark, 2019):

> *But again, that's one child out of 30 and actually what type of child is it? What what's their view on maths anyway, are there, you know, are we picking them for a particular reason?... our teaching might have*

> *been good enough at the time, which it was, but because of that child and their experience so far in maths and at the school, the teacher might've delivered a really great lesson, but that child has had a build up of maths previously. And that part might not have been good enough does not mean that the maths teaching was not good. (Brooke, MSL)*

Whilst demonstrative of double-loop learning (Argyris & Schön, 2003) in its effort to reflect more deeply on causality and meaning, this is also evidence of a lack of knowledge of valid interpretation as the perception of 'the children' as a homogenous group ought to be avoided (Robinson, 2018). Similarly, uncritical acceptance of children's views as 'true' is also problematic:

> *…the children can be quite honest and say what they think. And I think that's really important. (Beth, CT)*

This perception of children as 'honest' is contradictory to conclusions drawn by Almutairi & Shraid, (2021) who found that students tended to give a favourable view of their teachers to evaluators. Indeed, this use of focus groups with children as a data collection method is also potentially contradictory to core principles of effective encouragement of 'pupil voice' as responses are largely led by the interviewer, rather than encouraged or facilitated as part of a child-led discussion (Greene & Hogan, 2005), although more data would be needed to ascertain this across the dataset. Additionally, the lack of comment regarding the selection of children and acknowledgement of the influence of personality types on the group dynamic suggests that further study of this as a credible data collection method would be beneficial.

More credibility seemed to be attributed to the informal gathering of children's views, which can be characterised as when their thoughts or feelings are voluntarily offered following a lesson, or as part of wider school interactions.

> *…when a child tells me (own name), that was a fantastic lesson. And I said, what did you like about it? And they will tell you what they liked. And my class loves maths. And so they tell me, right. Maths was really brilliant today. I like the way we use all this, this, this, this. (Anna, CT)*

> *… in the end we just did like split it down into paper, got all those resources out. And the children said it was like an incredible lesson. (Becca, CT)*

> *I think if they're not, um, if they're not coming out for math lesson and going, oh, that was really good, that sort of thing… And that does ring alarm bells. I think for me… (Emily, MSL)*

Numerical attainment and progress data as part of value-added models (Coe et al., 2014) was used to informed the evaluation of both individual teachers' practice (*Elaine, SL, Amanda, SL*) and overall school performance (*Daniel, MSL, Elaine, SL, Brett, SL*). These data were attributed relatively high status as a reliable measurement of pupil outcomes, and as a benchmark for standards in line with an outcome

focussed definition for the quality of teaching (Coe et al., 2014).

> *And I'd say the real proof in the pudding was when I first started in September, it was 38% in the end of autumn. So teachers kind of feeling of where these children are sort of at their starting point of the academic year. And so now the most recent data's showing it's gone up to 52%. So we can at least say that actually the children are at the stronger starting point at the end of that Autumn term, as opposed to when they first started. (Daniel, MSL)*

> *…whether it's teaching or learning, undoubtedly, that is, um, qualified by results on a test like that. There's no question about that. Um, and certainly, I think that's why I was made math subject leader at my previous school because I got good outcomes on the test…So yeah, I think that's, there's, there's definitely an element of, of that, that is driving that sense of effectiveness (Brett, SL)*

Again, this can be seen as the morphing of individual and school perceptions of the validity and reliability of numerical data to reflect the importance placed on it as a measure of school effectiveness in wider contexts; local, national and even global (Ball, 2017; Stevenson, 2017). There was a sense that numerical data provided objective 'truth' and a feeling of control of the highly complex picture created by other, more qualitative data collection tools (Taubman, 2009). However, it was also evident that, by using numerical data as part of the 'big picture' school leaders were acknowledging that they must be understood within a broader context (Jarke & Breiter, 2019) and cannot be unquestioningly taken as valid or meaningful measures of the quality of teaching (Ball, 2017). The extent to which teachers and leaders were able to 'speak back to the numbers' (Stevenson, 2017) was, in part, facilitated by the employment of these other tools. One senior leader also spoke about the potential prejudicing of the observation process based on the prior evaluation of attainment and progress data, which was again consistent with the view that the use of numerical data as objective 'truth' influenced opinions and decisions in the evaluation of teaching (Jarke & Breiter, 2019).

> *…how many of those gradings were made before they stepped through the classroom because … they're happy because the outcomes were good. So actually there's nothing really to worry about… (Brett, SL)*

The final element of the evaluation process cited by participants was that of planning as a classroom artefact (Coe et al., 2014). Looking at teacher's mathematics lesson plans to gain insight into teaching and learning was spoken about in terms of fidelity to expectations of presentation and curriculum (*Alice, MSL, Daniel, MSL*) and evidence and development of subject knowledge (*Donna, CT, Daniel, MSL*), although this was not a predominant data collection tool, again perhaps indicative of school practice mirroring that of the inspectorate who no longer include planning scrutiny as part of their process (Ofsted, 2022a).

Underpinning the perceptions of validity of each of these data collection were implicit views related to

the ways in which each of them could provide observable or even measurable evidence of learning. Indeed, the word 'progress' appeared as a synonym for 'learning' throughout the data set, although predominantly by those in, or with experience of, leadership roles (*Beth, CT, Emily, MSL, Brooke, MSL, Daniel, MSL, Elaine, SL, Amanda, SL, Brett, SL, Dominic, SL*). At the root of this were conceptualisations of learning as the processing of information or experience that are most akin to definitions found in the fields of cognitive psychology, neuroscience and machine learning (Barron et al., 2015). These conceptualisations acknowledge that learning cannot be measured directly but only as observable changes in outcomes or 'behaviour'. This seemed consistent with the methods used for evaluating teaching, as they variously attempted to identify such changes and were supported by the views of Looney (2011) and Wayne & Youngs (2003) that the quality of teaching be evaluated through measurable standards which promote children's achievement (attainment *and* progress). However, the extent to which any evaluation process can isolate the influence of the teacher on the learning of their pupils is in doubt as the sheer complexity of factors that might affect the perceivable outcomes of learning such as motivation, physiological state, maturity, and/or emotion is "both practically and philosophically difficult to untangle" (Barron et al., 2015). Evaluating the quality of learning through what is 'produced' and using that as an indication of the quality of teaching was therefore increasingly complex and problematic (Nevo, 2015) as evidenced in participants' contradictory viewpoints of the validity of each method used in the evaluation process.

A lack of time to engage with this level of complexity, coupled with the need to prove competence in evaluating practice to develop and improve provision (Taubman, 2009) could account for a preference to simplify the picture into component parts, and rely on accrued experience to formulate views. In this way, the evaluation process draws on elements of a more positivist paradigm, in the use of triangulation of data from a range of sources attempts to discover 'the objective truth' about the teaching of mathematics by an individual, or across a school (Almutairi & Shraid, 2021), and acknowledges the interpretivist nature of subjective truths. This is particularly reflected in comments from two of the senior leader participants:

> *Yeah, so we're looking at the assessment documents. We're looking at the data to identify which children are looking at, um, any, um, provision maps, et cetera, to look at how that's been supportive, then lessons, um, looking at any targets that are being set as to how successful those children are and how are they being enabled to meet what they're being asked to do as a result of classroom resource provision. Speaking to the children, looking at the book, seeing what's going on in the classes, maybe looking at the planned intention… I was looking and trying very hard to triangulate it amongst what the children were*

telling me, what was in the books…" (Elaine, SL)

…she ticks all the exceeding boxes. She definitely ticks them all. But my gut says, she's not an exceeding teacher, but she did everything she needed to do. And I know the work going to come and it's going to be fantastic. Um, but yeah, I wouldn't say she's an exceeding teacher, but she ticked all the boxes for exceeding… it's really hard. (Dominic, SL)

4.3 Usefulness of evaluation

Throughout the data set, the extent to which the evaluation process is perceived as useful is in part connected to the credibility attributed to the evaluator. This largely related to the relevance and recentness of their teaching experience and knowledge of mathematics (*Anna, CT, Donna, CT, Brooke, MSL, Daniel, MSL, Elaine, SL, Brett, SL, Christina, SL, Dominic, SL*), which will be explored in greater detail in chapters 5 and 6. From a class teacher perspective, it was important that those evaluating their teaching did so from an informed position and were able to provide examples of practice on which teachers could base their development (*Donna, class teacher, Brooke, MSL, Daniel, MSL*) and this aligns with recommendations by Paufler & Clark (2019), Firestone and Donaldson (2019) and Levin-Rozalis (2015). Senior leaders acknowledged the length of time that had elapsed for them since they had last taught mathematics (*Elaine, SL, Brett, SL, Christina, SL, Dominic, SL*) and the impact they felt this had had on their ability to evaluate mathematics teaching as encapsulated by Alice (MSL) below:

I think again, confidence to teach maths and your confidence to evaluate others because personally, I feel that if I'm evaluating others, I need to be confident in how I teach maths. If I'm offering that advice or support or, um, coaching others, um, mentoring others that actually you need to go, oh, try this. This does work. And you can only have that. If you've got the (inaudible) again and subject language, it all ties together. If you've got the subject knowledge and you've got the confidence to express or offer solutions or ways to overcome barriers, you can, I think they will tie it together. (Alice, MSL)

As a result, they articulated various strategies for ensuring that their contribution to the evaluation process was useful such as; dedicating time to being informed about the teacher's context (*Elaine, SL, Dominic, SL*), conducting independent inquiry into mathematics-specific information from the internet (*Christina, SL*), and deferring to their mathematics subject leaders who have both current teaching experience and more recent access to subject-specific professional development (*Dominic, SL*). Although the last of these was potentially problematic for mathematics leaders when having their own teaching evaluated as:

...when I am being evaluated by, you know, SLT, I, you know, without sounding kind of arrogant, I do know more about maths than they do. So the feedback that I get is more to do with just general to, you know, it goes as, as bad as you need to sort out your book corner. So I would love for somebody ex- you know,

externally to come along and evaluate my maths… (Daniel, MSL)

The lack of capacity for senior leaders to engage with the levels of mathematics-specific content knowledge has the potential to result in tensions within the internal dynamics of the evaluations process. However, despite these acknowledgements by senior leaders, class teachers articulated their perception of the hierarchical status held by those they are evaluated by, and the ways in which this influenced their responses to the evaluation process and suggestions for development.

because sometimes you think, right, they're observing you so they are, they are in charge. So they need, they must know something, you know, and whenever they told me things, I used to do it… (Anna, CT)

…but you have to, uh, meet somebody's expectations rather than do your, do the teaching that you think is right. I mean, one head teacher might like, um, you know, group work and lots of hands on and practical and somebody else might like, um, something that's more formal. And I think that makes a difference as well. So it's, people's, different people's perceptions in maths and what they want to see, what their vision is. (Beth, CT)

The extent to which the evaluator "controls the field of judgement and what is judged" (Ball, 2017, p.58) is evident here as a driver for teacher behaviour in the evaluation process, and is notably influential in the development of a culture of performativity. Although it mut be noted that teachers showed their own judgements of evaluators to be more credible when they align with their own views.

So we had good leadership from him and things in observations, and he had, in my opinion, the right kind of the concrete and the pictorial kind of ideas, even at that time (Beth, CT)

…why are we listening to what they want? They're not doing particularly well. You know, we need to be listening to the, the leaders who are showing how to do it correctly… (Donna, CT)

The degree to which feedback following evaluations (particularly observations) was considered to be useful to those in a teacher role was influenced by whether it was perceived as relevant to them as individuals (*Brooke, MSL, Daniel, MSL, Brett, SL*). The extent to which it was structured and recorded into the identification of 'strengths' and 'areas for development', sometimes referred to as 'what went well' (WWW) and 'even better ifs' (EBIs) was variable with some referring to such categorisations (*Becca, CT, Beth, CT, Brooke, MSL*) and others citing less structured and unrecorded examples, which sometimes were anonymised and delivered to the whole staff group (*Emily, MSL, Brooke, MSL, Christina, SL*). Neither of these seem to align with recommended practice as the first firmly sits within single-loop learning (Argyris and Schon, 2003) and is not correlated with meaningful developments in practice (Kelly & Knight, 2019), and the latter does not encourage professional dialogue as part of meaningful sense-making (O'Leary, 2020). When teachers were given evaluative feedback or developmental suggestions that were perceived to lack credibility or usefulness, or contradict their own views, the responses

included overt challenge (*Anna, CT, Brooke, MSL*), performative compliance (*Becca, CT, Beth, CT, Donna, CT, Alice, MSL, Daniel, MSL*). There was also evidence of an awareness of the subjectivity of evaluative judgements (*Beth, CT, Daniel, MSL, Dominic, SL*) and the influence that this can have on the authenticity of the evaluation process. This is consistent with questions over the validity of numerical data as produced by practices that have the outcome as the measurable, observable goal (Ball, 2017).

> *I think different people have different perceptions of what think maths is good. And so I think it will say you, if you know what somebody wants to be looking for to some degree, you can play the game and, and do that. Um, and so different leaders and different people have different expectations and different visions of maths. And so sometimes they feel, but you have to, uh, meet somebody as expectations rather than do your, do the teaching that you think is right (Beth, CT)*

> *I think prior to that in previous schools, it was always the perception of the head teacher. So, you know, in my first school they might have had a different perception of what good maths learning looked like. And actually for me, I played to the preferences of the head teacher. (Daniel, MSL)*

This is also indicative of a reduction of the perceived credibility of the evaluator role due to inconsistency (Toch, 2008).

4.4 Influence of evaluations on development of evaluands' practice

As a consequence of all evaluative experiences and the identification of areas for development for both individuals and schools, 'training' was frequently referred to in a range of contexts by all participants. When recounting their professional history, many spoke about their initial teacher training through a variety of routes. There was an acknowledgement of the value of both university and school-based elements of teacher training, with positive developmental experiences recalled by many (*Anna, CT, Beth, CT, Donna, CT, Amanda, SL, Brett, SL*). Although inconsistent across participants' experiences, multiple instances of training for teaching in specific areas of mathematics as part of ongoing professional development were cited (*Anna, CT, Becca, CT, Beth, CT, Donna, CT, Alice, MSL, Elaine, SL, Amanda, SL*), these were externally provided courses in subject knowledge development (including the MaST programme), the use of mathematical resources, the delivery of a chosen scheme of work and assessment, and internally run staff meetings.

Across all these training experiences, in line with core principles of andragogy (Knowles et al., 2020), a common theme of those considered to be most useful comprised of the opportunity to engage with mathematics as a learner and develop deeper knowledge and understanding of the subject for themselves (*Anna, CT, Becca, CT, Beth, CT, Elaine, SL*). Opportunities to ask questions, develop dialogue with others, influence the direction or focus of the learning, develop connections between theory and practice and a degree of 'freedom' to experiment, both with mathematics, and with the teaching of

mathematics were key (*Anna, CT, Becca, CT, Beth, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Elaine, SL*). This is also consistent with views of effective professional learning as defined by Groundwater-Smith (2013) and Batteau (2017).

Also identified as valuable was the input from 'experts' or 'specialists' in the field of primary mathematics which could come in the form of those leading external courses, but also as in-school visitors leading staff meetings, or working with teachers and/or leaders within their own contexts (*Anna, CT, Beth, CT, Donna, CT, Emily, MSL, Brooke, MSL, Daniel, MSL, Elaine, SL, Brett, SL, Christina, SL*). The benefit of working with such colleagues was characterised as the opportunity to gain 'new' knowledge with an assurance of credibility due to the level of professional engagement with primary mathematics such colleagues are perceived to have and is consistent with the characterisation of 'consultant teachers' (Firestone and Donaldson, 2019).

> *(Names provider) had this fantastic level of training regarding going, not just going to other schools, but go listening to people that are the specialists. Who've done the research and have done the research in a primary classroom. So they're not just telling me how to do it off their book. They're telling me cuz they've done it…they were the ones who would provide the overviews, um, the suggestion of how children learn… when I say the best, you know, I want to, to meet someone who says that they've been outstanding in Ofsted every year or they've done this and they've written a book on that. I wanna meet them. I want them to teach me. (Donna, CT)*

This perception is also consistent with Addis and Winch's (2018) view of relative expertise and was perceived to offer more than simplified dissemination of information and an important element of developing double-loop learning (Argyris and Schon, 2003) and avoiding the repetition of internal outdated practices (Coe et al., 2014).

> *…teachers, I felt didn't have that enough of a knowledge of the wider perspective on maths. They had this narrow, trained knowledge. (Anna, CT)*

Despite this, peer-to-peer development was perceived as beneficial. It was most often characterised as informal interactions, instigated and driven by teachers (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Christina, SL*) and was the clearest example of communities of practice principles in action (Wenger, 1999) where each participant held interchangeable roles as evaluand and evaluator. Three of the sources of information utilised for the evaluation process (observations, children's books, and planning) were also used as peer-to-peer models of professional development with an emphasis on collaborative learning and practice (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Amanda, SL, Brett, SL, Christina, SL*). The benefit of creating space for this collaboration was acknowledged by senior leaders (*Elaine, SL, Amanda, SL, Brett, SL, Christina, SL*)

although the difficulty of finding the time outside of teaching hours, or the capacity to cover classes to release teachers during teaching hours to achieve this was a limitation (*Elaine, SL, Brett, SL*). Participants also spoke of the benefits of collaboration in terms of setting practice into the wider progression and context of mathematics within their school (*Anna, CT, Becca, CT, Beth, CT, Caroline, MSL, Elaine, SL*). Where collaboration was formalised into a more structured lesson study approach, the choice of focus for development was retained by the teachers (*Beth, CT*). Central to this collaboration was dialogue and discussion coupled with the opportunity to interrogate the teaching and learning of mathematics in rich detail (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL*), consistent with principles of collaborative enquiry (Levin-Rozalis et.al., 2015; Rallis and Militello, 2015). There was also evidence of participants across roles viewing the opportunity to observe others as a chance to develop their own practice or professional knowledge (*Christina, SL, Dominic, SL*). One participant cited two experiences with more formalised lesson study approaches, one as part of external development across schools and the other internal:

> *I think in a way the most supportive one, but it must've been awful for the teacher, but it's, because there were about 20 of us watching some of these lessons, but in our big group we've watched these and then we all talked together about a group. (Beth, CT)*

> *…the tri thing where we observed each, each other, but that was a few years ago, but we watched, we videoed each other and watched and gave each other advice and support for what we could improve and things. I think in a way the most supportive one. (Beth, CT)*

This experience was largely consistent with views of effective practice (Isoda, 2007; Murphy et al., 2017), particularly in terms of the mediation of the discussion as supportive and developmental (Mynott, 2020) in line with a 'human agency' perspective on evaluations (Levin-Rozalis, 2015).

> *And then they, weren't kind of critical. We weren't allowed to criticize. We were just allowed to take experiences from it. And we were allowed to say basically things that we had learnt from it. (Beth, CT)*

4.5 Influence of evaluations on development of evaluators' practice

In addition to experiences of training for the teaching of mathematics, some also referred to the training received in order to mentor student teachers and NQT/ECTs (*Claire, CT, Elaine, SL, Brett, SL*) which, though inconsistent across the data set, was an influential element of some participants' training in facilitating the development of others against a standards based model (Ball, 2017; Williams & Hebert, 2020) and was cited as influential in their development as evaluators. Those in leadership roles spoke of the need for both actual and perceived professional competence of subject leaders in this regard. Senior leaders acknowledged their need to be able to rely on their subject leaders to lead the development of mathematics teaching across their school, citing expectations that they would hold the most up to date

and accurate knowledge of both the subject, and the provision for teaching and learning in their specific context (*Brett, SL, Christina, SL, Dominic, SL*).

Mathematics leaders also spoke about the perception of their competence, with an awareness of not only the expectations from senior leaders, but also those of their fellow teachers, (*Emily, MSL, Alice, MSL, Brooke, MSL, Daniel, MSL*) and the impact this has on their confidence and self-perception of their effectiveness in their role. This is consistent with the findings of Gear and Sood (2021) whose study into primary mathematics leaders as change agents concluded that they need to occupy both a strategic and supportive position.

> *I think sometimes it can see where things have been difficult to implement things. Um, I could feel a little bit isolated, I think, um, from the other teachers, because there is, uh, in your role as math lead. (Emily, MSL)*

> *I think the challenge is that I might not necessarily always be the, the best person in a sense. And actually what I think is, is good practice might not necessarily be good practice of teaching for mastery because I'm still developing that in a sense, I feel confident to, you know, to do it, but I don't think I'm where my actual kind of like tutors are. So it's interesting then to think that actually, um, you know, I'm trying to get teachers to teach from, you know, teaching that style and teach from our... But yeah, I dunno if I'm still there yet. (Daniel, MSL)*

Some acknowledged the pressure they felt to "lead by example" (*Alice, MSL*) or "practicing what you preach" (*Caroline, MSL*) and to be "one step ahead" of their teacher colleagues in terms of their knowledge and practice (*Daniel, MSL*), whilst others were more comfortable with learning from and with their teacher colleagues (*Brooke, MSL, Caroline, MSL, Elaine, SL*). The benefits of participating in supportive mathematics leader networks and attending courses, including those with specialist input, were considered to be key to enabling this with an emphasis on the sharing of practice both for comparison and validation (Hipkins et al., 2011) and the provision of resources (*Beth, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Brett, SL, Christina, SL*). Participants spoke of their experiences of their mathematics leader role in disseminating information to teachers following attendance of networks and courses, and the benefits and limitations of this. It was considered an efficient way of sharing knowledge by acting as a conduit between a broader knowledge base and the specific context of an individual school or teacher (*Donna, CT, Alice, MSL, Caroline, MSL*) although the effectiveness of this dissemination was questioned with regard to the limited potential to replicate the learning experience of the attendee. This was consistent with Knowles et.al's (2005) view that professional development is ineffective when experienced vicariously through another's experiences:

> *You go to the (network) and, and watch these really interesting, um, sort of sessions and, and really be able to have that rich dialogue with the other math leads, but then the other staff didn't go through that*

> *process. And so it's already diluted in what I'm then imparting to, to everyone else. They, they missed out on that. (Daniel, MSL)*

The process of affecting change in teachers' practice was most effective when iterative as part of a reflexive cycle (*Brooke, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL*) and when consideration of a teacher's perceived individual needs was considered and the type of development offered differentiated accordingly (*Donna, CT, Emily, MSL, Brooke, MSL, Dominic, SL*). The pace of change was also cited as an influential factor in the effectiveness of development, in terms of the need to allow for gradual individual and collective adjustments to practice (*Emily, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL, Christina, SL*). Lastly, the requirement for teachers to "buy-in" to the purpose of and need for any changes to practice was widely acknowledged (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Alice, MSL, Caroline, MSL, Elaine, SL, Christina, SL*), with a lack of this identified as a key restriction to development:

> *So it wasn't just that it was a, there was a lot of input on planning at that time for us, um, at that particular place. And, um, yeah, so it was a lot of input and planning and changing things, but you were kind of some things she just didn't really see why, or this is the why, why, why don't we do this? Some of it really made sense and that's fine, but I don't know. I guess the support didn't feel quite as it should be. (Alice, MSL)*

> *I remember I spent hours with this woman really looking at her maths planning, and then her next observation, she just hadn't followed through on what we'd spoken about. And I questioned how effective my time with her had been… And depending on how much somebody has wanted the support in the first place or not as to how much you get from individuals. So I think when it's maybe part of a capability proceeding and somebody has been told, they're going to come and work with you, and maybe they're less enthused by the whole idea of having support. (Elaine, SL)*

These experiences are consistent with the work of Gear and Sood (2021) regarding the extent to which change can be led and managed, particularly by mathematics MSLs which is "subjective, circumstantial and contentious" (p.10).

Across all aspects of development as a result of the evaluative process, the culture within which each experience sat, or that underpinned and shaped each experience was key. Consistent with theories of andragogy (Knowles et al., 2005) and self-determination theory (Kelly & Knight, 2019), those experiences that were perceived to support learner choice were seen as most useful and beneficial by teachers.

> *my professors used to, um, uh, explain to us, you know, he would do a lesson on teaching mathematics or some aspect of it, and then we will bring our questions to him… My professors they've always taught us how to go about that, but not that they tell us, this is what you do, and this is what you do, but to find*

ways yourself. (Anna, CT)

So our early years teacher, for example… she's been able to then watch it and take that on board and take ownership for that for herself, which, um, you know, for her, certainly that's a far better model where she can see it and then say, those are the bits that I'm going to try this and this, and she's owned it and she's driving it forward. (Elaine, SL)

There was also further evidence that when this sense of autonomy over development is missing, it is less effective.

Um, I don't know. I find that a bit of a struggle because as I said earlier, I rolled out the scheme and said, what's here. If you, if you want to use it, um, perhaps assuming that people would, would use it more than they have. (Caroline, MSL)

So I think on the occasions where it really hasn't been successful is because the teachers haven't wanted the support. Um, but that's because it's probably been enforced on them rather than any level of choice about it… they don't want to be there and they don't want to take it on board and they have a perception that you're interfering with their class. (Elaine, SL)

Despite this, there was evidence of a lack of learner choice across the data set with targets, areas for development and measurement criteria set by those working 'with' teachers, suggesting that the dominant ideology of technical-rationalist (Levin-Rozalis et al., 2015) outweighs more sustainable and meaningful practice (Ryan & Fuller, 2015).

Um, but it was up to me to decide what we were gonna focus on for us as a team. So we would decide, okay, next time I meet you next half term, you are gonna have implemented or tried this, or you are gonna tell me about how terrible this went or, you know, what did you do to improve? (Emily, MSL)

This is consistent with a view of professional development as part of a standards-led accountability system that simplifies complexity and homogonises individuals (Ball, 2017). The findings of this study suggest that all participants are engaging with balancing the demands of accountability at all levels with acceptance of and respect for individuals needs' (Lowe et al., 2020). In order to grapple with this, the concept of reflexive practice was alluded to by participants which is consistent with the work of O'Leary (2020), Groundwater-Smith (2013) and Mintz (2014) and their advocacy of critical reflection and a state of 'productive uncertainty' as key tenets of effective professional development.

…always having that constant circle of reflective practice and moving forward and making sure that I'm doing my little tasks and stuff each time to just check actually, am I being able to solve these things? (Becca, CT)

Across the data set, it is evident that an andragogy-based model for professional development (Knowles et al., 2020) is implictly valued with key elements for the establishment of a learning culture articulated as safety, to try things out and make mistakes, openness, of dialogue and collaboration across all roles, and perceived relevance, both to the adults as learners and to the children whose learning is the

utimate priority for all concerned.

> *…I think if you evaluate that, that way, I think the observers knowledge will increase. And so will the teachers' knowledge. I think it'll be both ways and the observers can, can go through the things and say, oh, how did you manage to get them from that step to that step? What did you do? So we are all talking mathematics, the steps of learning. And so I think in evaluations that needs to happen, or that must happen from us as well. (Anna, CT)*
>
> *Um, so it was quite a safe kind of environment where we were maybe all on. I don't know, you just felt happy and safe to be there. (Alice, SL)*
>
> *…we had more training and that freedom in that sense to kind of try different things… (Brett, SL)*
>
> *…I feel that we have a culture in school here that the teachers are quite relaxed with people coming in and having those conversations and working alongside each other. (Christina, SL)*

4.6 Summary of findings regarding the evaluation of primary mathematics teaching through the Professional Development lens

When viewed through a professional development lens, the data collected offered insights into the perceptions and experiences of participants in several ways. Whilst the importance of mixed methods and triangulation of data was clear, there was a lack of clarity around the purpose of evaluations as formative or summative and there was often an amalgamation of these within isolated evaluative events. The perceived credibility of the evaluator varied across role and school and was influenced by perceptions of both the knowledge held by the evaluator in terms of mathematics teaching, as well as the level of scrutiny that the methods and tools of data collection and interpretation were subjected to. Indeed, the credibility and validity of the tools and processes of evaluation were largely not considered with any coherence across groups. There was a prevalence of single-loop learning evident, particularly due to a lack of capacity for those in a senior leader role to engage in double-loop learning practices as part of the evaluative process. Some double-loop learning was evident in teachers' and mathematics subject leaders' experiences, particularly as a result of discussion with external 'specialists' whose feedback and recommendations for practice were considered credible. Despite this, there was evidence that the power and autonomy over the evaluative process was largely held by these senior leaders, with a particularly complicated role for mathematics subject leaders in both a strategic and supportive position, and limited evidence of the evaluand being empowered to select the foci or methods for the evaluation of their practice. External evaluators were also perceived to hold a certain degree of power as the consequences of their validation influenced the perceived efficacy of teaching and informed targets or areas for development, although these were not always considered credible due to a lack of

contextual knowledge.

In summary, the findings relating to evaluations of primary mathematics teaching and professional development are listed below.

What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional development**?	- Valuing of mixed methods of data collection and triangulation - Evaluations are isolated events and lack clarity of purpose - Validity and reliability of tools and methods used are not considered - Feedback is corrective (single-loop learning) - Credibility of evaluators is correlated to perception of their knowledge for the teaching of primary mathematics - Usefulness depends on perceived quality of feedback - Senior Leaders lack capacity for developing knowledge for the teaching of primary mathematics - Mathematics subject leaders have most recent experiences of training for knowledge for the teaching of primary mathematics - Teachers and mathematics subject leaders question validity of data interpretations - Autonomy over evaluative process is held by Senior, and to some extent, Mathematics subject leaders - Discussion with external specialists is valued although a lack of contextual knowledge can mitigate usefulness of feedback

Table 7: Findings relating to professional developmentFindings and analysis of data through the professional development lens therefore offered some insight into the problems that this study seeks to explore and better understand as follows.

Problem 1: A potential lack of shared understanding around the varied purposes and consequences of evaluations

Participants valued mixed methods of data collection and triangulation as part of data interpretation in order that evaluations were perceived to be a fair and coherent representation of teaching quality. However, evaluative events were often isolated incidents and there was a lack of clarity around their purpose. There was very little evidence that the credibility and validity of the tools and processes of evaluation were considered by any participants. When feedback was offered to fulfil a formative purpose for evaluations this was most often corrective in nature and so the opportunity for meaningful double-loop learning was missed.

Problem 3: Under-representation of key stakeholder voices in research and lack of clarity around the relationship between their roles

The perceived credibility of evaluators was correlated to the knowledge of mathematics teaching that they were considered to hold. Teachers' and mathematics subject leaders' experiences of evaluation vary depending on the perceived quality of feedback and this was reduced in senior leaders due to a lack

of capacity to develop or maintain the requisite knowledge for effective mathematics teaching. Mathematics subject leaders were particularly challenged by this as they had often accessed the most current training relating to this. Some mathematics subject leaders and teachers also questioned the validity of the interpretations of data collected during evaluations.

Problem 4: The risk of deprofessionalisation of teachers and leaders through the evaluation process

Autonomy over the evaluative process was held by senior leaders. There was limited evidence of the evaluand being empowered to select the foci or methods for the evaluation of their practice.

Problem 5: Tensions and contradictions in the insider/outsider role of the evaluator

All participants, but predominantly teachers and mathematics subject leaders, valued discussion with external 'specialists' whose feedback and recommendations for practice were considered credible. Participants also perceived that external evaluators exerted influence on professional development as the consequences of their judgements influenced the perceived efficacy of teaching and informed corrective feedback, although this was not always considered useful due to a lack of contextual knowledge.

In the next chapter, data relating to the research question 'What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to professional knowledge?' is explored in relation to literature. The findings are analysed and discussed in relation to literature and a summary of these is provided with further insight into the five problems that this study seeks to address.

5. Findings, Analysis and Discussion - Professional Knowledge

This chapter explores participants' responses that relate to the second research question, 'What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to professional knowledge?'. Building on the processes involved in developing professional knowledge that were discussed in the previous chapter, the focus here is on the subject knowledge that is drawn upon to evaluate primary mathematics teaching. Rowland et.al's (2009) subject knowledge quartet and Shulman's (2005) pedagogical structures are used as a framework for analysing the generated themes of the subject-specific knowledge for effective mathematics teaching both held and perceived to be necessary by participants, the collective knowledge sources they draw on to inform evaluative knowledge of lesson and curriculum design, and the influence of these on their perceptions of effective mathematics teaching.

5.1 Evaluating subject-specific knowledge for effective mathematics teaching.

As discussed in Chapter 2.2, the subject-specific knowledge for teaching primary mathematics includes subject-matter, pedagogical-content and curriculum knowledge (Shulman, 1985). This is refined with regard to a signature pedagogy which encompasses surface, deep and implicit structures (Shulman, 2005). These are further codified for mathematics teaching by Rowland et.al's (2009) subject knowledge quartet which identifies key facets of mathematically specific subject knowledge and categorises them into 'foundation', 'transformation', 'connection' and 'contingency' knowledges (Table 2) and highlighted in **bold** throughout this chapter). As outlined in section 3.2, this framework will be used to categorise the findings regarding the professional knowledge held by the participants and further analysis and discussion will utilise Shulman's (1985; 2005) definitions of subject knowledge and signature pedagogy.

Foundation Knowledge

Participants referred to **overt subject knowledge** in terms of the level of subject-matter knowledge that they perceived they or others held (*Anna, CT, Becca, CT, Emily, MSL, Brett, SL, Christina, SL*). These participants' perceptions of what constituted mathematical subject knowledge separated the subject-matter of mathematics from what it is to be a mathematician or a mathematics teacher and demonstrated a prioritisation of number knowledge. When identifying a lack of subject-matter knowledge, the onus was placed on the individual and was reliant on them being able to identify what

they know they don't know (Lofthouse et al., 2010).

> *Um, you know, so what's your issues with shape? (Donna, CT)*

The **use of terminology** (*Claire, CT, Emily, MSL, Brooke, MSL*) and the complexity of accessing the language of mathematics were identified as key elements of effective mathematics teaching although it was noticeable that the participants were most concerned with enabling their learners to use terminology, rather than their own knowledge of accurate subject-specific vocabulary, as can be seen in the case of Emily, MSL, who used the phrase 'commutivity laws' for 'the commutative law' which raises a question over the accuracy of the 'known knowns' (Lofthouse et al., 2010) apparently held by this participant.

Two participants referred to their knowledge of **procedures**, but with differing perceptions of this. For Daniel (MSL), procedures were seen as a starting point for his own mathematical knowledge which has expanded to include conceptual knowledge over time, whereas for Dominic (SL), procedural knowledge was a route in to developing deeper conceptual understanding.

> *Um, I would still say even at that point, even when I was leading in year six, I was still driving that procedural element of, of mathematical teaching. I still hadn't really been shown or immersed into, or even in the sense believed of the kind of conceptual side of it, the bar models, et cetera. (Daniel, MSL)*

> *Um, and just go into, you know, in the old days, when you have to teach, chunking for division in, uh, first time I ever saw chunking, I was like, what is this I didn't under... I didn't understand what it was. Um, so I had to learn that process to make, you know, to be able to teach it to children, to understand division. And then suddenly it actually helped me understand division better because of this method of chunking, for example, which they don't do anymore. (Dominic, SL)*

The first of these viewpoints demonstrated a growing awareness of the relevance and interconnectedness of procedural and conceptual knowledge in mathematics as exemplified in the NCETM's 'mastery' approach (NCETM 2023a). However, whilst Dominic (SL), appeared to value his own strengthened conceptual knowledge prompted through the learning of an unfamiliar procedure, he also perceived that this knowledge was no longer relevant, "they don't do that anymore". The 'they' in this remark referred to a wider collective knowledge perhaps communicated through professional development, but more likely through changes in curriculum, assessment and/or schemes of work, and hinted at a resulting insecurity in this participant's professional knowledge. This could be interpreted as an example of the consequence of second-order technical knowledge (Argyris & Schön, 2003) whereby knowledge is constructed externally to the individual and prescribes what is, or isn't, effective and an

example of a lack of consistent and coherent guiding principles for practice (Knowles et al., 2005).

With further regard to this interplay between individual and collective knowledge only one participant referred to **theoretical underpinning**, and this was as part of their initial teacher training, "Everything that I'd learned theory-wise was being embedded" (*Emily, MSL*), but this element of foundational subject knowledge was absent in terms of any further explicit reference across the data set. This could also be attributed to a technical approach to the development of professional knowledge and a reduction of opportunities to develop praxis (Zimmerman, 2009) as the collective knowledge for teaching mathematics effectively is reduced to the communication of pedagogical surface structures, and opportunities to interrogate deep or implicit structures (Shulman, 2005) are limited (as discussed in chapter 2). Thus, the interdependence between 'knowing that' and 'knowing how' (Fenstermacher, 1994) is potentially weakened.

Finally, an **awareness of purpose** in mathematical teaching was demonstrated by participants with reference to their own perceptions, the perceptions of their learners, and the collective understanding of the broader purpose of learning and teaching primary mathematics. Firstly, with regard to the participants' own views on 'purpose', six made explicit reference to the need for there to be application of mathematical knowledge to 'real-life' (*Anna, CT, Becca, CT, Claire, CT, Donna, CT, Alice, MSL, Caroline, MSL, Christina, SL*) with some conflating this with a perceived need for children to understand why they are learning different parts of the curriculum particularly with regard to financial literacy and future careers (*Becca, CT, Donna, CT, Christina, SL*). This view of the functionality of mathematics is echoed in the National Curriculum's 'Purpose of Study' statement which lists various areas of 'life' for which mathematics is considered essential including "financial literacy, most forms of employment…" (DfE, 2013 p.3), and is representative of the interests of "industrial trainers (and)… technological pragmatists (Ernest, 2014 p.7).

This perception of purpose can also be related to the National Curriculum's 'Aims' for mathematics (DfE, 2013 p.3) and was evident in participants' responses as they referred to a need for children to acquire 'fundamental' mathematical knowledge which as reflected in the 'fluency' aim, (*Anna, CT, Claire, CT, Caroline, MSL, Brett, SL, Christina, SL*). It is worth noting that three of the four participants whose views are represented above are from the same school as this could be indicative of a shared narrative around the purpose of teaching mathematics in that setting.

The 'Purpose of Study' statement also refers to a purpose for learning linked to appreciating the "beauty

and power of mathematics" (DfE, 2013 p.3) more representative of the interests of "old humanist mathematicians (and)… progressive educators" (Ernest, 2014 p.7) and indeed, some participants articulated their perceptions of a purpose for mathematical learning rooted in exploration and a less functional view of the subject more akin to this viewpoint.

> *…the professional knowledge is to know how big maths is… (Anna, CT)*
>
> *…just that exploration of maths… So the strategy and logic and that kind of stuff…that ability to interrogate patterns and stuff were, were really, really important… (Brett, SL)*
>
> *So I feel like maybe in primary, we have that opportunity to really allow children to have that exploration of learning and maths. (Christina, SL)*

There was also acknowledgement of a purpose in developing a "sense of enjoyment and curiosity" (DfE, 2013 p.3) about the subject representing the interests of "progressive educators (and)…public educators" (Ernest, 2014 p.7).

> *…trying to make sure that by the end they leave by the end that they leave primary school, that they have a love of it. And they don't think that, oh, no, is just, I can't do that really hard. (Anna, CT)*
>
> *…my intent as a math leader is just that children will… join us enjoying maths. (Caroline, MSL)*

Many of these responses demonstrated an articulation of purpose that drew on knowledge bases held by individuals within each school, and the wider knowledge base within which they sit. The relationship between these knowledges is complex and interconnected, as the wider knowledge base is absorbed by individuals and validated by collective agreement and is, in turn, influenced by the enactors of that knowledge as they critique and evaluate the validity of the wider knowledge through their own perspectives and make practice-based decisions accordingly (Fenstermacher, 1994). However, the level of congruence between espoused and enacted knowledge was variable. As two participants acknowledged:

> *Because if it's not matching to what we are saying, our math curriculum…what is the point of it? We're just adding different layers and different. It might be relevant, but it might not be clear enough. (Brooke, MSL)*
>
> *…we've got our intent, our implementation and our impact. So that's, there's, that's been agreed and shared with everybody within staff. And does that get used as part of this evaluation process? That's a good question. Probably in a, um, I would say probably in a way that we have that knowledge of what maths provision looks like in the school. And I suppose if we actually got that document out and looked at it, we'd be able to say, oh yes, we've said that. And yes, we are doing that. So we do sort of live and breathe that, I suppose, it's, it's not just a piece of, a document to say, well, this is, you know, we need to tick this off. It's sort of part of what we, an integral part of our maths teaching. (Christina, SL)*

This awareness of purpose was strongly connected to underpinning beliefs which, for Rowland et.al

(2009) are included in foundation knowledge, and was a key theme identified in the data relating to professional identity and thus will be explored further in Chapter 6.

Transformation knowledge

All but one of the SLs (*Amanda, SL*) and all but one of the mathematics subject leaders (*Caroline, MSL*) articulated a perception of the importance of transformation knowledge for teaching mathematics, as illustrated by the following statements:

> *… I'd always been good at maths. I'd won awards at school for maths, and I could do things in my head and that was fine, but actually explaining to somebody else how to go about it wasn't necessarily a strength because I think when you understand something, you don't spend the time unpicking it. So looking at that range of models and images and how to explain to somebody, I think that's the key thing for me in terms of, in terms of subject knowledge and the pedagogy of how to go about teaching rather than necessarily just the concept. (Elaine, SL)*

> *It's, it's the, it's the how to teach the maths, not how much maths you know, I find is really important…So it's, it's the process of teaching the maths to those children more than understanding the maths, it's that process. (Dominic, SL)*

All participants except one (*Donna, CT*) referred to the **choice of representations** within mathematics teaching in the form of concrete manipulatives and images alongside more symbolic representations. The prevalence of this could be largely attributed to the far-reaching work of the NCETM in promoting this as a key element of effective mathematical pedagogy, and this is explicitly referred to as 'CPA' (concrete-pictorial-abstract) by Beth (CT), Emily (MSL), Alice (MSL), Brooke (MSL), Elaine (SL) and Amanda (SL). Both Emily, (MSL) and Alice (MSL) referred to the use of these representations in a linear way, concrete then pictorial then abstract, whereas Brooke (MSL) and Elaine (SL) spoke about moving between and across these, and so demonstrated differences in interpretations regarding the application of this principle in practice. Arguably, Elaine's perspective was an example of an understanding of deeper structures within mathematical pedagogy as she was exercising knowledge of the advantages of choosing certain practices over others (Shulman, 2005). Similarly, some participants (*Claire, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL*) referred to the provision of the 'right' representation to best support children's learning, and so acknowledged that it was not sufficient to offer choice of a generic variety of 'maths resources' and demonstrated a deeper structural pedagogical knowledge in decisions about how material is taught and presented (Shulman, 2005).

It was apparent that there was also a tendency to prioritise the preferences of the children in their choice of supportive equipment, or to satisfy the idea of 'conceptual variation' (NCETM 2023a) above a choice of that which is most accurately representative of the mathematics being learned (*Anna, CT,*

Becca, CT, Claire, CT, Emily, MSL, Alice, MSL, Caroline, MSL, Daniel, MSL) which exemplified a preferencing of the concrete operational acts of teaching and learning in accordance with surface structure pedagogical knowledge (Shulman, 2005).

Indeed, the use of a wider body of collective knowledge about mathematical teaching, beyond that espoused by the NCETM, to underpin or justify practice relating to representations was largely absent. For example, it was evident that the 'concrete' element was consistently referred to as 'resources' (*Becca, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Elaine, SL, Dominic, SL*) with only one participant referring to 'manipulatives (*Amanda, SL*) and that the types of materials used were limited to those contained within mastery-based planning materials. Similarly, the only pictorial representations explicitly referred to were two versions of part-whole models, 'the cherry model' and 'bar model' (*Claire, CT, Daniel, MSL*) and as with the concrete representations, a lack of awareness about the appropriateness of specific visual models to support understanding was implied. Although Brooke (MSL) did demonstrate a potentially deeper knowledge in this regard as illustrated below and a willingness to encourage teachers to analyse, test and refine their practice in keeping with a praxis based model of knowledge (Christianakis, 2010; Ernest, 1991; Fenstermacher, 1994).

> *I will say, um, Ooh, do you think you could have used, for example, um, a pictorial representation for those fractions, it would look like this, or it could look like this rather than just saying you could use pictorial representations, full stop. I'm providing an example where, where people can go, oh yeah. That's what you mean. (Brooke, MSL)*

Of the three strands related to transformation knowledge, representations were spoken about significantly more than the **choice of examples** or **demonstration** practices. In some ways, the awareness of the use of representations in order to provide conceptual variation demonstrated an overlap with the choice of examples (*Brooke, MSL, Daniel, MSL, Elaine, SL*), but there was an absence of references to related theoretical understanding in the form of variation theory (Lo et al., 2011), interleaving (Ollerton et al., 2020) or 'intelligent practice' (with the exception of Brooke (MSL) and Daniel (MSL) who cited this with reference to the NCETM mastery principles) with regard to the examples offered to the children in order to highlight particular relationships, processes or structures within number, calculation or geometry (Askew, 2016). 'Demonstration' was referred to as 'explanation' (*Elaine, SL, Christina, SL*) but there were no explicit references to mathematically specific

'demonstrating' or 'modelling' across the dataset.

Connection knowledge

Within references to connection knowledge in the dataset, there were clear overlaps with both overt subject knowledge (foundation knowledge) in the perception that teachers need to "have a really secure understanding of how the different concepts of maths link themselves" (*Caroline, MSL*) when making **decisions about sequencing.** In relation to this, connection knowledge was most clearly demonstrated in references to decisions about sequencing both within lessons (*Anna, CT, Claire, CT, Amanda, SL, Dominic, SL*) and across a series of lessons (*Claire, CT, Amanda, SL, Dominic, SL*). An overlap with transformation knowledge was also evident in the use of representations, examples and demonstration to support **connections between concepts and procedures** (*Donna, CT, Daniel, MSL*). One participant made implicit reference to the **anticipation of complexity** by highlighting the importance of identifying and addressing misconceptions (*Brooke, MSL*).

Some participants acknowledged perceived difficulties that occur as a result of a lack of this linear sequencing of learning with reference to 'gaps' in children's knowledge (*Becca, CT, Claire, CT*), a lack of understanding when maths is taught as 'isolated concepts' (*Christina, SL*), and the challenge of planning a sequence of maths lessons without reference to any pre-written or published materials (*Brooke, MSL*). Regarding evaluating an individual's subject specific knowledge, it is apparent that participants drew most strongly on subject-matter and curriculum knowledge (Shulman, 1985) to support sequencing decisions. Some potential benefits of non-linear connections within and beyond mathematics were mentioned in terms of 'cross-curricular' links (*Christina, SL*) and the application of mathematical knowledge and skills to activities such as cooking (*Becca, CT*).

Notably, the key benefit of the linear sequencing of teaching was seen to be that of efficient coverage of curriculum content. All participants referred to the linear nature of mathematics learning as illustrated by Beth (CT) who stated, "…once you have those structural things in place, like step by step…you really can't go wrong". The prevalence of this perception exemplified both a deep pedagogical structure in the form of an assumption about how mathematics is best taught, and an implicit pedagogical structure perception of the limits and bounds of learning (Shulman, 2005). However, this assumption is challenged by Coles and Sinclair (2022), who argue that although mathematical knowledge may be understood as a set of sequential building blocks, it is not exclusively the case that it is best learned in this way. When viewed through Fenstermacher's (1994) four questions for the scrutiny of knowledge 'What is known

about the effective teaching of primary mathematics?', 'What do teachers know about the effective teaching of primary mathematics?', 'What knowledge is essential for teaching?' and 'Who produces knowledge about teaching?', it is apparent that Coles and Sinclair's (2022) view was not evident in the participants' perceptions.

Contingency knowledge

Two participants made explicit reference to contingency knowledge in relation to decision-making 'in the moment' of teaching.

> *… sometimes you have to make the judgment, where's the right time and place… (Beth, CT)*
>
> *We don't follow by the book, we, we don't have a guide book to the job. There's not, you should do this. Or if you do this, this will happen. We have to be fluid throughout. And to be fluid, you have to have an embedded confidence, awareness, understanding. You need to have a bank of tools and resources to go to. (Brooke, MSL)*

This last comment exemplifies the way in which contingency knowledge is dependent on a variety of other knowledges for the effective teaching of mathematics as found across the other three categories of the subject knowledge quartet (Rowland et al., 2009).

Further references to contingency knowledge were made about responding to children's misconceptions in terms of whether to ignore the situation, acknowledge but side-line it, or acknowledge and incorporate it (Rowland et al., 2009), and the related levels of other elements of subject knowledge that would influence a teacher's decision as illustrated by Beth (CT), Amanda (SL) and Christina (SL) below.

> *Um, or if there's a misconception, yes, you can pick it up but on a normal day you might spend longer picking it out or you might notice a misconception and think we'll covered that the next day. Um, but it's not something at this time of moment that I can put good... if I do it off the cuff, I might not be giving the best teaching to make you learn this. So I've noted it in my assessment for learning and we will pick it up again tomorrow… (Beth, CT)*
>
> *um, being able to address misconceptions that you may not have even thought of who may not have arisen before thinking on your feet and going actually, that's what they need or let's hold fire. (Amanda, SL)*

These perceptions of knowledge sit securely within a tacit (Argyris & Schön, 2003) or strategic (Shulman, 1985) knowledge base and, as such, are subjective, instinctive and heavily influenced by context (Christianakis, 2010).

Each part of the subject knowledge quartet can be seen to combine to influence both evaluand and evaluator knowledge to enable the evaluation of the quality of primary mathematics teaching.

Additionally, beyond this individualised professional knowledge sit systems and cultures of teaching that exert an influence on the perceptions and assumptions of the relative values of different elements of this professional knowledge. One significant theme developed in the data is that of the collective knowledge base that is perceived to influence lesson and curriculum design.

5.2 Collective knowledge for evaluating lesson and curriculum design.

Turning now to examine the wider knowledge base that is drawn upon to evaluate lesson and curriculum design, this section will examine responses pertaining to the structure of lessons, planning systems and schemes of work.

Firstly, regarding the structure of individual lessons, differing perceptions of effectiveness were evident. Some participants referred to beginning with a 'context', 'problem, or 'question' that is shared and discussed with the class (*Beth, CT, Claire, CT, Alice, MSL, Daniel, MSL*), and others described a sequence that starts with some form of 'warm-up' or 'input' from the teacher (*Claire, CT, Amanda, SL*). These are indicative of inductive and deductive pedagogies respectively (Ensor et al., 2002) and are rooted in both participants' personal preferences and influenced by external factors relating to colleagues' preferences and endorsed curriculum materials (Moore et al., 2021). Regardless of the teacher-led starting point, participants described how children would then begin to work through related activities either on their own or in small groups, independently of the teacher (*Claire, CT, Donna, CT, Alice, MSL, Daniel, MSL*) with one participant explicitly stating that this was a necessary element of effective practice.

> *You cannot walk them through every single question… the children answer the questions independently. (Emily, MSL)*

This viewpoint resonates with one of Coe et.al.'s (2014) recommendations for measurement of effective teaching, that of the use of tracking learners' time 'on task' as a proxy for learning.

Elaine (SL) spoke of her perception of the disadvantages of a lesson structure that is more open and child-led.

> *I, I gave choice about some of the tasks at times and the children loved it, got a lot out of it, but I was on the floor by the end of it because I tried to juggle too many things at once. And it meant that none of them were as effective as they could have been… I think we did shapes and I remember putting a whole host of different activities that children could kind of self-select over the week. They'd all done them all, but trying to coordinate that with various levels of ability to in various different tasks at all, the same time was probably too much for the teacher to manage. (Elaine, SL)*

Again, this seems to reflect a lack of research evidence supporting the efficacy of 'discovery learning' in

favour of more direct instruction (Coe et al., 2014).

Building on this, a variety of organisational choices, regarding both the children and the chosen tasks, were described. Similarly to Elaine (SL), other participants valued opportunities for children to demonstrate their learning through application of their knowledge and/or skills to different questions, tasks or problems (*Claire, CT, Donna, CT, Alice, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL*) and frequently these responses were connected to the idea of differentiation or adaptations and 'ability'. Again, differing practices were described as some participants cited the provision of different tasks, questions or worksheets (*Donna, CT, Daniel, MSL, Elaine, SL*) or pedagogical adaptations in the form of scaffolding through the provision of different representations (*Beth, CT, Claire, CT, Emily, MSL, Alice, MSL, Elaine, SL, Amanda, SL*), throughout all of these, references were made to perceptions of the children's mathematical ability. Teachers' responses to perceived differences in ability were either pre-planned based on predictions of individual children's ability to complete tasks independently of the teacher (*Claire, CT, Donna, CT, Caroline, MSL*) or carried out during the lesson and action taken as a result of observations of learning (*Beth, CT, Daniel, MSL, Amanda, SL*). These actions might take the form of additional teaching to that provided in timetabled lessons.

> *…we can do interventions in the afternoons if we need to… (Becca, CT)*
>
> *Sometimes our children need additional bits of learning in between before we can carry on. (Alice, MSL)*

Whilst the efficacy of grouping by ability is largely unsupported by research evidence (Coe et al., 2014) this is nevertheless a prevailing idea in practice that is again used as a proxy for more robustly evidenced effective practice such as the use of formative assessment and scaffolding (Coe et al., 2014).

This high level of variation in participants' experiences of lesson structure design could be interpreted as a lack of collective agreement on the purpose of primary mathematics teaching as short-term pedagogical and curricular decisions enact the underlying values or beliefs of each participant (Chen et al., 2021; Ensor et al., 2002); these facets of professional identity are explored in more depth in Chapter 6. These inconsistencies were apparent between schools, and in some cases, within schools despite clear systems of planning and whole school policy documents that articulate the implementation of the mathematics curriculum. The broader planning systems that enacted the implementation of each school's curriculum were heavily influenced by the presence or absence of a centralised scheme of work. A variety of such schemes were used to varying degrees in the five case study schools, with participants also having additional experiences of other schemes and planning systems previously (both

within and beyond their current school).

Coverage of curriculum content and consistency of approach across a school were frequently cited as aims for curriculum design and justifications for the use of a mathematical scheme of work, (*Becca, CT, Donna, CT, Emily, MSL, Alice, MSL, Caroline, MSL, Daniel, MSL*), in line with governmental recommendations (DfE, 2016).

> *What you see in one class should essentially look pretty much the same… across a year group. I think so. Yeah. Um, I'm not talking about the actual teacher, the way you deliver it might be different, but the, the learning should essentially be the same and it's planned in a particular way online that you can follow that… It should, should all be the same. (Alice, MSL)*

> *I see a real benefit of a real genuine consistency of teaching and learning and also the actual visual representation of the, the, the, the slides… So I find that actually when the children know exactly the order in which the learning's gonna come through, they know exactly how it's gonna be visually represented. Then it just makes them feel a little bit more at ease. (Daniel, MSL)*

An alternative view of the type of consistency espoused by Daniel (MSL) was expressed by Donna (CT).

> *Um, the only thing I'm seeing with my children at the minute with (scheme) is they're a bit bored. You know, it's a bit samey. And, um, the amount of, I think, um, fractions, decimals, and percentages, I think… I think it was about 22 lessons. That's just boring, isn't it?... it was good in the sense of, you know, they need fractions, decimals, percentages, but I, I would've maybe done a few tweaks of how we get there and coming back to it a bit. (Donna, CT)*

This is indicative of a frequently mentioned sub-theme within the dataset relating to varying expectations of fidelity to the use of a scheme of work and the influence this has on evaluative feedback and judgements. It was clear that some participants valued the use of a scheme to provide overall guidance for a sequence of learning in the short, medium and long-term, citing the benefits both to workload, and the contributions this made to their own knowledge for the effective teaching of mathematics (*Donna, CT, Beth, CT, Alice, MSL, Brooke, MSL, Caroline, MSL*), again echoing governmental justifications (DfE, 2016). There were mixed perceptions of the benefits and disadvantages of planning mathematics lessons without a scheme, as some participants found this to be time-consuming, they lacked confidence in their choices and decisions and were not convinced of the benefits to children's learning (*Alice, MSL, Elaine, SL*), whereas others felt that they enjoyed planning 'from a blank sheet of paper' and drawing on a range of experiences and resources to do this (*Donna, CT*). For each viewpoint, there is evidence of curriculum resource materials operating as boundary objects whereby knowledge and practice is both informed by and informs their use (Moore et al., 2021).

The cited benefits of scheme use by participants were the embedded aspects of lesson design that were perceived to constitute effective practice; key vocabulary (*Brooke, MSL, Daniel, MSL*), variety of

representations/CPA (*Brooke, MSL, Daniel, MSL*), addressing of misconceptions (*Brooke, MSL*), progressive sequences of learning (*Donna, CT, Brooke, MSL, Caroline, MSL, Emily, MSL*), and differentiated worksheets (*Caroline, MSL*). Notably, these benefits were all cited by those who held or had held the role of subject leader, implying the possession of knowledge that enables this group to identify elements that encapsulate effective mathematics teaching (Moore et al., 2021). Table 6 shows how each of these perceived benefits correlates to the subject knowledge quartet (Rowland et al., 2009).

Perceived Benefits	Subject knowledge quartet
Key vocabulary	Terminology (Foundation)
Representations/CPA	Choice of representation (Transformation)
Addressing of misconceptions	Anticipation of complexity (Connection)
Progressive sequences of learning	Decisions about sequencing (Connection)
Differentiated worksheets	Anticipation of complexity (Connection)

Table 7: Perceived benefits of Scheme of work correlated with Subject Knowledge Quartet

The latter two benefits were both related to how, in practice, teachers worked to meet a wide variety of children's needs, and as such, could be seen to overlap with contingency knowledge. However, the pre-prepared curriculum and lesson plans contained within schemes cannot be fully classified as supportive of this as they are created without knowledge of specific learners, cohorts, or teachers (*Anna, CT, Becca, CT, Claire, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL*).

> *… I think any scheme is never gonna be, it doesn't think about the cohort that we have. And I think also it doesn't think about the teachers that you have and where they, where they are on their career (Donna, CT).*

This echoes the view of Coe et.al (2014) that professional judgement is a crucial part of pedagogical knowledge. Several participants spoke about the importance of being able to use such professional judgement to adjust the predetermined sequences or content of lessons contained within a scheme of work, which could be interpreted as a compromise between the perceived restrictiveness of following a scheme in every detail, and a complete 'free-rein' (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Brett, SL, Christina, SL, Dominic, SL*) and as evidence of the partial production of boundary objects (Moore et al., 2021).

> *Um, so I know, you know, so many times I say we're not slaves to (the scheme). Don't just follow it. If they haven't understood. Don't just move on to the next lesson, because you're worried about time and space because that's irrelevant if there's no point teaching for them to not master and understand that, that lesson objective, um, they're not ready because we're just making gaps rather than filling them. (Brooke,*

MSL)

Um, I think people can be too tied to things.(Emily, MSL)

I don't think schemes need to be adhered to 100% all the time, but I just think there are lots that recommend this scheme and to how I think maths is best learn and taught. (Caroline, MSL)

This last comment is particularly indicative of a faith in the materials to represent best practice (Moore et al., 2021) and of a two-way process of participation as teachers act a curriculum designers (Pepin et al., 2017). However, there is also a risk inherent in a "selective recruitment fragments narrative" (Ensor et al., 2002 p.27) that results in a dilution of the professional knowledge contained within such materials as teachers select elements that best suit their pre-existing ideas of effective practice. Therefore, the extent to which teachers and leaders perceived that it was acceptable to exercise such judgement varied, with experiences and perceptions ranging from those who were explicitly instructed to or advocated adjusting the scheme's plans and incorporate other planning resource materials (*Becca, CT, Claire, CT, Emily, MSL, Alice, MSL, Caroline, MSL, Christina, SL, Dominic, SL*), to those for whom such choices were significantly more restricted (*Anna, CT, Becca, CT, Donna, CT, Brooke, MSL, Daniel, MSL, Dominic, SL*). This was heavily context dependent and reliant on a range of complex internal factors (e.g. individual staff views and perceived competences) and external influences (e.g. guidance from advisors and Ofsted judgements) (Coldwell, 2019). In the latter group, participants spoke of being "allowed" to deviate from the scripted plans (*Anna, CT, Becca, CT, Donna, CT*).

I find it really difficult to, um, for example, with fluency, we've got (names scheme) as a, as a strategy to use. Um, and either some teachers would just follow step-by-step and not use their autonomy and change parts of it, and some will completely avoid it and just do their own thing and it's not sequenced and it's not good enough. (Brooke, MSL)

This perception of an inadequacy in teacher's knowledge for lesson and curriculum design was more evident in schools that showed less flexibility in the use of an established scheme. As Daniel (MSL) put it,

…in the politest way possible, I don't think they think better than (names scheme) do you know? I don't think they create questions better than (scheme) do. I don't think they present things in the conceptual way better than (scheme) are doing at the moment… I guess it, it forces them and I don't like to use that word, but in a sense it has done to, to represent the, the learning in that way. So, um, they are having to represent the understanding of mathematical concepts through conceptual sort of representations, pictorial representations, having to use particular language now that they never would've thought to use. (Daniel, MSL)

This last comment particularly resonated with an awareness that in order to have expertise in designing teaching, individuals need to hold sufficient curriculum design, subject-matter and pedagogical-content

knowledge (Huizinga, 2009, in Pepin et al., 2017).

In all schools, it was clear that there was a complexity to the fidelity or flexibility with which a scheme was utilised echoing "offloading, adapting and improvising" spectrum (Brown, 2009, in Pepin et al., 2017 p.802) with no school demonstrating a full fidelity approach, although this had been the case in School D until recently. In this instance it was clear that the scheme was recognised as a credible source of knowledge for teachers' development and initially close fidelity to all aspects of the established plans was expected (*Donna, CT, Daniel, MSL, Dominic, SL*). The perceived knowledge held by individual teachers was often the deciding factor as to whether they could reduce their fidelity to the school's scheme and use it more flexibly (*Donna, CT, Daniel, MSL, Dominic, SL*). In School A, it was also evident that fidelity to the scheme was used as an indicator of the possession of such knowledge as key elements of the scheme were being used as observation criteria (*Anna, CT, Alice, MSL, Amanda, SL*).

> *Yeah, so we were looking about, uh, how it was being delivered and whether it was being delivered in the way it needed to be delivered… we've got some training booked, which most of the training should come from (scheme) anyway, so it's going to recap what a lesson should look like. I'm hoping it's going to show us, um, the layout of a lesson, and how essentially, how resources should be used within the lesson, how it should be planned. (Alice, MSL)*

This is an example of the effective combining of curriculum materials with related training to support teacher knowledge development (Ensor et al., 2002) and of second-order technical knowledge whereby the prescribed techniques form part of a coherent environment created around the teacher which validates their effectiveness (Argyris & Schön, 2003).

In School D, fidelity not only to the scheme, but also to the MSL's interpretation of it and their explicit expectations of planning was also evident,

> *…they really did a fantastic job at, um, appeasing to my specific kind of vision of it… I was very, very meticulous with how I wanted it to be presented because I didn't want it just all, you know, all the learning just to be shown on the board in one go, I wanted it to be unpicked. (Daniel, MSL)*

The views of Brooke (MSL), Alice (MSL) and Daniel (MSL) above are reflective of a problematic double-edged sword in using schemes of work to develop knowledge for effective mathematic teaching. On one side, the utilisation of a checklist of observable constituent parts of teaching has the potential to reduce the meaningful whole into a disjointed set of insufficient practices, whereas it is equally undesirable to leave pedagogical knowledge as an unspecified, unobservable phenomenon (Coe et al., 2014). Again, the use of such materials cannot be separated from key epistemological questions about the teaching of primary mathematics; what is known, what do teachers know, what knowledge is essential, and who

produces this knowledge (Fenstermacher, 1994)? It is evident that the professional knowledge base drawn on by participants to evaluate teaching as effective was heavily influenced by the schemes utilised in each case which were influenced by and products of a larger context in mathematics education (Boylan & Adams, 2023) and reflect the priorities and ideologies of this regulated discourse (Ensor et al., 2002). This regulatory context is formed of the National Curriculum, the standardised assessment system and 'mastery' and we now turn to the influence of these on participants' professional knowledge.

England's standardised curriculum Programme of Study (PoS) and Standard Assessment Tests (SATs) were primary sources of professional knowledge against which participants evaluated their and others' mathematics teaching. Key aspects of the National Curriculum for Primary Mathematics (DFE, 2013) in terms of coverage (*Emily, MSL, Alice, MSL, Caroline, MSL, Amanda, SL, Brett, SL*) and with regard to the 'Aims' of fluency (*Beth, CT, Claire, CT, Brooke, MSL, Daniel, MSL, Brett, SL*), reasoning (*Claire, CT, Donna, CT, Alice, MSL, Brooke, MSL, Amanda, SL*) and problem solving (*Anna, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Brett, SL*) were included. Some cited the use of assessment frameworks or their own engagement with KS1 and KS2 Standardised Assessment Tests (SATs) as supportive of developing their awareness of gaps in their own mathematical subject-matter knowledge (*Becca, CT, Caroline, MSL, Amanda, SL, Christina, SL, Dominic, SL*). The knowledge acquired from this also incorporates curriculum knowledge, with some participants citing that their understanding of pitch and expectations for specific cohorts and children was enhanced (*Becca, CT, Donna, CT, Alice, MSL, Brooke, MSL, Daniel, MSL, Elaine, SL, Amanda, SL, Brett, SL*), and some highlighting an increased understanding of the progression of key ideas across the primary curriculum provision (*Beth, CT, Donna, CT, Caroline, MSL, Elaine, SL, Amanda, SL, Christina, SL*). The influence of the assessment system was also apparent in references to 'lower' (*Beth, CT, Caroline, MSL*), 'higher' (*Anna, CT, Beth, CT*) or 'greater depth' (*Becca, CT, Donna, CT, Daniel, MSL*) children and the knowledge required to teach and assess according to these perceptions. This influence is acknowledged by Coe et.al. (2014) who firmly attach the definition of effective teaching to its impact on assessed learning, therefore a reciprocal relationship whereby the content of the PoS and SATs affect the knowledge prioritised and valued in schools is also identifiable. As Brett (SL) clearly demonstrated,

> *I guess, I mean, you know, you've talked about effective, you know, whether it's teaching or learning, undoubtedly, that is, um, qualified by results on a test like that. There's no question about that. Um, and certainly, I think that's why I was made math subject leader at my previous school because I got good*

outcomes on the test.

However, some participants were of the view that the knowledge needed for effective teaching of primary mathematics goes beyond that which can be learned from the curriculum and assessment systems and is necessary in order to be able to 'break down' or 'unpick' the learning (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Caroline, MSL, Daniel, MSL, Elaine, SL, Brett, SL, Christina, SL*). Notably, all three participants from School A made explicit reference to knowledge that is 'bigger' than that contained in the PoS and SATs.

> *So I made (a number line) for 50 because if they're learning numbers to 20, they need to know there is, there is infinity, there is you're going to go on… last week we were talking about never ending numbers and (child's name) asked me, are you're telling me it goes to the moon and back? Now, I said, it's not enough to go to the moon and back you're going on forever. And you just leave it there. I don't discuss anymore because she, it'll play in her mind and she will think about it... You have put the idea of inquiry in the child because he will be forever inquiring. And then one day he will come to a point where he's mature enough to understand, ah, this is what (she) meant. (Anna, CT)*
>
> *…the national curriculum part of it is such a tiny part of maths teaching… (Alice, MSL)*
>
> *…the content of what you're teaching is only a small part of it is how you deliver the lessons… (Amanda, SL)*

This 'how' of 'lesson delivery' was spoken about in participants' descriptions of the pedagogical knowledge they prioritise when evaluating their own and others' teaching. Using 'resources and the conflation of that with providing a range of mathematical representations or characterised as 'CPA' was spoken about by *all* participants. Questioning and accurate vocabulary to promote mathematical talk and thinking was also highlighted (*Beth, CT, Claire, CT, Brooke, MSL, Daniel, MSL, Elaine, SL, Amanda, SL, Brett, SL, Christina, SL*), as was the breaking down of learning into small steps (*Becca, CT, Brooke, MSL, Daniel, MSL, Amanda, SL, Dominic, SL*), and the use of variation in given examples (*Daniel, MSL*). Overall, these pedagogical choices were rooted in a perception that supporting conceptual understanding in mathematics is a priority which was implicit in all participants' responses and explicitly spoken about by some (*Becca, CT, Claire, CT, Daniel, MSL, Amanda, SL, Christina, SL*). There are echoes of the cited benefits of the use of a scheme of work here, and considerable consistencies with key principles of a

mastery approach (NCETM, 2023a) as illustrated below (Table 7).

Pedagogical priorities	Mastery principle
'Resources'/mathematical representations/CPA/variation	Examples, representations and models are carefully selected to expose the structure of mathematical concepts and emphasise connections, enabling pupils to develop a deep knowledge of mathematics.
Questioning	In a typical lesson, the teacher leads back and forth interaction, including questioning, short tasks, explanation, demonstration, and discussion, enabling pupils to think, reason and apply their knowledge to solve problems.
Accurate vocabulary use	Use of precise mathematical language enables all pupils to communicate their reasoning and thinking effectively.
Breaking down of learning into small steps	Lesson design links to prior learning to ensure all can access the new learning and identifies carefully sequenced steps in progression to build secure understanding.
Conceptual understanding	Procedural fluency and conceptual understanding are developed in tandem because each supports the development of the other.
	Mathematical learning behaviours are developed such that pupils focus and engage fully as learners who reason and seek to make connections.

Table 8: Perceived pedagogical priorities and mastery principles

It is unsurprising that there were high levels of correlation between participants' perceptions of the benefits of schemes of work, valued pedagogical practices and the NCETM's mastery approach. Since the establishment of this approach and the associated support for NCETM 'maths hub' led professional development, the producers of both freely and commercially available schemes of work have overtly incorporated these key ideas into their materials (Boylan & Adams, 2023), and all participant schools use one of such schemes.

There was a strong reciprocal relationship between the NCETM's definition of 'mastery', and participants' perceptions of the constituent parts of effective mathematical teaching (Table 7). The extent to which each participant engaged with the component parts of this relationship was affected by their role. Across the dataset, it was clear that those participants with experience of mathematics subject leadership since 2014 or involvement in 'maths hub' led professional development and are classroom-based teachers had the strongest affiliation with this professional knowledge as their basis for evaluating teaching (*Beth, CT, Emily, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL*) with the most secure knowledge of 'mastery' principles and related teaching practices. The model below (Fig.9) shows the reciprocal relationship of influence between mastery principles teachers' practices and

perceived evaluation priorities.

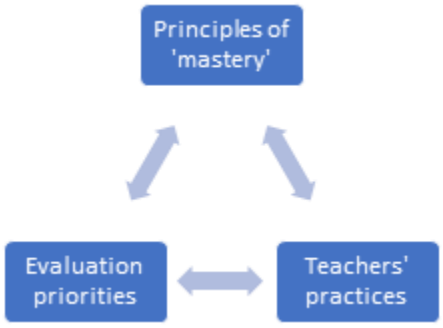


Figure 9: Relationship between 'mastery', teaching practices and evaluations

Those without such roles or experiences, who were classroom-based teachers, were exposed to these ideas through their use of a scheme of work which exemplified the core principles in practice (*Anna, CT, Becca, CT, Claire, CT, Donna, CT*). Senior leaders' knowledge of these principles was either shown through their knowledge of the expectations of the school's chosen scheme (*Amanda, SL*), or through reliance on their MSL's guidance (*Brett, SL, Christina, SL, Dominic, SL*). This resonates with Boylan and Adams' (2023) assessment of the relative nature of expertise and authority in the mathematics mastery market. Thus, the 'knowledge' that has value becomes part of a feedback loop which is restricted to that which already exists within the mastery-based school-led system (Coe et al., 2014). There is also evidence of the subject-specific knowledge remaining at a surface level, i.e., 'what does this look like in the classroom', and not progressing to deep, or an understanding of implicit, knowledge that examines the justifications for and beliefs about different practices (Shulman, 2005). This more reflective practice, according to Coe et.al. (2014), is required in order to evaluate teaching effectively as a superficial interpretation of aspects of pedagogical knowledge, coupled with an emphasis on performativity and accountability (Boylan & Adams, 2023) can result in the perception that what is already being done is aligned with new knowledge and therefore sufficient, and more meaningful opportunities for knowledge development are lost.

5.3 Influence of knowledge on perceptions of effective mathematics teaching

As part of this simplification and focus, shared criteria through which practice can be viewed is considered a prerequisite for effective evaluation (Almutairi, 2016; Williams & Hebert, 2020). The use of such criteria was inconsistent across the bounded case studies and was more aligned to general teaching principles rather than subject specific knowledge as expected by Ofsted (2019). In order to establish criteria against which to evaluate practice, participants spoke of the use of both statutory or

externally provided documents, and internally produced proformas. The former of these tended to be connected to whole school foci for development and came from the DfE (*Elaine, SL*), Ofsted (*Beth, CT*), mathematics specialists and organisations (*Caroline, MSL, Elaine, SL*), commercial mathematical curriculum and assessment resource companies (*Daniel, MSL, Brett, SL*), and attainment and progress data software (*Elaine, SL*). Externally provided documents were also cited by participants in relation to students on SCITT and SD programmes, and ECTs (*Claire, CT, Emily, MSL, Caroline, MSL*) and as such were evidence of standards driven measurement of teacher quality (Ball, 2017).

Participants from School B (*Beth, CT, Brooke, MSL, Brett, SL*) and School D (*Dominic, SL*) spoke about the consistent use of internally produced proformas whilst others referred to less formalised approach (*Emily, MSL, Alice, MSL, Caroline, MSL*) which is contradictory to best practice as defined by Williams and Hebert (2020) and Almutairi (2016). Where such documents were used, they were designed to support the evaluation of all teaching and learning and did not include mathematically specific criteria (*Beth, CT, Brooke, MSL, Christina, SL, Dominic, SL*). In the absence of this, participants spoke of relying on their own experiences and perceptions to identify and evaluate different aspects of practice.

> *And I also looked myself to see when I was, uh, you know, what things I would be, uh, being judged on, perhaps what would make a good maths teacher and those who I know myself, what I should be doing. (Beth, CT)*
>
> *I've just used my notes. I found myself making, I made my own questions and things up for pupil interviews. (Beth, CT)*
>
> *I was almost tracking my own thoughts of when teachers were doing things and noting them down. I was going back to when I was at university and I had my eight teacher standards and I was almost going back and filling those in mentally and just making notes of them. Um, and almost acting like a child. If I was a child, what was I able to access? Can I write those things down that didn't allow for it on that sheet? So I was more looking at it from how I was assessed before in maths. And also what's the children's experience like versus what the sheet had set out for me. Um, it wasn't strengths or weaknesses. It wasn't quite clear like that there was, there was parts of it. And I had to go back and say, well, I've written this on my notes and where would you put that in this audit? (Brooke, MSL)*
>
> *I observed others as I had been observed in the past. Right. I think so I never had any particular training on it, which was a mistake, I think. Um, and yeah, I, I guess my or so I observed in the way that I had been in the past with my own revisions about what I thought would, would, should, should have been. (Brett, SL)*

Some participants acknowledged elements of effective mathematical teaching that went beyond the sources of knowledge found in the National Curriculum Programmes of Study, the assessment system, and the NCETM's mastery approach. The use of 'low threshold, high ceiling (LTHC)' tasks (NRICH, 2019) or similarly investigative or 'open-ended' activities were valued by all participants from School B (*Becca, CT, Beth, CT, Brooke, MSL, Brett, SL*), and the importance of context, relevance and purpose were

spoken about by several others (*Anna, CT, Claire, CT, Donna, CT, Alice, MSL, Caroline, MSL, Brett, SL, Christina, SL*). Opportunities for children to apply their mathematical knowledge and skills to a range of such relevant contexts and/or purposes were also highlighted *(Anna, CT, Beth, CT, Claire, CT, Donna, CT, Caroline, MSL, Daniel, MSL, Elaine, SL, Brett, SL, Christina, SL*). Relating to this, explicit connections between aspects of mathematics were also regarded as important by some (*Caroline, MSL, Daniel, MSL*). Again, though, the extent to which the use of these might be evaluated as effective was reliant on the level of curriculum design, subject-matter and pedagogical-content knowledge held by individuals (Pepin et al., 2017). Across the data set, the interplay between individual and collective knowledge for the teaching of primary mathematics, and within these the interweaving of theory and practice resulting in 'praxis' (Zimmerman, 2009), was evident in the perceptions and experiences of the participants.

Whilst subject-matter and curriculum knowledge were identified, predominantly it was pedagogic-content knowledge (Shulman, 1985) that was most often spoken about as participants focussed on actions and practices of teachers. The influential role of curriculum materials such as schemes of work as boundary objects that act as "pedagogic pathways" (Ensor et al., 2002 p.22) between the individual and the collective knowledge bases was also clear. Through these materials, ideological mechanisms were at play as they foregrounded and prioritised certain content and approaches (Boylan & Adams, 2023). These in turn represented surface structure pedagogy (Shulman, 2005) and focussed on observable learner outcomes as proxies for learning (Coe et al., 2014) on which participants based their evaluations of their own and/or others' mathematics teaching. Participants with experience of mathematics leadership, except for Anna (CT), demonstrated knowledge of deep and/or implicit structural pedagogies, but within the regulative discourse (Ensor et al., 2002) of 'mastery' (NCETM, 2023). It can be argued that 'the mastery approach' has become a pervasive signature pedagogy for mathematics as it "…implicitly define(s) what counts as knowledge in a field and how things become known… (It) define(s) how knowledge is analyzed, criticized, accepted, or discarded… (It) define(s) the functions of expertise in a field, the locus of authority, and the privileges of rank or standing" (Shulman, 2005, p. 54). The participants that held the expertise and/or locus of authority were those who could most effectively articulate and demonstrate 'the mastery approach', and this was not always concurrent with those who held positions of senior leader, but those who have had access to further professional development in mastery related practices. There was also evidence of the de-valuing of highly experienced teachers whose praxis or 'theory-in-action'(Argyris & Schön, 2003) does not explicitly replicate the mastery discourse (Boylan & Adams, 2023), specifically in the cases of Anna (CT), Beth (CT) and Donna (CT). When considering the epistemology of the effective teaching of primary mathematics, 'What is known?',

'What do teachers know?', 'What knowledge is essential?' and 'Who produces knowledge?' (Fenstermacher, 1994), participants' experiences and perceptions were heavily influenced by the increasing prevalence of the NCETM's 'mastery', although the interpretation of this evidently varied within and between case study schools. Tensions between the collective replication of knowledge and practice and individual autonomy are evident and will be explored further in Chapter 6 and a focus on professional identity.

5.4 Summary of findings regarding the evaluation of primary mathematics teaching through the Professional Knowledge lens

When viewed through a professional knowledge lens, the data collected offered insights into the perceptions and experiences of participants in several ways. Firstly, whilst there was a coherence in participants judgement of 'effective/successful' teaching regarding progress and attainment related outcomes, there was a wide variation in knowledge of what 'good' mathematics teaching is regarding the wider body of collective knowledge in the field. Depth and breadth of understanding of this was reliant on the personal and professional opportunities participants had had to develop such knowledge. As such, there was significant evidence of the influence of the knowledge prioritised by the National Curriculum and related tests, the growing prevalence of a 'mastery' pedagogy and approaches to the structure and sequencing of individual and series of lessons espoused by related schemes of work. There was largely an absence of a conceptualisation of mathematics that goes beyond these proxies and therefore the shared criteria for evaluating the quality of teaching seemed to measure the implementation of these proxies. The foci for evaluations were selected from a range of criteria that are a mixture of the generic and subject-specific in terms of effective teaching and the selection and prioritisation of these was decided on, and limited by the knowledge of, the most senior evaluator. There was also lack of clarity, and in places coherence, between the curriculum of each school and the evaluation criteria, indeed no school used a subject-specific rubric as part of its formalised evaluation documentation although mathematics-based criteria for feedback and judgements were implicit throughout. Knowledge of robust and credible evaluation processes tended to mirror those employed by Ofsted and there was a lack of evidence that participants had knowledge of a wider evidence base to inform the valid and reliable collection and interpretation of data.

In summary, the findings relating to evaluations of primary mathematics teaching and professional

knowledge are listed below.

What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional knowledge**?	- Coherence in judgements of 'effective/successful' teaching regarding progress and attainment related outcomes - Wide variation in knowledge of what 'good' mathematics teaching is - Extensive influence of knowledge prioritised by NC and SATs, 'mastery', and related schemes of work - A mixture of generic and subject-specific principles for effective practice are used as criteria - Criteria are selected by the evaluator and consistent with NC, SATs and 'mastery' knowledge - Weak coherence between school curriculum and evaluation criteria - No use of mathematics-specific rubrics

Table 8: Findings related to professional knowledgeFindings and analysis of data through the professional knowledge lens therefore offered some insight into the problems that this study seeks to explore and better understand as follows.

Problem 1: A potential lack of shared understanding around the varied purposes and consequences of evaluations

It is evident that there was a coherence in participants judgement of 'effective/successful' teaching regarding progress and attainment related outcomes. However, it was also evident that there is a wide variation in knowledge of what 'good' mathematics teaching is regarding the wider body of collective knowledge in the field. In defining foci and criteria according to which to evaluate primary mathematics teaching, a mixture of generic and subject-specific principles for effective practice were used and these were selected by, and therefore reliant on, the knowledge held by the evaluator who holds the most senior position.

Problem 2: The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process

There was significant evidence of the influence of the knowledge prioritised by the National Curriculum and related tests, 'mastery', and published schemes of work that are consistent with these. There was an absence of a conceptualisation of mathematics that goes beyond these proxies. The importance of shared criteria was acknowledged by participants but the creation of these was often not shared and prioritised measurement of the observable features of the proxies. There was a lack of clarity, and in places coherence, between the curriculum of each school and the evaluation criteria and there was no evidence of the use of a subject-specific rubric to support evaluations of mathematics teaching.

In the next chapter, data relating to the research question 'What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in

relation to professional identity?' is explored in relation to literature. The findings are analysed and discussed in relation to literature and a summary of these is provided with further insight into the five problems that this study seeks to address.

6. Findings, Analysis and Discussion - Professional Identity

This chapter explores participants' responses that relate to the third research question, 'What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to professional identity?'. This chapter builds again on the concepts of professional development and knowledge, with the themes selected as most pertinent to professional identity being participants' perceptions of themselves as 'mathematical' (both as a learner and a teacher); beliefs as a foundation for professional identity, the formation of teacher and evaluator identity as a result of the evaluation process and identifying as a professional within role(s). The sections that explore 'beliefs' build on Askew et al.'s (1997) framework for the beliefs held by effective teachers of numeracy; about mathematics (what it is for, what it is to be mathematical, what mathematics is), how it is best learned and taught and the influence of wider, collective beliefs about the subject.

6.1 Perceptions of mathematical self (learner and teacher)

Participants' perceptions of themselves in relation to the subject of mathematics, both as learners *and* teachers, is a key theme generated from the dataset and begins to offer some insight into their professional identities. Related to this, *all* participants recounted shifts in their perceptions of their own identity as mathematics teachers at different points in their careers that provide evidence of multi-faceted and evolving professional identities (Brown & McNamara, 2011; Hodgen & Askew, 2007; Tomo & de Gennaro, 2019). Broadly speaking, they fell into two groups that characterised their relationship with mathematics in their own schooling or early career as positive (*Anna, CT, Beth, CT, Claire, CT, Donna, CT, Emily, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL, Brett, SL, Dominic, SL*) or negative (*Becca, CT, Alice, MSL, Amanda, SL, Christina, SL*). Those with positive perceptions referred to feeling enjoyment and confidence and related stories of success both as learners and teachers, whereas the latter group referred to a lack of understanding, low confidence and personal 'failure' in tests/exams.

Emotions, together with perceptions of knowledge (as explored in Chapter 5), play a notable role in the formation of identity (Hodgen & Askew, 2007) and strong feelings are evident in some participants' responses. Becca (CT) spoke of mathematics as the subject she was "the most scared about" during her training, of feelings of nervousness during lesson observations and of regressing to childhood anxiety when faced with mathematical ideas that she didn't understand; "I freeze because I go back to that place". Similarly, Alice (MSL) "never really got maths at school" and initially failed the mathematics QTS

skills test and experienced a “lot of criticism” during early lesson observations. She described feeling “like a fraud” when taking on the role of mathematics leader stating, “I've fallen into leading maths, I don't quite know how (laughs)”. For these teachers, mathematics has posed a significant threat to their professional identity as such feelings lead to a reluctance to be mathematically vulnerable, a key facet to the development of a positive relationship with the subject (Debellis & Goldin, 2006).

All current class teachers reported a fluctuating level of confidence in their mathematics teaching as a result of moving year groups or schools, or due to changes in curriculum resources or advocated teaching approaches and as such demonstrate the interwoven nature of professional identity across the public and private sphere (Day & Gu, 2010; Tomo & de Gennaro, 2019; Williams, 2013). For some participants, this constituted significant shifts such as for Anna (CT) who described feeling ‘inadequate’ despite many years of teaching experience;

> *…that was not a drop in my knowledge, but a drop in what I knew and couldn't say to people, because there was not the knowledge for them to pick up what I knew about mathematics teaching.*

Or for Becca (CT) who, as discussed earlier, despite an historical lack of belief in her own mathematical ability and consequently mathematics teaching “I’m not gonna be able to do this”, stated “…it's now one of my favourite lessons to teach within the curriculum”, crediting a “constant circle of reflective practice and moving forward and making sure that I'm doing my little tasks and stuff each time to just check actually, am I being able to solve these things?” as a core part of her practice that strengthens her identity as a good mathematics teacher. Here we see strong levels of mathematical integrity which, together with mathematical intimacy, or a willingness to be vulnerable (Debellis & Goldin, 2006) which could account for this positive change.

Indeed, all participants reported changing perceptions of their self-efficacy (Berger & Lê Van, 2019) in mathematics teaching describing improvements due to increasing familiarity with curriculum expectations and resources as illustrated by the following two statements.

> *…I had to like spend a whole term getting around my head around that, but actually now I've got my head around that I feel quite confident with teaching maths. (Alice, MSL)*

> *…first time I ever saw chunking, I was like, what is this I didn't under... I didn't understand what it was. Um, so I had to learn that process to make, you know, to be able to teach it to children, to understand division. And then suddenly it actually helped me understand division better because of this method of chunking.*

(Dominic, SL)

There was a notable distinction drawn by several participants between being personally 'good at maths' and being 'good at teaching maths' (*Beth, CT, Emily, MSL, Elaine, SL, Amanda, SL, Brett, SL, Dominic, SL*). This was perceived to be the case regardless of the extent to which a teacher identified as being mathematically proficient.

> *I wouldn't say I'm a great mathematician, but I think I can teach maths at a certain level to primary children… (Beth, CT)*

> *…my maths subject knowledge was always excellent but it's a whole different thing to be able to teach it… (Brett, SL)*

These views resonate with numerous studies (Thames & Ball, 2010) that have found that advanced levels of mathematical qualification provide no advantage to the effective teaching of mathematics at primary level. It is apparent that the extent to which participants identify as effective mathematics teachers is influenced by perceptions of learners' progress and outcomes and in the context of the community in which they are practising (Wenger, 1999). As indeed Brett (SL), stated.

> *Um, so yeah, I guess, you know, and Ofsted came in and watched me teach maths and they were positive, which probably led to me getting the math leadership because, okay, this is an external validation that this guy can teach maths… certainly, I think that's why I was made maths subject leader at my previous school because I got good outcomes on the test.*

Perceptions of whether participants identified as 'a maths teacher' varied across the data set with a variety of justifications. Two participants (*Anna, CT and Brooke, MSL*) explicitly identified as 'a maths teacher', while six stated that they did not, citing historical difficulties with the subject (*Becca, CT, Christina, SL*), a change in role and reduction in classroom autonomy (*Donna, CT*), comparison with a secondary school mathematics teachers for whom it is their only subject (*Daniel, MSL*) and a long period of time out of daily classroom teaching (*Elaine, SL, Dominic, SL*) as the reasons for this. Two participants said that they identified as 'a maths teacher' under certain circumstances: when seeing a specific group of children purely for maths lessons (*Beth, CT*), and as part of certain classroom behaviours or ways of thinking e.g. 'organised', 'tidy' and understanding 'why' (*Claire, CT*). Five participants were happy to describe themselves as 'a maths teacher' as part of their wider identity as 'a teacher' and did not differentiate their skills in mathematics teaching as different from their skills in teaching any of the other curriculum subjects (*Emily, MSL, Alice, MSL, Caroline, MSL, Amanda, SL, Brett, SL*). The proportionally high number of participants that would not explicitly identify as 'a maths teacher' seems in keeping with

a traditional model of primary teaching as a generalist discipline (Ardzejewska et al., 2010), despite recommendations that this model be revised in favour of more subject specialist teachers over thirty years ago (Alexander et al., 1992), the provision of the post-graduate accredited Primary Mathematics Specialist Teacher programme (MaST) from 2010, and access to the Primary Mastery Specialist Programme provided by the NCETM since 2014.

Inherent within these perceptions of identity are beliefs held by each participant that can be understood through three strands, 1) what it is to be mathematical; what mathematics is and what it is for, 2) how children best learn mathematically, and 3) how maths is best taught (Askew et al., 1997; Berger & Lê Van, 2019; Lim, 2009). These beliefs are inextricably linked to knowledge (Rowland et al., 2009) and form part of the foundational knowledge for teaching mathematics. In the following sections, the beliefs articulated in and inferred from participants' responses are explored in relation to Askew et.al.'s (1997) three strands in order to ascertain the extent to which their experiences influence their beliefs about mathematics and mathematics teaching (Lim & Kor, 2012).

Beliefs about mathematics (what it is for, what it is to be mathematical, what mathematics is)

All class teachers, three mathematics leaders and two senior leaders held the belief that the purpose of mathematics is to be able to use acquired mathematical knowledge proficiently enough to engage in practical aspects of life. This was characterised through an ability to 'apply' knowledge, often referred to as 'fluency' or by some as 'number sense' (*Emily, MSL, Alice, MSL*), to solve problems or understand contextualised situations (*Anna, CT, Becca, CT, Beth, CT, Claire, CT, Donna, CT, Alice, MSL, Brooke, MSL, Daniel, MSL, Brett, SL, Christina, SL*). The terms 'fluency' and 'number sense' were synonymous with the recall and use of arithmetical facts and strategies, as defined by the National Curriculum for mathematics (DfE, 2013). The prevalence of this view, favoured by technological pragmatists, is an indication of a largely industrial and work-centred view of mathematics as an "unquestioned absolutist body of applicable knowledge" (Ernest, 2014, p.7). Participants also indicated that the aim of mathematics was to achieve 'goals' or 'outcomes' as measured against standardised curricula or assessments (*Donna, CT, Daniel, MSL, Elaine, SL, Amanda, SL, Brett, SL, Christina, SL, Dominic, SL*), notably, this group consisted of all senior leaders, one maths leader and a class teacher with leadership experience in contrast to the former group, that was more weighted towards a class teacher role. In addition to this technological pragmatism, there was evidence of views aligned to progressive or public education aims to increase the confidence, enjoyment or empowerment of learners through

mathematics (Ernest, 2014) across all roles (*Anna, CT, Becca, CT, Claire, CT, Emily, MSL, Caroline, MSL, Daniel, MSL, Christina, SL, Dominic, SL*) and notably for all participants in School C.

Perceptions of what it is to 'be mathematical' or to be 'successful' in mathematics were aligned with these perceptions of the purpose of mathematics, and also with views about the mathematical knowledge that matters most for teachers (as explored in Chapter 5), and aligned with a mathematician's view that, "To do mathematics means more than just learning the facts of mathematics—it means seeing oneself as a capable mathematical learner who has the confidence and the habits of mind to tackle new problems" (Su, 2021 p.5).

> *What do we want the children to learn here? What do we want a year six child who's ready to go to year seven… what's the end product of our maths teaching? …problem solvers, able to speak like a mathematician can reason, um, is resilient, is open-minded knows what resources to use, um, knows the efficient methods, can solve, um, things mentally, but also know the written methods, is fluent… (Brooke, MSL)*

> *...what I would see as a successful mathematician, um, that they can essentially just yeh sit down, no support from any peers, no support from any adults and be able to apply their subject knowledge to a range of complex problem-solving questions. So, you know, that's what I would consider a successful mathematician… However, now it's kind of changed because a successful mathematician now in some sense is able to explain and unpick and make connections with previous learning and start to then question intelligently about what could be next steps and you know, what could be alternative ways to do this, as opposed to just the I've remembered how to do this procedurally…Um, so that gives a much richer understanding. (Daniel, MSL)*

Far fewer references were made to a definition of mathematics itself as a pure discipline separate from purpose or behaviours. Anna (CT) demonstrated her belief in the value of encouraging curiosity about the vast complexities of the subject beyond the primary school curriculum,

> *…they need to know there is, there is infinity, there is… So yest… last week we were talking about never ending numbers and (child's name) asked me, "Are you telling me it goes to the moon and back?" "Now", I said, "it's not enough to go to the moon and back you're going on forever"... You have put the idea of inquiry in the child...*

Some participants spoke about mathematics as patterns (*Claire, CT, Brett, SL),* logic *(Daniel, MSL, Brett, SL, Christina, SL*), efficiency (*Emily, MSL, Brooke, MSL*) and connections (*Beth, CT, Claire, CT, Caroline, MSL, Daniel, MSL*); ideas in line with multiple definitions of what it is to be a mathematician (Harris & Taylor, 2013; Nrich, 2023; Su, 2021). However, an "appreciation of the beauty and power of mathematics" (DFE, 2013, p.99) as found in the National Curriculum's Purpose of Study statement and representative of a mathematics-centred view of the subject (Ernest, 2014) is not evident in the dataset.

This suggested that a pure view of mathematics as held by many mathematicians and arguably necessary for continued motivation into the learning of mathematics post-16 is not present in these participants beliefs about the subject. However, an absolutist perspective was expressed by Becca (CT) and Daniel (MSL) respectively,

> *…maths is at the end of the day. Like this is what it is. It's not so like subjective compared to some of the other subjects.*
>
> *…it's so black and white, you know, it it's truth. And that's what I like about teaching math. That's what I like about leading, you know, leading math is there's nothing to really infer because it is what it is.*

It may be that this perception of mathematics provides some comfort to teachers and leaders, particularly if their own experiences of mathematical learning were negative as in Becca's (CT) case, but is an example of an unchallenged dogma prevalent in perceptions of mathematics that has the potential to be restrictive, irrelevant to life experiences and ultimate alienating for teachers and learners (Coles & Sinclair, 2022).

Beliefs about how mathematics is best learned.

Differentiating between beliefs about how mathematics is best *learned* as distinct from how it is best *taught* was difficult due to the complex overlap between these two activities. Indeed, pedagogy can be understood as inherent within the relationship between teaching and learning (Loughran, 2013). For the purposes of this analysis, a focus on participants' references to the experiences of children that contribute to how they best acquire mathematical knowledge and skills, rather than the choices made by teachers to enable this to happen, was used.

Beliefs about how children best learn mathematics, separate to beliefs about teaching, are prevalent within subject-focussed academic and research literature and a reciprocal process between literature and data here enabled relevant themes to be classified as worthy of consideration. These included beliefs in the value of 'attitudes/behaviours/feelings', and 'resources/models/images/CPA' (cited by all participants, across roles); and 'context/application/problem-solving/purpose/meaning' (cited by two thirds of participants, across roles). References to a sense of 'investigating/exploring/play/have a go'/exploring', 'practical activities' and 'talk' were equally valued by a third of participants, followed by 'having individual needs met', 'scaffolded learning' and 'sufficient time'. These, along with 'active learning', 'building on prior knowledge', 'outdoors', and 'choice/child-led' learning demonstrated beliefs

which, whilst viewable through a mathematical learning lens, can also be broadly related to how children learn best across the curriculum, rather than specifically in mathematics, and classified as 'hygiene factors' of classroom management for effective learning (Coe et al., 2014). References to beliefs in the benefits to learning of 'mixed ability groupings', 'conceptual understanding', 'links/connections', 'variation' and 'number sense' are directly relatable to mathematics (Boaler, 2011; Harris & Taylor, 2013) but were cited by far fewer participants (up to three for each element). It is evident that subject-specific clarity is lacking but the three most frequently mentioned factors, 'attitudes/behaviours/feelings', and 'resources/models/images/CPA' and 'context/application/problem-solving/purpose/meaning' can be usefully analysed further through a mathematical lens.

Within 'attitudes/behaviours/feelings', growth-mindset, independence and resilience were cited and are generic components of classroom climate (Coe et al., 2014) but also strongly advocated as essential to mathematical learning (Boaler, 2016). The less frequently mentioned elements of enjoyment, interest and enthusiasm can be seen as both precursors for and results of a classroom culture that encourages a growth-mindset, independence and resilience in its learners. Evidence of beliefs in this wider context of conditions for learning was identified in references to classrooms that are 'a hive of activity' (*Dominic, SL*), or have a 'buzz…organised chaos' (*Becca, CT*), or that are examples of 'how we do maths here' (*Elaine, SL*).

All participants also expressed the belief that mathematics is best learned through access to a range of representations ('resources/models/images/CPA'), a viewpoint which is strongly supported by decades of mathematics education literature (Askew, 2012; Barmby, 2009; Boaler, 2011; Cockcroft, 1986; EEF, 2020; Harris & Taylor, 2013; Henderson et al., 2018; Liebeck, 1990) and heavily promoted by the NCETM's (2023) mastery approach. Notwithstanding the historical value placed on this belief, its current prevalence can be attributed to its promotion by the NCETM, but this may not explain the close to universal agreement that this is a crucial way in which mathematics is best learned. When viewed through an identity lens, the majority of the participants shared common positive experiences in mathematics related to 'enactive' and 'iconic' representations (Bruner, 1982) as part of their own learning, as encapsulated by Alice (MSL).

> *…it was really hands-on… I was like, wow. Yeah. Can I actually see the reason why we're doing this now?...it was just a real eye-opener I saw maths in a way that had never been taught…. That was how I*

should have been taught in school.

For Daniel (MSL) however, it was seeing the impact on children's engagement and enjoyment and an upturn in summative test data that affected a significant shift in his own beliefs in the value of visualising mathematics as part of developing conceptual, rather than purely procedural, understanding.

> *I was then in Year Five with (colleague), who was the maths leader at the time. And she was then looking into the conceptual methods of teaching. I think still at the time I was, I was still quite sceptical, you know, um, and I don't think I was a true believer of that until I then was part of it myself and, and then started to, you know, be part of the math hub, working alongside yourself as well…it kind of, it challenged my own perceptions and successes. So I always knew that and because being in year six for, you know, predominantly most of my career, I always knew that teaching in that sort of procedural way was successful. So then I challenged the, the notion of why do I have to teach it in this way? Why does it have to be so complicated in a sense? But I think because it challenged my understanding. So for me it was almost like a defence mechanism of, I don't understand what I see, so I don't want to accept it. And actually what I'm doing anyway has been shown to be successful. So not, so once I actually then started to see it in action and saw what it was actually doing to the children's confidence, hearing them, able to unpick these really technical elements of the maths curriculum, I was, you know, actually kind of blown away and impressed with the importance behind it...*

Similarly, nine participants that expressed a belief that the related elements of 'context/application/problem solving/purpose/meaning' were key, also made links with their own experiences of learning in the subject, mostly conversely through negative experiences when it was considered *not* to be relevant or make sense to them. This belief also overlapped with participants' beliefs about what mathematics is for in terms of its utility as explored in the previous section. There is strong support for application as an essential component of how mathematics is best learned (Boaler, 2011; DfE, 2013; Harris & Taylor, 2013; Ofsted, 2021) but again, it was clear that this belief was rooted more in participants' experiences, than in engagement with such literature.

Beliefs about how mathematics is best taught.

Unsurprisingly, there are considerable overlaps between the beliefs that participants hold about how mathematics is best learned and how it is best taught. The importance of providing 'resources' or adopting a 'CPA' approach as part of lessons in order that more children can better develop conceptual understanding correlates exactly, as all participants spoke about these. For most participants, the use of this approach was sequential, 'concrete', *then* 'pictorial', *then* 'abstract', echoing the view of Ofsted (2021) that "the aim should be that pupils move to working with symbols and abstract representations". One participant referred to the potential for children to move across and between such representations as relevant to the mathematical content and their understanding, more in line with the views of Drury

(2015) who supports the use of representation to prove abstract ideas equal to their use to understand them.

After 'resources/CPA', the belief articulated by the next largest group of participants is that of the benefits and necessity of the teacher's role in 'breaking down' the mathematics to be learned into 'steps' and 'sequences' to 'simplify' and 'scaffold' learning. This is strongly correlated to two key principles of the NCETM's (2023) mastery approach; "Curriculum design ensures a coherent and detailed sequence of essential content to support sustained progression over time (and)… Lesson design links to prior learning to ensure all can access the new learning and identifies carefully sequenced steps in progression to build secure understanding" (bullet points 4 and 5). It is also evidence of another prevalent dogma about mathematics, namely that it is a 'building block subject' that needs to be taught sequentially to protect learners from being overwhelmed by its complexity (Coles & Sinclair, 2022).

The concept of 'scaffolding' overlaps with beliefs about effective teaching related to 'differentiation', 'adaptive teaching' and '(ability) grouping' as expressed by the next largest group of participants. Underpinning all participants responses was a belief in the responsibility of a teacher to meet the needs of their learners in order that every child can make progress towards, and consequently meet, curriculum expectations. This view is represented by Amanda's (SL) comment "…keep up, not catch up… that was our sort of mantra for the classroom".

> *…what is there in place to enable them all to get to that end point? Because if you're trying to get them to different end points, it's really not going to help. Let's try and get them all to where they need to be. (Elaine, SL)*

Again, this is strongly reminiscent of another NCETM (2023) principle for mastery "If a pupil fails to grasp a concept or procedure, this is identified quickly, and gaps in understanding are addressed systematically to prevent them falling behind", and of the 'building blocks' dogma (Coles & Sinclair, 2022).

However, within this shared view, varying beliefs about how such a principle might be achieved were evident. Common to each of these ten participants was the belief in the use of 'resources, models and images' to facilitate increased access to mathematical concepts and processes for all learners. Indeed, the strong belief in these as a key element in 'best' learning and teaching of mathematics was evidently closely linked to beliefs about inclusivity in the pursuit of attainment. The clearest difference in beliefs

was evident in the extent to which the use of such resources was encouraged for *all* children (*Becca, CT, Beth, CT, Brooke, MSL, Daniel, MSL, Elaine, SL*) or targeted at specific children classified as in need of support (*Donna, CT, Emily, MSL, Amanda, SL, Brett, SL, Christina, SL*). Notably, this latter belief was largely expressed by those who were in a senior leadership role, whereas the former is weighted towards class teachers or participants who have participated in and valued mathematics-specific professional development and therefore developed a more informed view of resource use.

These beliefs were also linked to the extent to which participants utilised grouping by 'ability' and differentiation by pre-planned group-assigned tasks. Those in the latter group referred to the type of mathematical activity that children perceived as 'lower' might be expected to engage in as ideas mostly related to number knowledge and calculation skills and the successful completion of practice related to these, whereas those categorised as 'higher' would progress to 'reasoning' and application of that knowledge. This aligns with views expressed by Ofsted (2021) that "Useful facts and efficient and accurate methods are ideally paired within a topic sequence. Strategies for solving problem types are then best taught and learned once pupils can recall and deploy facts and methods with speed and accuracy" (paragraph 30). The former group acknowledged a variety of strategies for meeting individual need more responsively by offering resources, asking questions and adapting one task according to learners' responses within a lesson (Boaler, 2011; Drury, 2015; Henderson et al., 2018).

A belief in the importance of providing opportunities for the practice of number knowledge and calculation methods was expressed by eight participants, again with varying views on what such opportunities should involve. For some participants, an emphasis on the development of number flexibility (Boaler, 2011) was key (*Beth, CT, Claire, CT, Emily, MSL, Brooke, MSL*) whereas others referred to more traditional forms of arithmetic proficiency (Ofsted, 2021) in the recall of knowledge to answer a set of calculations (*Donna, CT, Alice, MSL, Daniel, MSL, Amanda, SL, Brett, SL*).

Seven participants expressed a belief in the need for teaching to provide 'real-life' or 'practical' contexts in order that the mathematics seems both interesting and relevant to the learners. This is fewer than the ten participants who stated a belief that this was a feature of best mathematical *learning*. All the class teachers stated this as a belief about both learning *and* teaching, whereas, of the four subject leaders that mentioned it, all believed this mattered for learning, but three did not mention it in the context of beliefs about teaching. This lack of correlation in the subject leader group could be accounted

for by a dissonance between espoused and enacted values (Lim & Kor, 2012) as, although contextual application was deemed to be important for learning mathematics, their beliefs about 'best' mathematical teaching were more reflective of those found in their mastery-based schemes of work. Of the senior leaders, Amanda referred to the importance of context as a belief about learning (children need) and Christina as a belief about teaching (teachers should provide). However, there was a distinction made about the importance of providing 'opportunities for application' in participants' beliefs about teaching as separate to 'real-life' or 'practical' contexts as in their beliefs about learning. Nine participants referred to this, classifying 'application' as children independently demonstrate their knowledge by answering different questions or applying number knowledge to solve word problems. This functional use of content knowledge is on aspect of problem solving but does not provide a purpose or context for the learning of mathematics (Ollerton, 2007).

Lastly, six participants referred to beliefs about 'best' mathematics teaching that related to the idea of 'pace'; the extent to which the teacher sets the timing and duration of different parts of the lesson (Sangster, 2007). Again, the form that these beliefs took varied across this group.

> *…allowing them to talk out loud to you and giving him the time just to talk, they're learning out loud… it's time and talk, isn't it. It's giving them time to think. (Claire, CT)*
>
> *…every minute counted and we had to grab them and their interest and enthusiasm quickly to make it count. (Donna, CT)*
>
> *…something I've pushed as maths lead this year in particular is just, is pace… saying, right, you know, let's use AFL a lot more effectively, get these children, um, working. (Daniel, MSL)*
>
> *…the best lessons I see as where there's not a lot of input, but more of the children doing the work with the teacher supporting and, you know, the TA supporting, those are the lessons I like the most. (Dominic, SL)*

Views about the pace of a lesson were rooted in narratives about what was likely to be most beneficial for the engagement and learning of the children. However, the likelihood that the pace set by the teacher will suit every child is low (Sangster, 2007) and so participant perceptions are more likely to be based on their personal beliefs and preferences, and again this is a belief about generic, rather than mathematics-specific, principles of effective teaching.

Throughout the data set, it was evident that whilst similar themes of beliefs about what mathematics is, its purpose, how children best learn mathematics and how it is best taught can be interpreted, the nuances of these beliefs were varied and complex. Each participant brought their individual identity as a

mathematician, teacher and mathematics teacher to their perceptions and experiences and these informed their beliefs about what is 'best' (Ernest, 2014) when evaluating the quality of teaching. These findings correlate with wider research as exemplified by Williams (2008), "It is widely recognised that a teacher's own enthusiasm for, and knowledge of, mathematics, as well as their beliefs about teaching and learning, will impact on their classroom practice, regardless of the external constraints on curriculum and lesson design." (p.63) and raise important questions about the influence of belief-consistent information processing for both evaluators and evaluands when offering feedback on and judging the quality of teaching.

Collective beliefs

Individual identities are inextricably linked to the wider contexts in which they are situated (Day & Gu, 2010; Tomo & de Gennaro, 2019; Williams, 2013) and each participant's beliefs sat within the context of their school, the local and national context of the NCETM's mastery, and the wider context of the field of mathematics education as nested contexts (Fig.10).

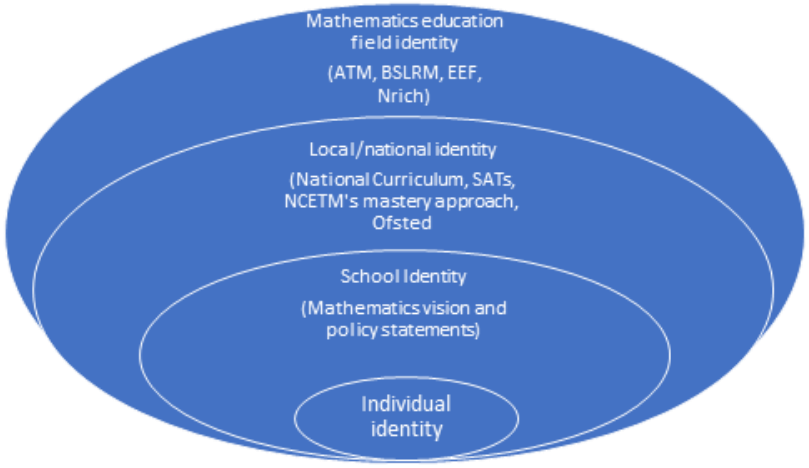


Figure 10: Nested contexts of professional identities

When articulating each school's mathematical identity, participants referred to publicly shared vision statements for the subject, all of which identify intent, implementation and impact, thus mirroring the Ofsted (2018) model for curriculum inspection. The 'intent' of each school's mathematics curriculum reflects beliefs or espoused values (Lim & Kor, 2012) about what mathematics is and its purpose, and the aspirations for learners' feelings and attitudes, and is therefore most relevant to collective identity. There were correlations evident between these articulations of collective beliefs and those of each

school's participants suggestive of the interconnected nature of overlapping spheres of identity (Berger & Lê Van, 2019; Day & Gu, 2010; Wenger, 1999). For example, 'application' of mathematical knowledge was frequently mentioned by participants in schools A and B and this was reflected in their 'intent' statements (see each school's pen portrait in chapter 3). Similarly, 'representations' in the form of concrete, pictorial and abstract resources were repeatedly mentioned by Emily (MSL) and Elaine (SL) and were prominent in their school's 'intent' statement. The voices of the mathematics subject leader of schools B, C, and D was apparent in their school's 'intent' statements, as was Elaine's (SL) voice in school E's statement, and Brett's (SL) in School B's. This was potentially due to their high levels of involvement in mathematics leadership in their schools based on their prior experiences of leading mathematics themselves. In school A the subject leader was new to the role and so had inherited their school level statement, which could explain the relative lack of congruence between her identity comments and the school's espoused beliefs. Conversely, there was also evidence of inconsistencies between individual and collective beliefs within each school as individual participants placed greater or lesser personal emphasis on the component parts according to their own views and experiences. Indeed, only those currently in a class teacher role did not refer to the these 'intent' statements, whereas those in leadership roles did, suggestive of a lack of explicit knowledge of these shared beliefs as best exemplified by Christina (SL).

> *…we have that knowledge of what maths provision looks like in the school. And I suppose if we actually got that document out and looked at it, we'd be able to say, oh yes, we've said that. And yes, we are doing that. So we do sort of live in and breathe that, I suppose, it's, it's not just a piece of a document to say, well, this is, you know, we need to tick this off. It's sort of part of what we, an integral part of our maths teaching.*

It was also possible to identify the influence of local/national beliefs on these 'intent' statements as all referred to 'fluency', 'reasoning' and 'problem solving' as described in the mathematics national curriculum (DfE, 2013), either explicitly referred to 'mastery' or to key principles thereof (NCETM, 2023), and/or reflected key ideas about knowledge from the Ofsted research review (Ofsted, 2021).

6.2 Identity formation through evaluation

Several participants spoke of the influence that being evaluated had had on their identity as a primary mathematics teacher. Some attributed benefits to the process as they felt their classroom practice was validated by others who were perceived to hold higher levels of status or expertise than themselves (*Becca, CT, Donna, CT, Brooke, MSL, Amanda, SL*). These experiences improved their confidence through concurrence between the evaluator and evaluand's beliefs about what good mathematics teaching

involved. Conversely, others described experiences whereby their teacher identity was destabilised through a dissonance between their beliefs and those of the person evaluating them (*Becca, CT, Claire, CT, Donna, CT, Alice, MSL, Caroline, MSL*). Anna (CT) described initially feeling "inadequate", despite high levels of confidence in her own mathematical subject knowledge, but shared how she chose to overcome these feelings and re-stabilise her teacher identity.

> *…when I'm evaluated by people who don't have that view, you will find, they'll tell you, you need to improve on this and it might be a very minute thing and that didn't matter. I took a decision and I said, right, I'm going to go my way of teaching and so far... (smiles, shrugs)*

Beth (CT), Claire (CT), Caroline (MSL) and Daniel (MSL) all spoke of experiences whereby they suppressed their personal beliefs in favour of performing or conforming to their perceptions of what the evaluator would most value, the first three of these participants citing 'pressure' or 'judgement' as key drivers for this. However, whereas Daniel (MSL), similarly to Anna (CT) acknowledged behaving like this at earlier points in his career, since participating in mathematics specific professional development his personal identity as a primary mathematics teacher had solidified and influenced his perceptions of the evaluators.

> *So when I am being evaluated by, you know, SLT, I, you know, without sounding kind of arrogant, I do know more about maths than they do. So the feedback that I get is more to do with just general to, you know, it goes as, as bad as you need to sort out your book corner. So right now I, I I'm yet to be challenged since I've been maths lead and evaluated really kind of deeply in terms of how I am teaching, teaching maths. I think prior to that in previous schools, it was always the perception of the head teacher. So, you know, in my first school they might have had a different perception of what good maths learning looked like. And actually for me, I played to the preferences of the head teacher. But none of my feedback, I don't think has ever been really, really deep and rich to come back to me and say, you know what…the variation could have been improved in this manner. You know, when you delivered this element of the, you know, the pictorial representation, I would've done it this way. So I don't think I've, I've been evaluated. So my experience of evaluation so far is, is not, is not impressive in that sense. (Daniel, MSL)*

Two class teachers (*Becca and Donna*) also demonstrated a secure sense of identity which they characterised as an openness to feedback as they both described conscious decisions not to adapt their practice to match their perceptions of evaluator's expectations.

> *…my attitude is always, I'll just teach how I always teach. And if there's anything I can improve on, at least you're going to see what I normally do. Not me trying to just pull everything out of the bag. (Becca, CT)*

These responses are evidence of participant's engagement in identity construction through alignment (Wenger, 1999). Each individual made a choice about how to act in a way that expressed their belonging to their chosen community of practice. In Anna (CT) and Daniel's (MSL) cases, they were more strongly

aligned to the values of the mathematics community external to their school where they perceived subject expertise to sit, whereas Beth (CT), Claire (CT) and Caroline (MSL) all demonstrated alignment with the higher status group within school. Alignment as part of identity formation was therefore shown to both "amplify our power and our sense of the possible… (and) be a violation of our sense of self that crushes our identity" (Wenger, 1999, p.180-181).

Participants across all role groups also spoke of their formation of an identity as an evaluator. For some, this was part of self and peer evaluation of teaching practice (*Anna, CT, Beth, CT, Donna, CT, Emily, MSL, Alice, MSL, Caroline, MSL, Elaine, SL, Amanda, SL, Christina, SL*) and was viewed positively as belonging to a community of practice whereby knowledge and practices were shared and discussed democratically was highly valued (Berger & Lê Van, 2019; Wenger, 1999).

For those with formal experience in a subject or senior leadership role, identifying as an evaluator was more complex. Firstly, regarding subject leadership, several participants spoke of a tension between their teacher and leader identities (Gear & Sood, 2021). Emily (MSL) spoke of feeling "a little bit isolated" as belonging to two communities simultaneously led to a lack of full alignment with either one (Wenger, 1999). Brooke (MSL) and Daniel (MSL) described doubting their own self-efficacy (Berger & Lê Van, 2019) when evaluating others' practice.

> *…um, yeah, it is interesting kind of going into classrooms and, and watching the math teaching, because I think the challenge is that I might not necessarily always be the, the best person in a sense. And actually what I think is, is good practice might not necessarily be good practice of teaching for mastery because I'm still developing that in a sense, I feel confident to, you know, to do it, but I don't think I'm where my actual kind of like tutors are. (Daniel, MSL)*

Caroline (MSL) gave a clear example of the influence of individual teaching beliefs on the formation of a developing leadership identity.

> *Yeah. It's interesting. You know what, you're, you're at a cusp point aren't you of transitioning into leadership, but you've got one for in leadership and one for in teaching. And I think that middle leader role is complex because of that reason. And sometimes inevitably we will draw on what works for me as a teacher or what's my experience as a teacher. And that's where I'll start with what I do when I'm leading and developing others.*

And also of the tensions related to bridging those two identities and communities of practice (Gear &

Sood, 2021; Wenger, 1999),

> *I suppose it can be a help knowing that, knowing what teachers have to kind of cope with on a day to day, but then maybe it can hold you back a bit, a bit as well, because you've got that sympathy and your empathy. It can stop you delivering what you think you need to or working on what you think you need to.*

Secondly, regarding those with a senior leadership role, tensions and inconsistencies were evident between their perception of self-efficacy and that of those whose teaching they evaluated. All senior leaders spoke about their lack of recent or age-specific teaching experience in mathematics and their awareness that this meant they did not identify as 'teachers', although they were all confident in their ability to identify good teaching'. Amanda (SL) and Christina (SL) acknowledged the necessity of mathematical subject knowledge to be able to evaluate others' practice, whereas Dominic (SL) relied on his teachers and mathematics subject leader for guidance with this. Similarly to Brooke (MSL), Caroline (MSL) and Daniel (MSL), Brett (SL) and Dominic (SL) explicitly acknowledged the influence of their own beliefs on their perceptions when observing teaching, and that looking for progress in children's work was one way in which they mitigated the impact of this.

> *You, because obviously you're gonna, especially if you're drawing on your own experiences, the thing you often say to yourself is I would have done that differently, right. Because obviously, you know, the way I might, the way I might've taught it, they're not doing it the same way. Um, and I've got to always remember to not judge them on that because at the end of the day, they're still getting, when I talked about coming back to the books, they're still getting the pro-, the progress is still in the books. Although their pedagogy, the way they've done, it would have been different to the way I would have done it. (Dominic, SL)*

> *I observed others as I had been observed in the past. Right. I think so I never had any particular training on it, which was a mistake, I think. Um, and yeah, I, I guess my or so I observed in the way that I had been in the past with my own revisions about what I thought would, would, should, should have been. (Brett, SL)*

Indeed, the degree of mathematics specific focus in evaluations, particularly observations of classroom practice was variable within both leadership groups. All referred to the use of the Teachers' Standards (DfE, 2021) as one source of criteria for judging the quality of teaching, and both Alice (MSL) and Amanda (SL) referred to the use of a checklist of criteria related to their school's scheme of work to evaluate fidelity to its recommended practices (Russell et al., 2022). Elaine (SL) referred to the use of curriculum and assessment materials produced by the DfE, Otrack and some Local Authority produced documentation, all focussed on the expectations of children's attainment. Brett (SL) and Dominic (SL) had both devised documentation to support the evaluation of teaching in line with their perceptions of successful generic teaching based on a range of experiences with Ofsted and Challenge Partners

(practitioner-led peer-review).

Only one participant spoke about the potential for individual and collective beliefs about the effective teaching of mathematics to inform evaluation, as advocated by (Lim & Kor, 2012).

> *Um, I think it would be really lovely if as a whole school, we took our three I's for each of the subjects that we have developed and said, this is what we're doing. And there is a subject audit based on those three I's. And it's all agreed by us staff again, if we're being assessed and evaluated. So I'm still evaluated on my maths as a teacher, why would it not be that we have an input and a share into what that document looks like? But we haven't so far. (Brooke, MSL)*

Arguably such practice has the potential to support greater stability of identity across all roles and reduce some of the tensions and inconsistencies interpreted in this data set.

6.3 Identifying as 'a professional'.

All participants made connections between perceptions of their own professional identity and the extent to which they felt they had autonomy in their roles, with most comments being related to their experiences as teachers. This was most clearly expressed by Caroline (MSL).

> *…my professional identity is bound up with the extent to which I control what's happening in this room.*

Similarly Brooke's (MSL) perception of her autonomy was highly congruent with Berger & Le Van's (2019) major components of teacher's professional identity "motivation, self-efficacy beliefs, sense of responsibility, affective commitment and perception of expertise" (p.164),

> *I think we make professional judgments. We don't follow by the book, we, we don't have a guide book to the job. There's not, you should do this. Or if you do this, this will happen. We have to be fluid throughout. And to be fluid, you have to have an embedded confidence, awareness, understanding. You need to have a bank of tools and resources to go to. And I think that's what makes you the professional. We are almost our own bosses because we are in charge of our own classes and we're in charge of the attainment of 30 children.*

The extent to which all participants with a current teaching role felt able to make decisions that were congruent with their beliefs about mathematics teaching was viewed as an important element of feeling respected as a professional, and this was also acknowledged by Elaine (SL) and Christina (SL). The influence of the use of schemes of work for mathematics teaching on professional identity was perceived in three different ways. Firstly, some participants found them to be restrictive and limiting, particularly regarding the prescriptive content and use of time and the repetitive range of question and activity types (*Anna, CT, Claire, CT, Donna, CT*) and felt that their use contributed to a reduction in their sense of identity as a professional. Secondly some, notably those that found the key principles of their

school's scheme consistent with their own beliefs about mathematics teaching (*Becca, CT, Beth, CT, Donna, CT, Emily, MSL, Alice, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL*), found that using a scheme contributed to their sense of self-efficacy and positive perceptions of their own expertise (Berger & Lê Van, 2019), as long as they were able to adjust aspects of the materials to better suit the needs of their learners (Hoyle & John, 1995). These context related adjustments were also identified as part of a broader feature of professional identity connected to reflexive practice. Participants felt that they identified more strongly as a professional when they were given "freedom" and supported to "experiment" and "learn from mistakes" (*Anna, CT, Becca, CT, Claire, CT, Donna, CT, Emily, MSL, Alice, MSL, Elaine, SL, Brett, SL*) as part of their continued development (Addis & Winch, 2018; Tomo & de Gennaro, 2019).

Such autonomy was also viewed in a range of ways by participants currently in a leadership role. For Brooke (MSL), ensuring that teachers retained their autonomy, characterised as support to use their "initiative", by not being "slaves to the scheme", was perceived as a key component of her role. This contrasted with Amanda (SL) who demonstrated traits of a 'policy enthusiast' (Ball et al., 2012) in her loyalty to and advocacy of the implemented scheme.

> *I became sort of a champ, a champion, um, and other teachers would come and see me teach, deliver the (scheme) lessons. And, um, we sort of developed like a coaching model for the (scheme) because it was such a different way of teaching than we've had ever done before. Um, so yes, people were coming to see me. I was going to see them and that whole sort of two way street was evaluating myself and evaluating others.*

Both Brooke (MSL) and Daniel (MSL) commented on the potential consequences of affording teachers autonomy at the expense of consistency and the risk of a reduced quality of teaching due to poor subject knowledge.

> *And you know, when that teacher plans that maths, then there's just, there's just too much room for manoeuvre for me. So I do like the systematic element and the consistency and the, almost the lack of autonomy that happens now in the school, because I just know that every single teacher is at least showing what they need to show… (Daniel, MSL)*

And later in the interview, he continued,

> *But then as I've been in the profession longer, um, I do see a danger in the side of autonomy that does come through and, you know, particularly for those core subjects in particular. And actually, um, it could be question, but I've tried to pull away from autonomy for maths, 'cos I see a real benefit of a real genuine consistency of teaching and learning…in the politest way possible, I don't think they think better than (the scheme) do you know? I don't think they create questions better than (the scheme writers) do. I don't think*

they present things in the conceptual way better than (the scheme writers) are doing.

Caroline (MSL) also spoke of an awareness of the complex relationship between teacher autonomy and curriculum, attainment and inspection expectations.

> *…so how much autonomy do I think teachers should be allowed to not be allowed, should have in their planning and teaching of maths?...Um, I don't know. I find that a bit of a struggle because as I said earlier, I rolled out the scheme and said, that's here if you, if you want to use it, um, perhaps assuming that people would, would use it more than they have. Um, and it's, it's difficult because we're very experienced staff as a whole, um, and where I've been, I mean, I do, I do think my now understanding of maths mastery is probably all it is, um, greater than other teachers was they haven't been on the same courses that I've been lucky enough to go on done the same readings. So in that extent, to that extent, I, I should then feel more confident saying, no, this is what we should use. This is why these do it. But then don't know again, you've got that understandings of teaching myself of the busy-ness and the stress and not wanting to add to people's mental load. And, um, but then you've got to kind of balance that with the no, but I think this will make life easier in the long run for teachers and obviously the children…. but then I guess I'm accountable as a leader on top, if an external agency comes in and says, well, why aren't year one for example doing the mastery approach? And it will kind of be down to me to explain why they all aren't.*

For two participants in a leadership role, the level of teaching experience held by an individual was positively correlated to the degree of autonomy given (*Caroline, MSL, Dominic, SL*), but it was more common for the level of autonomy given to be dependent on the extent to which teachers had proved their capability to achieve the desired outcomes for their learners, or were perceived to demonstrate high levels of mathematical subject knowledge, regardless of length of time in post (*Emily, MSL, Daniel, MSL, Elaine, SL, Amanda, SL, Brett, SL, Dominic, SL*).

> *…because we've, uh, tried our best with the scheme and we've showed that we know how to use it (Daniel, MSL) is now letting us soon to be able to now apply our, our experience of teaching and our confidence that we will be able to pick and choose… (Donna, CT)*

This was experienced by the four longest serving teachers (*Anna, CT, Beth, CT, Claire, CT, Donna, CT*) as challenging to their identity as competent professionals (Berger & Lê Van, 2019) and they each recounted incidents whereby their experience was disregarded and autonomy withdrawn in pursuit of performative practice that was visibly consistent with a scheme of work or leaders' expectations (Ball, 2003).

> *I don't know if other people view me with that stronger professional identity… I've had lots of background skills and things, but because we are now just class teachers, we've taken steps backwards maybe we're not viewed in these ways. (Beth, CT)*

> *But then I felt that people are still coming in and having expectation. You're going to teach it to the way that they're expecting it to be taught. Right. So then they're whether it would be easier just to tell us how*

to teach it. And then we just do what has been asked. (Claire, CT)

I wanna do it, right. I don't wanna just open up (the scheme)… it was really, it was a wasted lesson, but we weren't allowed to change anything at that point. I, I would've maybe done a few tweaks of how we get there and coming back to it a bit. So I'm looking forward to being able to have, you know, authority of decision on how we, how we do it next year. (Donna,CT)

Those in leadership roles also commented on their perceived freedom to operate autonomously as leaders with both mathematics subject leaders and senior leaders demonstrating an awareness that others' exerted some control or influence over their practice, exemplified in the following comment.

…obviously I had to, because I had a point to prove. Um, but just probably not just teaching maths, but just generally being a head teacher when I first came here, you know, I had to ask (Trust CEO) for anything because she wouldn't let anything go because this was their number one priority, was this school. Um, but now three years down the line… you know, um, yeah, they almost let me do what I want now, because I think I've proved myself. And I think that's the same with any maths teacher. If they've proved themselves, you don't need to, you know, you don't need to keep the shackles on… (Dominic, SL)

This can be interpreted as an example of a culture of deprofessionalisation and mistrust of both teachers and leaders (Keddie & Mills, 2019). Indeed, 'trust' was both explicitly referred to and interpreted from several participants comments as integral to their perceptions of identifying as a professional with regard to both horizontal and vertical surveillance (Skerritt, 2020) as exemplified by trusting and being trusted by peers (*Donna, CT, Elaine, SL*) and trusting and being trusted relative to hierarchical positions (*Becca, CT, Emily, MSL, Brooke, MSL, Caroline, MSL, Daniel, MSL, Christina, SL, Dominic, SL*). Again, perception of expertise as demonstrated through an individual's impact on learners' outcomes was a clear condition for such trust to develop, as encapsulated by Dominic's (SL) description of Daniel (MSL).

Well trust is part of it. That's for sure. You know, I know that he's had the right training, obviously I've observed him. He's an outstanding math teacher and an outstanding practitioner. Um, he's got the support from the maths hubs. So I know he's getting the right stuff. He's got the support from the university. Um, but generally, you know, he's, he's a very strong, for him, It's, he's such a strong teacher. He gets such good results and he's very knowledgeable.

Participants from all groups explicitly referred to 'accountability' (Bates et al., 2019; Brown & McNamara, 2011) as part of their perceptions of professional identity (*Claire, CT, Donna, CT, Alice, MSL, Daniel, MSL, Amanda, SL*) and this was consistently related to learners' progress and attainment. Further implicit references to this, sometimes characterised as 'responsibility' (Berger & Lê Van, 2019) for children's learning and linked to changes in attitude, feelings and understanding rather than measurable progress and attainment were made by others (*Anna, CT, Becca, CT, Claire, CT, Donna, CT, Emily, MSL,*

Brooke, MSL, Caroline, MSL, Daniel, MSL, Elaine, SL, Brett, SL and Christina, SL). It was apparent that these 'responsibilities' were more closely aligned with participants' personal identities as they reflected their beliefs about the importance of relationships and learner's emotions as a core component of effective mathematics teaching and learning. There was a sense of such professional responsibility connecting to a bigger purpose or mission for teachers' practice as exemplified by Donna (CT).

> *professional is you're current in the pedagogy, you're current in what's happening in not just academic wise, but also what's happening in our society and our initial demographic of, you know, I mean, I'm trying to change the world in my little classroom and it's, it is always a fight.*

6.4 Summary of findings regarding the evaluation of primary mathematics teaching through the Professional Identity lens

When viewed through a professional identity lens, the data collected offered insights into the perceptions and experiences of participants in several ways. The personal relationship participants had with mathematics influenced and informed their professional identity in terms of their perceived self-efficacy, although there was evidence that many conceptualise 'being good at maths' as a separate and not necessarily precursive condition of 'being good at teaching maths'. These formed part of the foundational beliefs upon which participants' professional identities were built and were informed by their experiences of evaluation. Perceptions of teaching efficacy and therefore the extent to which participants identified as a 'good' teacher of mathematics were influenced by these experiences in both validating and invalidating ways depending on the level of congruence between the evaluand and evaluator beliefs about mathematics itself, and how it is best learned and taught. There was some evidence of consistency between individual and collective beliefs, which demonstrated the overlapping spheres of professional identity and their reciprocal influence. Participants with high levels of recent reflective engagement in teaching practice were able to maintain a secure sense of professional identity despite belief-based challenges, although some chose to exhibit compliance with evaluator beliefs and expectations despite this. There was an acknowledgement in senior leaders of a tendency to evaluate the quality of teaching as consistent with their own beliefs and experiences.

Tensions between the multiple identities held by all participants were evident. Teachers with experience as evaluators, particularly those who had held leadership positions previously in their careers, found that the minimisation of this experience when in the role of evaluand was challenging. Mathematics subject leaders found balancing their teacher and leader identities complex, particularly when in the

role of evaluator with the higher levels of subject-specific knowledge but lower levels of autonomy over the foci and criteria of evaluations. Senior leaders for whom recent experience in teaching mathematics was lower expressed a lack of confidence in their judgements of the quality of mathematics teaching and a tension between this and the high level of accountability they felt for ensuring that the evaluative process leads to both formative and summative improvements in practice. There was some evidence of senior leaders trusting the subject-specific knowledge of mathematics subject leaders in informing this element of evaluations, but all leaders acknowledged that they were not fully autonomous in their roles due to a sense of external accountability.

The perceptions of autonomy and its relationship to identifying as a professional were largely related to being earned as a result of demonstrating compliance with the expectations of leadership and therefore trusted, rather than related to acknowledgement of experience. Expectations of compliance to schemes of work was viewed as restrictive to autonomy by more experienced teachers but necessary for the development of a coherent and consistent curriculum by middle and senior leaders resulting in tensions around potential deprofessionalisation in their use. Where they were perceived to be consistent with individual beliefs about effective mathematics teaching, they were considered to support and enhance autonomy through increased capacity to adapt in context.

In summary, the findings relating to evaluations of primary mathematics teaching and professional identity are listed below.

What are the perceptions and experiences of senior leaders, subject leaders and teachers of the evaluation of primary mathematics teaching in relation to **professional identity**?	- Personal relationships with mathematics are highly influential on perceptions of self-efficacy - 'Being good at maths' is separate to 'being good at teaching maths' - Evaluators judge quality of teaching consistently with their own beliefs and experiences - Some consistency between individual and collective beliefs demonstrating reciprocity of professional identity spheres - Congruence between evaluator and evaluand beliefs strongly influenced perceptions of efficacy - Experiences of teachers as evaluators were not always recognised or valued - Balancing teacher and leader identities when evaluating others was complex for Mathematics subject leaders - Most senior leaders lacked confidence in their judgements of the quality of mathematics teaching - Many leaders view autonomy as earned and awarded to others when they have demonstrated compliance - Leaders do not feel fully autonomous in their roles due to internal and external expectations of accountability

	- Teachers had mixed perceptions of their own autonomy, particularly related to use of schemes of work

Table 9: Findings related to professional identity

Findings and analysis of data through the professional identity lens therefore offered some insight into the problems that this study seeks to explore and better understand as follows.

Problem 1: A potential lack of shared understanding around the varied purposes and consequences of evaluations

The influence of the personal relationship participants have with mathematics on their professional identity as a teacher of mathematic was evident although for most participants, 'being good at maths' was separate to 'being good at teaching maths'. When evaluating, it was evident that senior leaders have a tendency to evaluate the quality of teaching as consistent with their own beliefs and experiences.

Problem 2: The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process

There was some evidence of consistency between individual and collective beliefs as coherent with those espoused by the National Curriculum and 'mastery' demonstrating the overlapping spheres of professional identity and their reciprocal influence.

Problem 3: Under-representation of key stakeholder voices in research on the evaluation of primary mathematics teaching and a lack of clarity around the relationship between their roles

The level of congruence between evaluator and evaluand beliefs strongly influenced perceptions of efficacy. Where these were not aligned, length of career and recent experience were stabilising influences on identity, but some still chose to exhibit compliance. The historical experiences of teachers as evaluators were not always perceived as valued or recognised in the evaluative process. Balancing teacher and leader identities when evaluating others was complex for mathematics subject leaders. Most senior leaders lacked confidence in their judgements of the quality of mathematics teaching and this caused tension when considering their accountability for ensuring the quality of teaching.

Problem 4: The risk of deprofessionalisation of teachers and leaders through the evaluation process

It was evident that many leaders view autonomy as earned and awarded to others when they have demonstrated that they can be trusted through showing compliance with evaluators views of effective practice. All leaders also acknowledged that they do not feel fully autonomous in their roles due to both internal and external expectations of accountability. Teachers had mixed perceptions of their own

autonomy, particularly related to the expectations of evaluators, and also in response to the use of schemes of work which were seen to both limit and support aspects of autonomy as dependent on congruence with their beliefs about the effective teaching of mathematics.

In the next chapter the study is summarised and conclusions regarding the findings drawn. Implications of the findings and recommendations for practice are discussed, as is the original contribution to knowledge that this study makes.

7. Conclusions, Implications and Recommendations

This chapter synthesises the findings, analysis and discussion in Chapters 4, 5 and 6 to identify key findings from each research question which are then combined and synthesised in order to draw conclusions which provide original theoretical insights into the evaluation of primary mathematics teaching. It then outlines further original contributions made by this study to research and methodological knowledge. It also clarifies original contributions to professional knowledge by identifying the implications and recommendations for professional practice, including a suggested model detailing necessary components of the evaluation process. In doing so, it draws on LaFollette's (2020) definition of theorising as "…not some enterprise divorced from practice, but is simply the careful, systematic, and thoughtful reflection on practice" (p.4). The limitations of the study are articulated and recommendations for further research made. Finally, reflections on personal and professional development as a result of participation in the EdD programme are shared.

7.1 Summary of study

When the findings in relation to each conceptual lens are combined and synthesised at the intersection of the conceptual framework (figure 11), three overarching issues are identifiable as three key findings of this study into the experiences and perceptions of class teachers, mathematics subject leaders and senior leaders of the evaluation of primary mathematics teaching. These are summarised below (tables 11, 12 and 13), with initials attributed to each underpinning finding in order to clarify their origin (Professional Development = PD, Professional Knowledge = PK, Professional Identity = PI), and expanded

on to articulate conclusions that can be drawn from this study in section 7.2.

Key finding 1: Varying views of effective mathematics teaching
- Valuing of mixed methods of data collection and triangulation (PD)
- Teachers and mathematics subject leaders question the validity of data interpretations (PD)
- Coherence in judgements of 'effective/successful' teaching regarding progress and attainment related outcomes (PK)
- Wide variation in knowledge of what 'good' mathematics teaching is (PK)
- Criteria are selected by the evaluator and consistent with NC, SATs and 'mastery' knowledge (PK)
- Weak coherence between school curriculum and evaluation criteria (PK)
- Personal relationships with mathematics are highly influential on perceptions of self-efficacy (PI)
- 'Being good at maths' is separate to 'being good at teaching maths' (PI)
- Some consistency between individual and collective beliefs demonstrating reciprocity of professional identity spheres (PI)
- Congruence between evaluator and evaluand beliefs strongly influenced perceptions of efficacy (PI)

Table 10: Key Finding 1

Key finding 2: Varying knowledge of primary mathematics and evaluation processes
- Validity and reliability of tools and methods used are not considered (PD)
- Credibility of evaluators is correlated to perception of their knowledge for the teaching of primary mathematics (PD)
- Mathematics subject leaders have most recent experiences of training for knowledge for the teaching of primary mathematics (PD)
- Teachers and mathematics subject leaders question validity of data interpretations (PD)
- Discussion with external specialists is valued although a lack of contextual knowledge can mitigate usefulness of feedback (PD)
- Extensive influence of knowledge prioritised by NC and SATs, 'mastery', and related schemes of work (PK)
- Evaluators judge quality of teaching consistently with their own beliefs and experiences (PI)
- Experiences of teachers as evaluators were not always recognised or valued (PI)
- Teachers had mixed perceptions of their own autonomy, particularly related to use of schemes of work (PI)

Table 11: Key finding 2

Key finding 3: Varying clarity of purpose and ownership of evaluations
- Evaluations are isolated events and lack clarity of purpose (PD)
- Feedback is corrective (single-loop learning) (PD)
- Usefulness depends on perceived quality of feedback (PD)
- Autonomy over evaluative process is held by Senior, and to some extent, Mathematics subject leaders (PD)

- A mixture of generic and subject-specific principles for effective practice are used as criteria (PK) - No use of mathematics-specific rubrics (PK) - Balancing teacher and leader identities when evaluating others was complex for Mathematics subject leaders (PI) - Most senior leaders lacked confidence in their judgements of the quality of mathematics teaching (PI) - Many leaders view autonomy as earned and awarded to others when they have demonstrated compliance (PI) - Leaders do not feel fully autonomous in their roles due to internal and external expectations of accountability (PI)

Table 12: Key finding 3

Each of these, varying views of effective mathematics teaching, varying knowledge of primary mathematics and evaluation processes, and varying clarity of purpose and ownership of evaluations, are barriers to the implementation of fair, coherent and useful evaluations in primary mathematics teaching.

7.2 Key Findings and Conclusions

This study found high levels of variation in the perceptions and experiences of class teachers, mathematics subject leaders and senior leaders in relation to effective mathematics teaching, knowledge of primary mathematics and evaluation processes, and the clarity of purpose and ownership of evaluations. Atomised pockets of knowledge and unchallenged individual biases were liable to lead to summative evaluative judgements that were perceived variously as unfair, contradictory or useless, and formative feedback that is inconsistent in its impact on the improvement of mathematics teaching. It has highlighted a need for a standardised evaluation framework for primary mathematics teaching to make sense of the complicated mass of subject-specific information regarding effectiveness, and for the development of a methodological approach that can enable the complex work of using such evaluations meaningfully for formative purposes in the context of specific schools and classrooms.

Varying views of effective mathematics teaching

It was evident that the perceptions of what constitutes effective mathematics teaching were influenced by personal views of what mathematics is for and how it is best learned and taught, and broader messages communicated through the curriculum, assessment systems and the professional

development opportunities that participants had accessed.

There was a distinction of emphasis between the groups of participants on how they know whether effective mathematics teaching is taking place. The middle and senior leaders' perspectives of evaluating effective mathematics teaching tended towards measurable learner outcomes, whereas the teachers valued less measurable indicators of learner attitude and progress 'in the moment'. These perspectives are related to issues of accountability and responsibility and perceptions of these within an individual's identified role. There is, of course, nuance within the data suggestive of tensions within individuals as they identify a range of competing values and identities that influence these perceptions.

Collectively, each school had a published statement regarding the intent of their mathematics curriculum, and it was clear that whilst these represented some individual beliefs and knowledge held by participants in each school, they also show strong influence from external sources. The National Curriculum, the NCETM's 'mastery' approach, and perceptions of Ofsted expectations are clearly identifiable, and this speaks to a wider systemisation of knowledge and identity around the characterisation of effective mathematics teaching. These external sources are legitimatised as the ways in which mathematics is perceived and communicated, particularly through published 'schemes of work'.

However, despite espousing the values of these collective knowledge bases of effective mathematics teaching, it was apparent that interpretations and applications of these were highly subjective. It was evident in data from all participants that their perceptions of that which constituted effective mathematics teaching were fundamentally influenced by belief-consistent information processing resulting in identifiable biases in the types of practice that were prioritised and valued (Oeberst & Imhoff, 2023).

Varying knowledge of primary mathematics and evaluation processes

Participants' perceptions of the credibility of their own and others' evaluative judgements with reference to knowledge of primary mathematics and the validity and reliability of the evaluation process. Individual credibility was heavily influenced by self-perceptions of mathematical knowledge and informed the professional identity of each participant as both personally mathematically capable and professionally competent as a mathematics teacher.

The group that identified most strongly as capable of identifying effective mathematics teaching were the mathematics leaders, attributed to a combination of current classroom experience and prioritisation

of their involvement in external professional development opportunities. Teachers demonstrated mixed perceptions of their personal mathematical credibility as both teachers and evaluators and these were largely rooted in their identity as learners of mathematics, and the mathematics-specific developmental experiences that they had, or had not, had access to in their careers to date. For the senior leaders, credibility was firmly rooted in their evaluator role through their ability to identify generic good teaching but confidence in their mathematics-specific knowledge was less secure. When evaluations did go beyond general principles for effective teaching, it was evident that a reliance on fidelity to schemes of work and selective mastery principles was used by leaders to guide a focus on mathematics. It was acknowledged by several participants that there was a lack of time and capacity within the evaluation process to develop deep understanding of both the subject, and the teachers and teaching.

The perceived credibility of the evaluation process was also a source of tension for participants, although this was characterised in variable ways. The tools used reflected those utilised by external agencies to evaluate teaching quality and there was a commitment by leaders to try to build an accurate picture of individual practice and teaching across their schools. However, some questioned the validity and reliability of the various data collection tools employed, and the analysis of the information they generated. A lack of knowledge about the ways in which data collection and analysis can be methodologically weak was evident, and again this vacuum was filled by a reliance on personally subjective views. The accruing of knowledge is a core feature of developing expertise and the journey from novice through competent practitioner to expert is often characterised by a move to the repeated effective use of tacit knowledge, astute assessment of situational need and enhanced theoretical understanding, as such these abilities distinguish the expert teacher from the technician (Addis & Winch, 2018). Provision for developing this knowledge can be found through subject associations and universities who have a clear role to filter and disseminate relevant research evidence to schools and teachers, but whose independence from ideological state agendas is imperative (Boylan, 2019). Many participants valued the mathematics-specific knowledge that is held by external specialists that they work with as part of evaluating the quality of teaching. It is also worth considering that those with knowledge and experience of data collection and interpretation as part of research enquiry also have a valuable contribution to make to the development of fair, coherent and useful evaluations.

Varying clarity of purpose and ownership of evaluations

The findings of this study demonstrated a lack of clarity over the purpose of the evaluation process. The formative and summative nature of teacher and teaching evaluations were frequently conflated as

efforts were made to identify areas for individual and whole-school development, as well as form overall judgements on the quality of teaching.

The latter was particularly evident in senior leader data as whilst 'labels' for individual lessons or teacher were not employed, there was a sense of comparison and value-judgements related to learner outcomes that alluded to a broader summative purpose. Mathematics subject leaders were most likely to identify formative uses for the evaluations and incorporate these into feedback and support for individual teachers. Teachers were primarily interested in the formative nature of the evaluative process, but aware of the consequences of negative summative judgements. This led to practices suggestive of performativity (Ball, 2003) as they made choices that matched their perceptions of leaders' expectations of effective teaching as identified in the foci of school improvement towards the shared vision for mathematics teaching. Those whose teaching did not observably 'match' felt coerced into conformity through increased monitoring and targets that affiliated with the vision of the evaluator. Conversely, those whose practice did reflect the observable features of effectiveness were considered to have proved themselves worthy of a limited range of autonomy within the system valued by the school. The purpose of the evaluations therefore became a test of fidelity to specific pedagogical practices, rather than a thorough evaluation of the effectiveness of mathematics teaching in all its richness and complexity.

This lack of a clarity of purpose was also evident in the absence of standardised instruments to support subject-specific evaluations of the quality of teaching. Where this did exist, in two of the five schools, the rubric was coded towards generic teaching principles and both mathematics subject leaders relied on their own understanding of effective mathematics teaching for elaboration.

Finally, it was evident that efforts to afford teachers ownership of or autonomy over the evaluation process was limited to sparse efforts to gain further detail about the learning sequence within which observations of teaching were taking place. Whilst some development opportunities that encouraged peer-to-peer collaboration were cited, these were separate to evaluations that involved school leaders. When, how, which data was collected and to what purpose evaluations were carried out was decided primarily by the school leaders, and feedback consisted of leaders' perceptions of practice being shared with teachers, with minimal time and attention paid to professional dialogue to develop depth of contextual understanding. Further interaction only occurred where there was deemed to be a deficiency

in practice that needed to be corrected.

7.3 Implications and Recommendations

Firstly, the implications of the findings of this thesis are initially outlined with reference to the problems identified as part of the wider contextualisation of the study into which it sought to gain insight, and then to further implications that have arisen. This leads to a professional model which is presented as a recommendation for practice that has the potential to address many of the tensions and contradictions identified through the study and support the development and improvement of evaluations of primary mathematics teaching which are perceived and experienced as fair, coherent and useful by evaluands and evaluators.

Implications related to the wider professional context.

This study sought to gain insight into five identified problems as part of the wider context in which participants' experiences and perceptions of the evaluation of primary mathematics teaching sat. The following summaries outline the implications of the study as relevant to each of these problems.

Problem 1: A potential lack of shared understanding around the varied purposes and consequences of evaluations

'Effective' and/or 'successful' mathematics teaching was predominantly understood to be aligned with practices that appeared to bring about desired learning, with less consideration of or agreement on what constitutes 'good' practice as aligned with the broader body of knowledge that exists about mathematics teaching. Overall, when children's outcomes aligned with the education systems' expectations, as limited by the processes in place to measure them, the practices exhibited by teachers and schools were judged to be 'effective'. One implication of this perception is that it can lead to a focus on identifying and replicating such practices with the assumption that they will automatically lead to desired outcomes. Consequently 'evaluations' were the core process by which such practices are identified and replicated and are increasingly used to measure and develop teaching against a checklist of features presumed to be 'effective'.

Problem 2: The impact of significant changes in mathematics curriculum, assessment and pedagogy on the evaluation process

This checklist of features was heavily influenced by the content and pedagogy advocated by the National Curriculum, end of key stage tests, and a 'mastery' approach. Many of the core principles of 'mastery' are aligned with decades of research in mathematics education that to a certain extent validates the

recommended teaching practices in terms of pedagogy and in this way can be seen making a coherent and credible contribution to the teaching of primary mathematics. However, the reduction of the complexities of mathematics as a field of study to a linear curriculum delivered through a carefully designed sequence of lessons seems to be becoming a proxy for mathematical learning that influences a surface level of understanding of the quality of teaching for evaluators and evaluands alike.

Problem 3: Under-representation of key stakeholder voices in research on the evaluation of primary mathematics teaching and a lack of clarity around the relationship between their roles

The perceptions and experiences of all individuals involved in the evaluation of primary mathematics are highly subjective leading to a complex picture overall with unavoidable tensions and contradictions. Whilst full consensus is therefore an impossible dream, greater clarity and coherence needs to be sought through reflective dialogue which acknowledges the varying contributions that can be made by teachers, mathematics subject leaders and senior leaders to discussions about what constitutes 'good' mathematics teaching and therefore incorporates and transcends the simply 'effective'. Further discussion of what is meant by 'good' mathematics teaching and how this can be encouraged in specific contexts must take account of a purpose that goes beyond test related outcomes, as already espoused in school visions and intentions for the subject.

Problem 4: The risk of deprofessionalisation of teachers and leaders through the evaluation process

Teachers, mathematics subject leaders and senior leaders viewed their professional identity as congruent with the extent to which they feel themselves to be autonomous and able to make decisions about practice which are consistent with their beliefs about effective mathematics teaching. However, tensions between this and a perceived need for consistency of practice resulted in a mixed picture for individuals in all roles. Autonomy was not correlated with experience, but awarded more to those who had demonstrated compliance with delivery of specific proxies for mathematical learning and were then permitted to 'tweak' these, leading to a reduction in the perception of professional trust for many participants. Accountability was firmly embedded as an influencing factor for the control and standardisation of autonomy and again limited the field of primary mathematics education to the 'effective' through identification of the measurable.

Problem 5: Tensions and contradictions in the insider/outsider role of the evaluator

The credibility of external evaluators and perceptions of their usefulness in the evaluation process was measured by the degree of subject-specific knowledge they hold, whether it was broader or deeper than that held by internal evaluators, and their demonstration of recent and relevant experience of teaching.

Therefore, in order that such 'experts' are held accountable to the joint enterprise of conducting effective evaluations of mathematics teaching, their own knowledge base and beliefs ought also to be scrutinised, as should the rubrics they utilise. Wherever possible, such rubrics should not be simplified checklists, but support the joint exploration of higher-order questions that are informed by thoughtful and considered views of the professional body of mathematicians and mathematics educators in the field. The voices of those in mathematics education as represented by professional bodies such as the ATM should be made widely accessible in order that over-simplified proxies for effective mathematics teaching do not eclipse the potential for more nuanced and meaningful professional conversations about the complexities of primary mathematics teaching in varying contexts. This is in line with arguments made by (Firestone & Donaldson, 2019) and is in direct contradiction of the development of a reductive, technicist model of teacher development that such evaluative 'checklists' serve.

Further implications

Beyond these identified problems, it also became apparent in this study, through participants' descriptions of their experiences, that the process of evaluating the quality of teaching has much in common with that of research, or at least, enquiry-based models of action research. Evaluators engage in thinking, behaviours and actions that are akin to those of an empirical researcher when they define a question or problem, gather information from a wider knowledge base about the context, design methods by which to gather information about the specific case, analyse and evaluate the information gathered to judge its 'truth', and draw conclusions and recommendations for practice. There is therefore an argument that those with experience and expertise in conducting research external to individual school contexts can play an important role in a community of practice committed to developing fair, coherent and useful evaluations. The development of the external evaluator role in this way can offer support and challenge to the joint enterprise of the evaluative process, particularly regarding the encouragement of critical reflection to mitigate against bias as rooted in core ethical research principles. This conceptualisation of their role echoes the work of Tillin (2023), as it acknowledges the "...integration of research-based and professional knowledge...as collaborative endeavour" (p.11) not solely pertaining to knowledge about primary mathematics teaching, but more of the necessary knowledge for how evaluations are conducted effectively. Such a role within the proposed conceptual model of this study has the potential to promote professional trust and autonomy for all involved in the evaluative process in collaboration to develop shared knowledge and understanding, as advocated by Mayer & Mills (2020).

The tensions and contradictions identified through this study were largely related to the variable nature of the professional knowledge held by participants in all roles, both in terms of mathematics-specific knowledge, and knowledge of credible evaluation processes. Where mathematics-specific knowledge was informed by engagement with formalised professional development opportunities, these were heavily influenced by the prevailing reified systems of curriculum (National curriculum), assessment (SATs expectations and Ofsted) and pedagogy (mastery) of the time. Where participants were unable to access such development, their views of effective mathematics teaching were restricted to surface level understanding of pedagogy, influenced by their historical experiences as learners and teachers of the subject, and subject to bias. Where knowledge of credible evaluation processes was held, this was lacking in criticality and tended towards generic principles of effective teaching. Coupled with a lack of mathematical knowledge, the professional implications of these issues are the deprofessionalisation of teachers to technicians, of leaders to monitors of technical efficiency, and to a reductive narrowing of mathematical learning experiences for learners.

Recommendations for practice

What follows is a recommended model for teacher evaluation in primary mathematics teaching which details necessary components of a fair, coherent and useful system that has the potential to address the issues identified in this study. The model combines the empirical findings and theorisations identified through the conceptual framework of this study to confirm and add to existing body of knowledge on the conceptualisations of teacher evaluation (Fig.12). It is organised around the three core principles of communities of practice as identified by Wenger (1999); mutual engagement, joint enterprise, and a shared repertoire of tools. It also utilises principles of andragogy and collaborative enquiry to encourage double-loop learning. It draws on established rubrics for the development of mathematical knowledge for teaching as a basis for categorising salient elements and supporting analysis of surface, deep and implicit structures of mathematics-specific pedagogy. It supports the development of knowledge of effective evaluation processes and builds the capacity of evaluators through supporting the examination of belief-consistent information-processing in primary mathematics. It values equally the potential contributions of all participants and empowers all involved in the evaluation process through the

acknowledgement of multi-layered roles and experiences.

Model for teacher evaluation in primary mathematics teaching

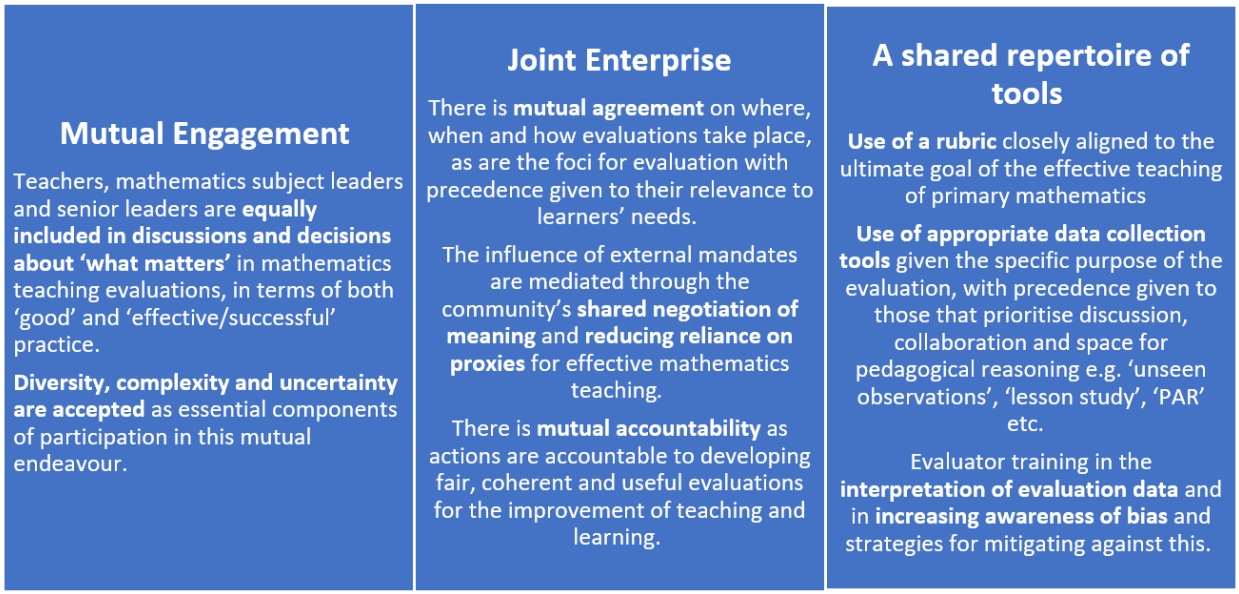


Figure 11: Model for the evaluation of primary mathematics teaching

It is recommended that this model be used to underpin and facilitate professional development in and across schools for improving the evaluation of primary mathematics teaching. Initially, all those involved in such evaluations will engage in reflective dialogue about the components relating to mutual engagement and mutual agreement. Subsequently, professional learning activities and opportunities to explore each of the components relating to the shared repertoire of tools would be provided, coupled with supported access to pertinent and credible sources of wider professional knowledge to enable double-loop learning. Ultimately, such a model for practice has the potential to support teachers, mathematics subject leaders and senior leaders to move beyond a checklist when evaluating primary mathematics teaching and into richer professional communities of practice that acknowledge and respect the individual and collective wisdom of those involved contributing to the professional empowerment of all.

7.4 Original Contribution to Knowledge

Contributions to theoretical knowledge

This study claims to make an original contribution to theoretical knowledge with its use of a conceptual framework that explores the evaluation of mathematics teaching through three conceptual lenses of professional development, professional knowledge and professional identity. By initially analysing

responses through each separate lens, and then combining and synthesizing the findings, this study enables rich theoretical conceptualisation of participants' perceptions and experiences. It therefore offers a new theorisation of the evaluation of primary mathematics teaching that is otherwise absent from recent studies (Donaldson & Firestone, 2021).

Contributions to research knowledge

This study also claims to make an original contribution to research knowledge as a result of both its exploration of evaluative processes within primary schools and its exploration of primary mathematics teaching, an area of research hitherto neglected in the field of education. It adds new empirical data to pre-existing theories of effective evaluative and developmental practice. The empirical data of this study centralises the perspectives and voices of stakeholders that are largely unrepresented in the existing research in the field of evaluations, and the domain of primary mathematics. It therefore builds on Almutairi & Shraid's (2021) recommendation that more studies into the perspectives of stakeholders about the combination of evaluation data sources are conducted, and into the perceptions of the evaluation process held by practitioners and considers how gathering these views can inform practice development (Paufler & Clark, 2019).

The data is distinctive as each of the individual personal stories and cases cannot be replicated and so this study offers a unique and valuable insight to the issues identified. It foregrounds the pre-existing model of Rowland et al.'s (2009) 'Subject Knowledge Quartet' as a potential rubric for developing shared criteria and foci for evaluations that have relevance and credibility beyond and inclusive of those generated by proxies for mathematical teaching and learning in the form of 'mastery' and National Curriculum compliant schemes of work. It offers empirical data on the influence and impact of relatively recent mathematics specific curriculum, assessment and pedagogy changes on practice. Finally, in its application of a unique conceptual framework to offers a new theorisation of the evaluation of primary mathematics teaching that is otherwise absent from recent studies (Donaldson & Firestone, 2021) which acknowledges the complex interplay between the professional development, professional knowledge and professional identity of each of the stakeholders involved and the influences and consequences of these in the pursuit of high-quality teaching.

Contributions to methodological knowledge

This study also claims to offer new contributions to methodological knowledge through its choice of bounded case studies and inclusion of teacher, mathematics subject leader and senior leader participants which demonstrates the potential insight to be gained from seeking patterns and

relationships in perceptions and experiences through comparison. This choice allowed for insight into the consistencies and contradictions within role and school contexts and therefore clarity in identifying both common issues and nuance within these in order that deeper understanding of complex systems can be gained. The use of these multiple cases increases this study's claim for potential theoretical and literal replication of methods to secure further insights. The 'insider' position of the researcher added depth to the analysis at each stage which would not have been possible from a purely 'outsider' perspective.

Contributions to professional knowledge

Finally, this study claims to offer new insight into the need for increased clarity of purpose for evaluations in schools, and of developing both mathematics-specific knowledge and knowledge of valid and appropriate methods of data collection and interpretation. Very little attention is currently paid to the role of inquiry-based practices in the evaluation of teaching and this study makes the case for the incorporation of these into practice. It offers recommendations of the use of a mathematics specific rubric for evaluating mathematics teaching that is largely absent and has the potential to be supportive in developing coherent professional knowledge for all involved and in doing so builds on the work of Charalambous & Litke, 2018 and Walkington & Marder, 2018.

7.5 Limitations of study and recommendations for further research

The findings of this study should be considered in the light of some limitations. Resulting from the selected methodology, the first of these is the lack of generalisability, although the methods themselves could be replicated with a similar sample of participants in other setting to begin to ascertain commonalities of perceptions and experiences with a wider group. Secondly, analysis is limited in places due to a literature gap in prior research in the specific domains of perceptions and experiences of senior leaders in relation to evaluations, the impact of the ascendancy of a 'mastery' approach to teaching mathematics, and a lack of research within the context of one multi-academy trust. Selection of pilot participants from within the targeted research sample group could have highlighted this earlier and led to adaptations in wording or tools to support this aspect of the interview. Due to time constraints and a sensitivity to the goodwill of participating schools and individuals, the decision not to pursue the recruitment of a teacher from school E caused a further limitation to the full coherence of data findings and analysis across the bounded case studies. Resulting from the positioning of the researcher, a final limitation was the potential influence of an 'insider' perspective on the interpretation of data, in terms

of views held in reference to both the effective teaching of primary mathematics, and the effective implementation of evaluations of teaching.

The choices made that led to these limitations can be justified as they align to the overall aim and objectives of the research. The small sample size allowed for deeper understanding of a situated context to be developed. The 'insider' positioning of the researcher added layers of knowledge and understanding to the research design and analysis and enabled increased rapport to be established within a limited time frame of data collection. The inclusion of a fifth teacher as a member of school B ensured parity of voices across the three roles of participants, and lent depth to the data set as any individual voice would have done. The correlation of views within schools was not strong within any of the bounded case studies and so there is little reason to believe the lack of a teacher in school E reduced the value of its inclusion in the final data set. The unanticipated lack of understanding about the concepts of professional identity and autonomy perhaps speaks to a broader issue of deprofessionalisation as highlighted in other areas of the study, and therefore is itself of value.

Further research into the evaluations of primary mathematics teaching could be carried out by researchers with a purely outsider position, and in other primary education contexts to seek correlation or contradiction with the findings of this study. Further study into the views of senior leaders in relation to evaluations, the impact of the ascendancy of a 'mastery' approach to teaching mathematics, and a within the context of one multi-academy trust could strengthen the body of literature available to inform research knowledge in these areas. Finally, the model proposed for improvements to the evaluation process could be implemented to explore its use in professional practice. The impact of this on the perceptions and experiences of those involved in the evaluation of primary mathematics could also be evaluated to provide clarity and refinement of this process in ways that could benefit individuals, schools and ultimately the quality of mathematics education provided for all learners.

7.6 Reflections

Conducting this study has also made a significant contribution to my own professional development. One intended outcome, related to the tensions and contradictions within the insider/outsider role of the evaluator, was that I would gain insight that would inform my own professional practice and role as an evaluator. As a primary mathematics School Improvement Specialist for a university-affiliated academy trust, my understanding of the overlapping spheres of my own professional knowledge and identity have been enhanced in the following ways. I have gained greater awareness about my own subjectivity and biases that influence my perceptions of what constitutes both effective and successful mathematics

teaching, and am better equipped to understand and navigate tensions and contradictions that arise between my own and others' views. Through actively seeking out viewpoints and research evidence that offer challenge and alternatives to my own biases, I have strengthened and deepened my commitment to my own professional integrity and humility. Indeed, I am now more accepting of the complexities that are an inevitable part of any attempt to reach consensus and able to conduct my practice with a more open and curious mindset. I have developed a greater clarity of understanding about the contributions that colleagues make to a community of practice and feel better equipped to support and enhance the growth of these across the spheres of primary education, professional development and higher education. As a researcher, participation in the educational doctorate has also supported necessary developments in my understanding of research methodology and the meaningful connections between my ontological and epistemological position and the methodology and methods I choose to utilise to produce meaningful and useful data and findings. This, is turn, has strengthened my ability to support and engage with school and university colleagues in their own research and enquiry-based endeavours. Finally, I am looking forward to sharing and deploying the model for teacher evaluation in primary mathematics in my future work with schools.

References

Addis, Mark., & Winch, Christopher. (2018). *Education and Expertise*. John Wiley & Sons, Incorporated. http://capitadiscovery.co.uk/chi-ac/items/dda-2/EBC5516384

Alexander, R. (2013). *Curriculum freedom, capacity and leadership in the primary school*. http://eprints.whiterose.ac.uk/76338/1/Alexander_Nat_Coll_curric_capacity.pdf

Alexander, R., Rose, J., & Woodhead, C. (1992). *Curriculum organisation and classroom practice in primary schools : a discussion paper*. Department of Education and Science.

Allen, R. E. S., & Wiles, J. L. (2016). A rose by any other name: participants choosing research pseudonyms. *Qualitative Research in Psychology*, *13*(2), 149–165.

Almutairi, T. (2016). *Teacher evaluation in Kuwait : evaluation of the current system and consideration of risk-based analysis as a principle for further development*. Durham University, 2016. http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsble/edsble.699526

Almutairi, T. S., & Shraid, N. S. (2021). Teacher Evaluation by Different Internal Evaluators: Head of Departments, Teachers Themselves, Peers and Students. In *International Journal of Evaluation and Research in Education* (Vol. 10, pp. 588–597). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/eric/EJ1299262

Almutairi, T., Tymms, P., & Kind, P. (2015). *The Tools of Teacher Evaluation: What Should Be Used in Teacher Evaluation from the Teachers' Perspective*. http://www.cluteinstitute.com/proceedings//?page=260Tel:+44

Argyris, C., & Schön, D. A. (2003). *Theory in practice : increasing professional effectiveness*. Jossey-Bass.

Ark Curriculum Plus. (2023). *Mathematics Mastery Primary*. https://www.arkcurriculumplus.org.uk/our-programmes/primary/mathematics-mastery

Askew, M. (2016). *Transforming primary mathematics : understanding classroom tasks, tools, and talk*. London:Routledge.

Askew, M., Rhodes, V., Brown, M., Wiliam, D., & Johnson, D. &. (1997). *Effective teachers of numeracy : final report (Feb 1997)*. King's College London.

ATM. (2018). *Variation in Mathematics teaching and learning: A collection of writing from ATM Mathematics Teaching* (A. Watson, Ed.). Association of Teachers of Mathematics. https://www.atm.org.uk/shop/Variation-in-mathematics-A-collection-of-writings-from-ATM-Mathematics-Teaching/REA027

Babione, C. (2015). *Practitioner teacher inquiry and research*.

Ball. (2017). *The education debate: Stephen J. Ball, 3rd ed*. Bristol Policy Press. http://prism.librarymanagementcloud.co.uk/chi-ac/items/487256

Ball, S. J. (2003). The Teacher's Soul and the Terrors of Performativity. *Journal of Education Policy*, *18*(2), 215–228.

Barron, A. B., Hebets, E. A., Cleland, T. A., Fitzpatrick, C. L., Hauber, M. E., & Stevens, J. R. (2015). Embracing multiple definitions of learning. *Trends in Neurosciences*, *38*(7), 405–407. https://doi.org/10.1016/J.TINS.2015.04.008

Bassey, M. (1999). *Case study research in educational settings*. Open University Press. https://ebookcentral.proquest.com/lib/reading/detail.action?docID=6212101

Bates, J., Lewis, S., & Pickard, A. (2019). *Education policy, practice and the professional*. Bloomsbury Academic.

BERA. (2018). *Ethical guidelines for educational research* (4th ed.). British Educational Research Association.

Berger, J. L., & Van, K. L. (2019). Teacher professional identity as multidimensional: mapping its components and examining their associations with general pedagogical beliefs. *Educational Studies*, *45*(2), 163–181. https://doi.org/10.1080/03055698.2018.1446324

Berliner, D. C. (2005). The near impossibility of testing for teacher quality. *Journal of Teacher Education*, *56*(3), 205–213. https://doi.org/10.1177/0022487105275904

Bethke, L., Bird, L., Sigsgaard, M., & MacEwen, L. (2015). *Overview: incorporating safety, resilience, and social cohesion in education sector planning*. UNESCO IIEP, UNESCO International Bureau of Education & Education Above All Foundation.

Biesta, G. (2016). *The beautiful risk of education*. Routledge. http://capitadiscovery.co.uk/chi-ac/items/dda-2/EBC4185950

Bloom, B. S. (1968). *Learning for Mastery. Instruction and Curriculum. Regional Education Laboratory for the Carolinas and Virginia, Topical Papers and Reprints, Number 1.* Regional Education Laboratory for the Carolinas and Virginia.

Boylan, M. (2019). *Remastering mathematics: Mastery, remixes and mash ups*. www.atm.org.uk

Braun, V., & Clarke, V. (2022). *Thematic analysis: a practical guide*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/532779

Braun, V., & Clarke, V. (2023). Towards good practice in thematic analysis: Avoiding common problems and be(com)ing a knowing researcher. *International Journal of Transgender Health*, *24*(1), 1–6.

Breakell, John. (2002). *The teaching of Mathematics in schools in England and Wales during the early years of the Schools Council 1964 to 1975.*

Brown, M. (2014). The Cockcroft Report: Time past, time present and time future. In *MATHEMATICS TEACHING -DERBY-* (pp. 5–10). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsbl/RN362004330

Brown, T., & McNamara, Olwen. (2011). *Becoming a mathematics teacher: identity and identifications*. Springer. http://prism.librarymanagementcloud.co.uk/chi-ac/items/476471

Bruner, J. S. (1982). *Toward a theory of instruction.* Harvard University Press.

Campbell, Anne., Gilroy, Peter., & McNamara, Olwen. (2009). *Practitioner research and professional development in education*. Chapman.

Cartwright, S. (2002). Double-Loop Learning: A Concept and Process for Leadership Educators . *Journal of Leadership Education*, *1*(1).

Charalambous, C. Y., & Litke, E. (2018). Studying instructional quality by using a content-specific lens: the case of the Mathematical Quality of Instruction framework. *ZDM - Mathematics Education*, *50*(3), 445–460. https://doi.org/10.1007/s11858-018-0913-9

Chen, O., Watson, A., & Ollerton, M. (2021). Mathematics teaching: Professional knowledge and cognitive load theory. *Mathematics Teaching*, *275*, 31–34.

Christianakis, M. (2010). Collaborative Research and Teacher Education. *Issues in Teacher Education*, *19*(2), 109–125.

Christie, C. A., & Klein, B. M. (2015). Developing a Community of Practice: Learning and Transformation through Evaluation. In K. E. Ryan & J. B. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 357–374). SAGE.

Cockcroft, W. H. (1986). *Mathematics counts : report of the Committee of Inquiry into the Teaching of Mathematics in Schools*. Her Majesty's Stationery Off.

Coe, R., Aloisi, C., Higgins, S., & Major, L. E. (2014). *What makes great teaching ? Review of the underpinning research*. *October*, 57. http://www.suttontrust.com/researcharchive/great-teaching/

Cohen, L., Manion, L., & Morrison, K. (Keith R. B.). (2017). *Research methods in education, Eighth edition.* Routledge. http://prism.librarymanagementcloud.co.uk/chi-ac/items/513949

Day, C., & Gu, Q. (2010). *The New Lives of Teachers* (1st ed). Routledge.

Denzin, N. K., & Lincoln, Y. S. (2017). *The SAGE handbook of qualitative research, Fifth edition.* SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/509803

Department for Education. (2010). *The importance of teaching*. The Stationery Office Limited.

DfE. (2013). *Mathematics programmes of study: key stages 1 and 2 National curriculum in England*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335158/PRIMARY_national_curriculum_-_Mathematics_220714.pdf

DfE. (2016). *Educational excellence everywhere*.

Donaldson, M. L., & Firestone, W. (2021). Rethinking teacher evaluation using human, social, and material capital. *Journal of Educational Change*, *22*(4), 501–534. https://doi.org/10.1007/s10833-020-09405-z

Drury, H. (2015). *Mastering mathematics : teaching to transform achievement*. Oxford University Press.

Ellis, V. (2009). *Subject Knowledge and Teacher Education The Development of Beginning Teachers' Thinking*. London: Bloomsbury.

Ernest, P. (1991). *The philosophy of mathematics education*. London: Routledge.

Ernest, P. (1996). *Constructing mathematical knowledge : epistemology and mathematics education*. London: Falmer.

Ernest, P. (2014). What is mathematics and why learn it? In P. Andrews & T. Rowland (Eds.), *Mathematics Education: International Perspectives on teaching and learning*.

Etherington, Kim. (2004). *Becoming a reflexive researcher: using our selves in research*. Jessica Kingsley Publishers. http://prism.librarymanagementcloud.co.uk/chi-ac/items/dda-2/EBC290568

Fenstermacher, G. D. (1994). The Knower and the Known: The Nature of Knowledge in Research on Teaching. *Review of Research in Education*, *20*, 3.

Fenstermacher, G. D., & Richardson, V. (2005). On Making Determinations of Quality in Teaching. *Teachers College Record*, *107*(1), 186–213.

Fidan, T., & Balcı, A. (2017). Managing schools as complex adaptive systems: A strategic perspective. *International Electronic Journal of Elementary Education*, *10*(1), 11–26. https://doi.org/10.26822/iejee.2017131883

Firestone, W. A., & Donaldson, M. L. (2019). Teacher evaluation as data use: what recent research suggests. In *Educational Assessment, Evaluation and Accountability* (Vol. 31, Issue 3, pp. 289–314). Springer Netherlands. https://doi.org/10.1007/s11092-019-09300-z

Fleming, Ted., & Murphy, M. (Mark T. F.). (2010). *Habermas, critical theory and education*. Routledge. http://prism.librarymanagementcloud.co.uk/chi-ac/items/dda-2/EBC460268

Flores, M. A., & Derrington, M. L. (2017). School principals' views of teacher evaluation policy: lessons learned from two empirical studies. *International Journal of Leadership in Education*, *20*(4), 416–431.

Floyd, A. (2012). Narrative and Life History. In A. Briggs, M. Coleman, & M. Morrison (Eds.), *Research Methods in Educational Leadership & Management* (3rd ed.). SAGE Publications Ltd. https://doi.org/10.4135/9781473957695

Freire, P. (1996). *Pedagogy of the oppressed, Rev. ed.* Penguin. http://capitadiscovery.co.uk/chi-ac/items/231589

Freire, P. (1998). *Pedagogy of freedom : ethics, democracy, and civic courage*.

Gaiman, N. (2021). *Art Matters: Because your imagination can change the world*. Headline.

Gardner, J. (2007). Is teaching a "partial" profession? *Make the Grade*, *Summer*, 18–21. https://www.researchgate.net/publication/324165229_Is_teaching_a_'partial'_profession

Gilbert, N. (2008). *Researching social life, 3rd ed.* http://prism.librarymanagementcloud.co.uk/chi-ac/items/436300

Gillham, Bill. (2000). *Case study research methods*. Continuum. http://prism.librarymanagementcloud.co.uk/chi-ac/items/372709

Gillham, Bill. (2005). *Research interviewing: the range of techniques*. Open University Press. http://prism.librarymanagementcloud.co.uk/chi-ac/items/408889

Greene, S., & Hogan, Diane. (2005). *Researching children's experiences: methods and approaches*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/474652

Groundwater-Smith, S., Mitchell, J., Mockler, N., Ponte, P., & Ronnerman, K. (2013). *Facilitating practitioner research : developing transformational partnerships*. Routledge. http://site.ebrary.com/id/10589007

Hall, E., & Wall, K. (2019). *Research methods for understanding professional learning*. Bloomsbury.

Hallinger, P., Heck, R. H., & Murphy, J. (2014). Teacher evaluation and school improvement: An analysis of the evidence. In *Educational Assessment, Evaluation and Accountability* (Vol. 26, Issue 1, pp. 5–28). Kluwer Academic Publishers. https://doi.org/10.1007/s11092-013-9179-5

Hammersley, M. (2013). *What is Qualitative Research?* (1st ed.). Bloomsbury Academic. https://doi.org/10.5040/9781849666084

Hammersley, Martyn. (2008). *Questioning qualitative inquiry: critical essays*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/448660

Harris, D. N., Ingle, W. K., & Rutledge, S. A. (2014). How Teacher Evaluation Methods Matter for Accountability: A Comparative Analysis of Teacher Effectiveness Ratings by Principals and Teacher Value-Added Measures. In *American Educational Research Journal* (Vol. 51, p. 73). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsjsr/edsjsr.24546670

Hiebert, J., Gallimore, R., & Stigler, J. W. (2002). A Knowledge Base for the Teaching Profession: What Would It Look Like and How Can We Get One? *Educational Researcher*, *31*(5), 3–15. https://doi.org/10.3102/0013189X031005003

Hill, H. C., & Grossman, P. (2013). Learning from Teacher Observations: Challenges and Opportunities Posed by New Teacher Evaluation Systems. In *Harvard Educational Review* (Vol. 83, pp. 371–385). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/eric/EJ1017296

Hopkins, E., Hendry, H., Garrod, F., McClare, S., Pettit, D., Smith, L., Burrell, H., & Temple, J. (2016). Teachers' views of the impact of school evaluation and external inspection processes. *Improving Schools*, *19*(1), 52–61. https://doi.org/10.1177/1365480215627894

Hoyle, Eric., & John, P. D. (1995). *Professional knowledge and professional practice*. Cassell. http://capitadiscovery.co.uk/chi-ac/items/212809

Isoda, M. (2007). Japanese lesson study in mathematics: Its impact, diversity and potential for educational improvement. *World Scientific.*

Jarke, J., & Breiter, A. (2019). Editorial: the datafication of education. *Learning, Media and Technology*, *44*(1), 1–6. https://doi.org/10.1080/17439884.2019.1573833

Kelly, M., & Knight, J. (2019). *Why Teacher Autonomy Is Central to Coaching Success » Instructional Coaching Group*. https://www.instructionalcoaching.com/why-teacher-autonomy-is-central-to-coaching-success/

Kershner, B., & Mcquillan, P. (2016). Complex Adaptive Schools: Educational Leadership and School Change. In *An International Journal of Complexity and Education* (Vol. 13, Issue 1, pp. 4–29).

Knight, G. (2020). Why Teacher Autonomy Is Central to Coaching? In *Instructional Coaching Group*. https://www.instructionalcoaching.com/article-why-teacher-autonomy-is-central-to-coaching/

Knight, J. (2017). *The Impact Cycle*. https://www.instructionalcoaching.com/wp-content/uploads/2016/03/Jimknight_Workbook_7_14_KUCRL.pdf

Knowles, M. S., Holton, E. F., Swanson, R. A., & Robinson, P. A. (2020). *The adult learner : the definitive classic in adult education and human resource development* (9th ed.). London: Routledge.

Korthagen, F. (2017). Inconvenient truths about teacher learning: towards professional development 3.0. *Teachers and Teaching: Theory and Practice*, *23*(4), 387–405. https://doi.org/10.1080/13540602.2016.1211523

Kvale, S., & Brinkmann, Svend. (2009). *InterViews: learning the craft of qualitative research interviewing, 2nd ed.* Sage Publications. http://prism.librarymanagementcloud.co.uk/chi-ac/items/398417

Lawrenz F., Kollmann E., King J. (2018). Promoting evaluation capacity building in a complex adaptive system. *Evaluation and Programme Planning (69) 53-60*

Leshem, S., & Trafford, V. (2007). Overlooking the conceptual framework. In *Innovations in Education and Teaching International* (Vol. 44, Issue 1, pp. 93–105). https://doi.org/10.1080/14703290601081407

Levin-Rozalis. M, Rosenstein, B., & Cousins, J. B. (2015). A Precarious Balance: Educational Evaluation Capacity Building in a Globalized Society. In K. E. Ryan & J. B. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 191–212).

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage. http://prism.librarymanagementcloud.co.uk/chi-ac/items/45146

Liu, S., & Zhao, D. (2013). Teacher evaluation in China: Latest trends and future directions. *Educational Assessment, Evaluation and Accountability*, *25*(3), 231–250. https://doi.org/10.1007/s11092-013-9168-8

Lo, M. L., Marton, F., Lo, & Marton. (2011). Towards a science of the art of teaching : Using variation theory as a guiding principle of pedagogical design. In *International Journal for Lesson and Learning Studies* (Vol. 1, pp. 7–23). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsemr/edsemr.10.1108.20468251211179678

Lofthouse, Rachel., Leat, David., Towler, Carl., & Trust., C. E. (2010). *Coaching for teaching and learning : a practical guide for schools : guidance report*. CFBT Education Trust.

Looney, J. (2011). Developing High-Quality Teachers: teacher evaluation for improvement. In *European Journal of Education* (Vol. 46, p. 440). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsjsr/edsjsr.41343393

Maths - No Problem! (2023). *The Maths - No Problem! Programme*. https://mathsnoproblem.com/en/approach/maths-no-problem-programme

Matsopoulos, A. S., Griva, A.-M., Psinas, P., & Monastirioti, I. (2018). Teacher evaluation in the era of globalization: Teachers' views on evaluation, quality, and resilience in the Greek educational system. *Community Psychology in Global Perspective*, *4*(1), 1–19.

Mayer, D., & Mills, M. (2020). Professionalism and teacher education in Australia and England. *European Journal of Teacher Education*, *44*(1), 1–17.

McNiff, J. (2013). *Action research: principles and practice, 3rd ed.* London: Routledge.

Moore, N., Coldwell, M., & Perry, E. (2021). Exploring the role of curriculum materials in teacher professional development. *Professional Development in Education, 47(2-3), 331-347.*

Murphy, R., Weinhardt, F., Wyness, G., & Rolfe, H. (2017). *Lesson Study Evaluation report and executive summary Independent evaluators*. www.educationendowmentfoundation.org.uk

Mynott, J. (2019). Lesson Study Outcomes: a theoretical model. *International Journal for Lesson and Learning Studies,*. https://doi.org/10.1108/IJLLS-08-2018-0057

Mynott, J. (2020). Dysfunctional Collaboration-when lesson study collaboration needs help! *CollectivED*, *10*, 34–39.

NCETM. (2014). *Mastery approaches to mathematics and the new national curriculum*. http://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf

NCETM. (2023a). *Mastery Specialists*. https://www.ncetm.org.uk/teaching-for-mastery/mastery-opportunities/mastery-specialists/

NCETM. (2023b). *Five Big Ideas in Teaching for Mastery*. https://www.ncetm.org.uk/teaching-for-mastery/mastery-explained/five-big-ideas-in-teaching-for-mastery/

NCETM. (2023c). *Maths Hubs*. https://www.ncetm.org.uk/maths-hubs/

NCETM. (2023d). *Supporting research, evidence and argument*.

NCETM. (2023e). *Teaching for Mastery*.

Nevo, D. (2006). Evaluation in Education. In I. F. Shaw, J. C. Greene, & M. M. Mark (Eds.), *The Sage Handbook of Evaluation* (pp. 441–460). SAGE.

Nevo, D. (2015). Accountability and Capacity Building: Can They Live Together? . In K. E. Ryan & J. B. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 291–304).

Newby, P. (2014). *Research methods for education* (2nd ed). Routledge.

Niessen, T. J. H., Abma, T. A., Widdershoven, G. A. M., & van der Vleuten, C. P. M. (2015). Learning-in-(Inter)Action A Dialogical Turn to Evaluation and Learning. In K. E. Ryan & B. J. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 375–394).

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria . In *International Journal of Qualitative Methods* (Vol. 16, Issue 1, pp. 1–13). SAGE Publications . https://doi.org/10.1177/1609406917733847

Oeberst, A., & Imhoff, R. (2023). Toward Parsimony in Bias Research: A Proposed Common Framework of Belief-Consistent Information Processing for a Set of Biases. *Perspectives on Psychological Science*, 174569162211481. https://doi.org/10.1177/17456916221148147

Ofsted. (2022a). *School Inspection Handbook*.

Ofsted. (2022b). *School Monitoring Handbook*.

Ofsted. (2023). *Schools commentary: Deep dives in school inspections*. Gov.Uk.

O'Leary, M. (2020). *Classroom Observation: A guide to the effective observation of teaching and learning*. Routledge.

O'Leary, M., & Savage, S. (2020). Breathing new life into the observation of teaching and learning in higher education: moving from the performative to the informative. *Professional Development in Education*, *46*(1), 145–159.

Ollerton, M., Stratton, J., & Watson, A. (2020). Inquisitive about inquiry? Loaded with cognitive load? Part 2. *Mathematics Teaching*, *271*, 35–39. www.atm.org.uk

O'Reilly, K. (2009). *Key Concepts in Ethnography*. SAGE.

Painter, S. R. (2000). Principals' efficacy beliefs about teacher evaluation. In *Journal of Educational Administration* (Vol. 38, Issue 4, pp. 957–8234). # MCB University Press. http://www.emerald-library.com

Paufler, N. A., & Clark, C. (2019). Reframing conversations about teacher quality: school and district administrators' perceptions of the validity, reliability, and justifiability of a new teacher evaluation system. *Educational Assessment, Evaluation and Accountability*, *31*(1), 33–60. https://doi.org/10.1007/s11092-019-09292-w

Pearson. (2023). *Power Maths*. Pearson Education. https://www.pearsonschoolsandfecolleges.co.uk/primary/subjects/mathematics/power-maths

Pritchard, A., & Woollard, J. (2010). *Psychology for the classroom: constructivism and social learning*. Routledge. http://capitadiscovery.co.uk/chi-ac/items/dda-2/EBC515360

Punch, Keith. (1998). *Introduction to social research: quantitative and qualitative approaches*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/326083

Rallis, S. F., & Militello, M. (2015). Inquiry-Minded District Leaders: Evaluation as Inquiry, Inquiry as Practice . In K. E. Ryan & J. B. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 253–272).

Reynolds, D., Muijs, D., & Treharne, D. (2003). Teacher Evaluation and Teacher Effectiveness in the United Kingdom. In *Journal of Personnel Evaluation in Education* (Vol. 17, Issue 1).

Robinson, C. (2018). Engaging with pupils: Listening to the voices of children and young people. In T. Cremin & C. Burnett (Eds.), *Learning to teach in the Primary School* (4th ed.).

Rogers, P. J., & Williams, B. (2006). Evaluation for Practice Improvement and Organizational Learning. In I. F. Shaw, J. C. Greene, & M. M. Mark (Eds.), *The Sage Handbook of Evaluation* (pp. 76–97). SAGE.

Rowland, T., Turner, F., Thwaites, A., & Huckstep, P. (2009). *Developing Primary Mathematics Teaching: Reflecting on Practice with the Knowledge Quartet*. SAGE Publications Ltd.

Ryan, K. E., & Feller, I. (2015). Evaluation, Accountability and Performance Measurement in National Education Systems: Trends, Methods and Issues. In K. E. Ryan & J. B. Cousins (Eds.), *The Sage International Handbook of Educational Evaluation* (pp. 171–190).

Schoenfeld, A. H., Floden, R., El Chidiac, F., Gillingham, D., Fink, H., Hu, S., Sayavedra, A., Weltman, A., & Zarkh, A. (2018). On Classroom Observations. *Journal for STEM Education Research*, *1*(1–2), 34–59. https://doi.org/10.1007/s41979-018-0001-7

Shulman, L. S. (1985). *Those who understand : knowledge growth in teaching*. CERAS, School of Education, Stanford University.

Shulman, L. S. (2005). Signature Pedagogies in the Professions. *Daedalus*, *134*(3), 52–59. https://www.jstor.org/stable/pdf/20027998.pdf?refreqid=excelsior%3A8f45f1a8ee48aecb079e1a7271aaa16c&ab_segments=&origin=&initiator=&acceptTC=1

Skemp, R. R. (2006). Relational Understanding and Instrumental Understanding. *Mathematics Teaching in the Middle School*, *12*(2), 88–95.

Stahl, N. A., & King, J. R. (2020). Expanding Approaches for Research: Understanding and Using Trustworthiness in Qualitative Research. *Journal of Developmental Education*, *44*(1), 26–28.

Stake, R. E. (1995). *The art of case study research*. Sage. http://prism.librarymanagementcloud.co.uk/chi-ac/items/222928

Stancic, M. (2015). Teachers' reflections upon evaluation of their work. *Nastava i Vaspitanje : Časopis Pedagoškog Društva SR Srbije i Pedagoškog Društva SR Črne Gore*, *65*(4), 697–713.

Steadman, S. (2023). *Identity*. Bloomsbury Academic.

Stevenson, H. (2017). The "Datafication" of Teaching: Can Teachers Speak Back to the Numbers? In *Peabody journal of education* (Vol. 92, pp. 537–558). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsbl/vdc.100048802589.0x000001

Symon, Gillian., & Cassell, Catherine. (2004). *Essential guide to qualitative methods in organizational research*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/398421

Taubman, P. (2009). *Teaching by numbers: deconstructing the discourse of standards and accountability in education*. Routledge. http://prism.librarymanagementcloud.co.uk/chi-ac/items/dda-2/EBC460352

Thomson, P. (2011). Coming to terms with "Voice." In G. Czerniawski & W. Kidd (Eds.), *Student Voice Handbook: Bridging the Academic/Practitioner Divide*. Emerald Group Publishing Limited. https://books.google.co.uk/books?id=pTaoFaYfn2MC

Tidbury, F. (2019). A mastery approach: Taking the long view. *Mathematics Teaching*, *266*, 19–20. https://www.atm.org.uk/write/MediaUploads/Journals/MT266/MT26606.pdf

Tillin, J. (2023). The university role in new teacher learning – why it matters: Teach First trainee perspectives. *London Review of Education*, *21*(1). https://doi.org/10.14324/lre.21.1.03

Toch, T. (2008). Fixing Teacher Evaluation. In *Educational Leadership* (Vol. 66, pp. 32–38). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/eric/EJ814363

Tomo, A., & de Gennaro, D. (2019). *Professional identity crisis : balancing the internal and external perception of professional image*. https://www.emeraldinsight.com/doi/book/10.1108/9781787698055

Turner, Sylvia. (2013). *Teaching primary mathematics*. SAGE.

Tuytens, M., Devos, G., & Vanblaere, B. (2020). An integral perspective on teacher evaluation: a review of empirical studies. In *Educational Assessment, Evaluation and Accountability* (Vol. 32, Issue 2, pp. 153–183). Springer Science and Business Media B.V. https://doi.org/10.1007/s11092-020-09321-z

Walkington, C., & Marder, M. (2018). Using the UTeach Observation Protocol (UTOP) to understand the quality of mathematics instruction. *ZDM - Mathematics Education*, *50*(3), 507–519. https://doi.org/10.1007/s11858-018-0923-7

Waring, M., Hedges, L. V, Coe, R., & Ashley, L. D. (2021). *Research methods & methodologies in education, 3rd edition.* SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/531928

Wayne, A. J., & Youngs, P. (2003). Teacher Characteristics and Student Achievement Gains: A Review. In *Review of Educational Research* (Vol. 73, pp. 89–123). http://prism.librarymanagementcloud.co.uk/chi-ac/items/eds/edsjsr/edsjsr.3516044

Wellington, L. (2015). *An Exploration of Teachers' Views of Evaluation in a Choice-Based System*.

Wenger, E. (1999). *Communities of practice: learning, meaning, and identity*. Cambridge University Press. http://prism.librarymanagementcloud.co.uk/chi-ac/items/398002

White, R., & Gunstone, R. (1992). *Probing understanding*. Falmer Press. http://prism.librarymanagementcloud.co.uk/chi-ac/items/312870

White Rose Education. (2023). *Primary Maths resources*. https://whiteroseeducation.com/resources/maths/primary

Williams, J. (2013). *Constructing new professional identities : career changers in teacher education*. Sense Publishers.

Williams, P. (2008). *Independent review of mathematics teaching in early years settings and primary schools : final report*. Department for Children, Schools and Families.

Willis, J. (2007). *Foundations of qualitative research: interpretive and critical approaches*. SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/429010

Winch, C. (2004). What do teachers need to know about teaching? A critical examination of the occupational knowledge of teachers. *BJES British Journal of Educational Studies*, *52*(2), 180–196.

Wragg, E., Haynes, G., Wragg, C., & Chamberlin, R. (1999). *Failing Teachers?.* Taylor & Francis Ltd. http://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=240299

Yee, S. P., Rogers, K. C., Miller, E., & Galvin, T. (2022). Collegiate Mathematics Observation Protocols: Current Characteristics and Desired Foci. *International Journal of Research in Undergraduate Mathematics Education*. https://doi.org/10.1007/s40753-022-00199-4

Yin, R. K. (2014). *Case study research: design and methods, Fifth edition.* SAGE. http://prism.librarymanagementcloud.co.uk/chi-ac/items/498737

Yin, R. K. (2017). *Case Study Research and Applications Design and Methods, 6 ed.* SAGE Publications Inc Thousand Oaks, CA. http://prism.librarymanagementcloud.co.uk/chi-ac/items/517616

Zimmerman, L. W. (2009). Reflective Teaching Practice: Engaging in Praxis. *Journal of Theory Construction & Testing*, *13*(2), 46–50. http://search.ebscohost.com/login.aspx?direct=true&db=asx&AN=44882142&site=eds-live

Appendices

Appendix 1: Example of reflective timeline completed by participants.

Appendix 2: Interview Guidelines

Research Questions

- How are 'high-quality mathematics teaching' and 'evaluation processes' defined, understood and implemented in schools?

- What is the impact of recent national developments in curriculum, assessment and pedagogy in primary mathematics on evaluations of the quality of teaching?

- How do the views of teachers, mathematics subject leaders and school leaders within one school and across a group of schools within a MAT intersect?

- How do teachers, mathematics subject leaders and senior leaders understand and identify with the concept of being a 'professional', and how do they perceive autonomy as a key element of this?

- What are school colleagues' perceptions and experiences of the role of external evaluators and how can these inform the role of these individuals in the evaluation of primary mathematics teaching?

Key questions/guidance for 'reflective time line' activity.

Please use the graph to plot your professional life in primary mathematics education.

Please draw onto your graph a separate timeline to represent each of the three ideas and how they have developed or changed over time:

a. Your mathematical subject knowledge;

b. Your experiences as a teacher of mathematics;

c. Your experiences of evaluating the mathematics teaching of others;'

Please annotate onto your graph key experiences and moments that shaped each of your timelines

Indicative questions for semi-structured narrative interview:

Please tell me the story of your professional life in primary maths education.

Do you consider yourself to be a professional? Why/why not?

What does the phrase professional identity mean to you? Do you identify as a mathematics teacher?

What professional knowledge do you consider to be of value for primary teachers of mathematics?

Which experiences have contributed the most to your development as a teacher/evaluator of primary mathematics?

Can you tell me about your experience of being evaluated as a maths teacher? Who was involved? What happened? How did you feel?

Can you tell me about your experience of evaluating others as maths teachers? Who was involved? What happened? How did you feel?

Do you consider autonomy to play a role in the perceptions and experiences of primary mathematics teachers? If so, in what way?

What documentation is used to support the evaluation of mathematics teaching in your experience? Which parts are helpful? Why? Is there anything you would change? Why?

Prompts for expansion on key points

Do you remember anything else about this?

And what happened after that?

Sometimes these timelines can support connections between different elements of experience. Do you think there any such connections evident on your graph?

Date	Interviewee	School	Code	Notes
31.1.22	[redacted]	[redacted]	MSL1	Timeline had been completed but not as intended, despite visual and verbal clarification before the interview. Participant is not currently MSL although did start in that role for the preceding term and will be returning to it. Awareness throughout interview that I was needing to concentrate my focus on the indicative questions and did not probe those that arose from reading (primarily around professional identity) as much as perhaps I could. Although potentially the lack of response could be due to the participant having not fully understood the concept of teacher identity had this not been part of their PD conversation before. There was also a discrepancy in the usage/definition of the word 'autonomy' that did not arise in the pilot interviews – perhaps a shared definition should have been offered? Or again, this could be an interesting point to analyse in terms of professional lexicon/knowledge. Status/power dynamic imbalance due to level of experience and participant awareness of and reference to my role in places.
31.1.22	[redacted]	[redacted]	SLT1	Timeline not completed prior to interview. Participant spent short time (2 minutes) doing this prior to the interview. Indicative of confidence in subject matter/embedded high levels of self-reflection/assurance in own story? Overlapping identities – past MSL/maths advisor Significant emphasis on use of data as evaluation measure and of a focus on CPA. Interesting that participant no longer identifies as a 'maths teacher'. Again, aware of status/power dynamic but more balanced this time, at times even tipped towards participant – aware of feeling slightly overwhelmed and not able to think quickly enough to probe answers/statements of fact – collusion?
1.2.22	[redacted]	[redacted]	SLT2	Teacher/MSL and SLT. ?years qualified Gaining in competence in the management of the interview – more actively listening, more focussed on research themes and coverage of indicative questions. Felt that this interview gave a depth and breadth of data for analysis and aware of themes beginning to emerge; the use of data as a key evaluation tool, a deficiency in the use of mathematical pedagogies or subject-specific knowledge beyond CPA, questioning and the curriculum/scheme of work. Repetition of the benefits of moderation activities as part of CPD that increased confidence in own 'judgements' due to external reassurance/validation – indicative of assimilation into societal/cultural/professional norms. Need to revisit sub questions, and re-focus recruitment of teacher participants
10.2.22	[redacted]	[redacted]	MSL2	QTS 20 years First time of meeting this participant in person. Rapid development of rapport needed. Some responses less rich – as a result of this? Beneficial for long term working relationship. Comparable to MSL1 in terms of length of time in role.

Appendix 4: Participant information and consent form

I would like to invite you to take part in a research study about evaluating the quality of teaching in primary mathematics as part of my doctoral thesis.

What is the study?
The study aims to investigate the perceptions and experiences of teachers, mathematics leaders and senior leaders across the primary age range of the evaluation of the quality of primary mathematics teaching. This will be examined through three conceptual lenses; professional identity, professional knowledge and professional development. The study will provide an opportunity to understand the current context within which improvements in mathematics teaching are set, and hopes to offer recommendations for the development of effective models of professional learning for the development of good primary mathematics teachers.

Why have I been chosen to take part?
You have been invited to take part in the project either because you are a primary school teacher who is responsible for teaching mathematics, or because your work in primary schools includes evaluating mathematics teaching through observations and/or monitoring planning, children's work and data analysis. You can choose whether you identify primarily as 'teacher' or 'evaluator'. You also work within a network of schools local to the researcher's work base and as such, can potentially be met in person for interview. Consent from the headteacher of each participating school has been sought and gained.

Do I have to take part?
It is entirely up to you whether you participate. You may also withdraw at any time during the project, up to April 30th 2022 without any repercussions to you, by contacting the researcher using the details below.

What will happen if I take part?
You will be asked to complete a 'reflective time line' prior to a 1:1 narrative interview. Instructions and guidance on how to complete this will be given beforehand. This visual medium will ask you to reflect on your professional experiences in the teaching of primary mathematics from a starting point at the beginning of teacher training, through to your current role, focusing on measuring key moments against a high/low confidence scale. It will ask you to focus on three timelines; development of mathematical subject knowledge, moments of 'learning' and identity as a 'maths teacher'. The narrative interview will be mediated by this time line and questions and prompts may be used to probe your answers.

The interview will be recorded using audio software. Key sections of the data will be identified and transcribed using transcription software and analysed thematically according to the three conceptual themes.

Any time commitment you are asked to make will be within the following parameters:

You will be invited to consider the time line two weeks prior to your interview, the time and location of which will be set at your convenience between the end of November 2021 and the end of April 2022. It is anticipated that you will spend up to 1 hour on the reflective time line, and allow 1 hour for the narrative interviews.

If your headteacher has given consent, you may also be asked to provide examples of any policies or proformas used as part of the evaluative process of mathematics teaching in your setting. Depending on your specific school context and practices, these could include school professional development policies and guidance documents, subject vision statements, and classroom planning and assessment materials..

What are the risks and benefits of taking part?
The information you give will remain confidential and will only be seen by the researcher and project supervisors. Neither you nor your place of work/schools you might make reference to will be identifiable in any published report resulting from the study. Information about individuals will not be shared with anyone in the department/school/course/workplace.

I anticipate that the findings of the study will be useful for teachers and schools in planning how they support the development of professional knowledge, learning and identity in the teaching of mathematics. A summary of the findings of the main thesis can be made available to you by contacting the researcher.

What will happen to the data?
All information collected will be kept strictly confidential (subject to legal limitations). In order to protect the anonymity of each participant, pseudonyms will be used to ensure participants cannot be identified. The university name will also be changed. All electronic data will be held securely in password protected files on a non-shared PC and all paper documentation will be held in locked cabinets in a locked office.

In line with University policy, data generated by the study will be kept securely in electronic form for a period of five years after the completion of the research project.

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

The University of Reading collects, analyses, uses, shares and retains personal data for the purposes of research in the public interest. Under data protection law we are required to inform you that this use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research

purposes. If you withdraw from a research study, which processes your personal data, dependant on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims. We will always have in place appropriate safeguards to protect your personal data.

If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact either Sam Parkes or Alan Floyd.

You have certain rights under data protection law which are:
Withdraw your consent, for example if you opted in to be added to a participant register
Access your personal data or ask for a copy
Rectify inaccuracies in personal data that we hold about you
Be forgotten, that is your details to be removed from systems that we use to process your personal data
Restrict uses of your data
Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes. You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.uk

You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

What will happen to the results of the research?

The data will be analysed and used in an EdD Thesis. It may also be used in future publications in appropriate academic journals and/or books. If you would like a summary copy of the research findings, these will be sent to you on request.

Who has reviewed the study?

This application has been reviewed following procedures of the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

Name, position and contact address of Researcher	**Name, position and contact address of Supervisor**
Samantha Parkes *Senior Lecturer*	**Dr. Catherine Foley**

School Improvement Specialist - Mathematics University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	*Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

I do hope that you will agree to take part in the study. If you do, please complete the attached consent form and return it via email to s.parkes@chi.ac.uk, or complete a hard copy and return it at the time of your interview. Thank you for your time.

Participant Consent Form

Research Project:

An exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of classroom practice evaluation and development in primary schools.

Name, position and contact address of Researcher	Name, position and contact address of Supervisor
Samantha Parkes *Senior Lecturer* *School Improvement Specialist - Mathematics* University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	**Dr. Catherine Foley** *Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, up to 30th April 2022 without giving reason. ☐

3. I agree to take part in the above study. ☐

Please tick box

	Yes	No
4. I agree to the interview being audio recorded.	☐	☐
5. I agree to the use of anonymised quotations in publications.	☐	☐

Name of Participant	Date	Signature
_____	_____	_____

Appendix 5: Gatekeeper information and consent form

I would like to invite staff of your school to take part in a research study about evaluating the quality of teaching in primary mathematics as part of my doctoral thesis.

What is the study?
The study aims to investigate the perceptions and experiences of teachers, mathematics leaders and senior leaders across the primary age range of the evaluation of the quality of primary mathematics teaching. This will be examined through three conceptual lenses; professional identity, professional knowledge and professional development. The study will provide an opportunity to understand the current context within which improvements in mathematics teaching are set, and hopes to offer recommendations for the development of effective models of professional learning for the development of good primary mathematics teachers.

Why has my school been chosen to take part?
Your school has been invited to take part in the project because you are a primary school in which teachers are responsible for teaching mathematics, and members of your staff team hold responsibility for evaluating mathematics teaching through observations and/or monitoring planning, children's work and data analysis. You also work within a network of schools local to the researcher's work base and as such, participants can potentially be met in person for interview.

Do I have to take part?
It is entirely up to you whether you consent for your school's staff to participate. You may also withdraw your consent for them to participate at any time during the project, up to the end of April 2022 without any repercussions to you, by contacting the researcher using the details below.

What will happen if my school takes part?
Participants will be asked to complete a 'reflective time line' prior to a 1:1 narrative interview. Instructions and guidance on how to complete this will be given beforehand. This visual medium will ask them to reflect on their professional experiences in the teaching/evaluating of primary mathematics from a starting point at the beginning of teacher training, through to their current role, focusing on measuring key moments against a high/low confidence scale. It will ask them to focus on three timelines; development of mathematical subject knowledge, moments of 'learning' and identity as a 'maths teacher'. The narrative interview will be mediated by this time line and questions and prompts may be used to probe answers.

The interview will be recorded using audio software. Key sections of the data will be identified and transcribed using transcription software and analysed thematically according to the three conceptual themes.

Any time commitment they are asked to make will be within the following parameters:

They will be invited to consider the time line two weeks prior to interview, the time and location of which will be set at the participant's convenience between the end of November 2021 and the end of April 2022. It is anticipated that they will spend up to 1 hour on the reflective time line, and allow 1 hour for the narrative interviews.

You and your staff will also be asked to consent to the sharing of policies and proformas used as part of the evaluative process of mathematics teaching in your setting. Depending on your specific school context and practices, these could include school professional development policies and guidance documents, subject vision statements, and classroom planning and assessment materials. School anonymity will be ensured through the removal of all identifying names and features such as school logos, whole documents will not be reproduced and short excerpts will only be included in the final report for where key features are necessary to support analysis.

What are the risks and benefits of taking part?
The information participants give will remain confidential and will only be seen by the researcher and project supervisors. Neither they nor your place of work/schools that might be made reference to will be identifiable in any published report resulting from the study. Information about individuals will not be shared with anyone in the department/school/course/workplace.

I anticipate that the findings of the study will be useful for teachers and schools in planning how they support the development of professional knowledge, learning and identity in the teaching of mathematics. A summary of the findings of the main thesis can be made available to you by contacting the researcher.

What will happen to the data?
All information collected will be kept strictly confidential (subject to legal limitations). In order to protect the anonymity of each participant, pseudonyms will be used to ensure participants cannot be identified. The university name will also be changed. All electronic data will be held securely in password protected files on a non-shared PC and all paper documentation will be held in locked cabinets in a locked office.

In line with University policy, data generated by the study will be kept securely in electronic form for a period of five years after the completion of the research project.

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

The University of Reading collects, analyses, uses, shares and retains personal data for the purposes of research in the public interest. Under data protection law we are required to inform

you that this use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research purposes. If you withdraw from a research study, which processes your personal data, dependant on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims. We will always have in place appropriate safeguards to protect your personal data.

If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact either Sam Parkes or Alan Floyd.

You have certain rights under data protection law which are:
Withdraw your consent, for example if you opted in to be added to a participant register
Access your personal data or ask for a copy
Rectify inaccuracies in personal data that we hold about you
Be forgotten, that is your details to be removed from systems that we use to process your personal data
Restrict uses of your data
Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes.
You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.uk

You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

What will happen to the results of the research?
The data will be analysed and used in an EdD Thesis. It may also be used in future publications in appropriate academic journals and/or books. If you would like a summary copy of the research findings, these will be sent to you on request.

Who has reviewed the study?
This application has been reviewed following procedures of the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

Name, position and contact address of Researcher	**Name, position and contact address of Supervisor**
Samantha Parkes	**Dr. Catherine Foley**

Senior Lecturer *School Improvement Specialist - Mathematics* University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	*Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

I do hope that you will agree to your school staff taking part in the study. If you do, please complete the attached consent form and return it via email to s.parkes@chi.ac.uk. Thank you for your time.

Gatekeeper Consent Form

Research Project:

An exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of classroom practice evaluation and development in primary schools.

Name, position and contact address of Researcher	**Name, position and contact address of Supervisor**
Samantha Parkes *Senior Lecturer* *School Improvement Specialist - Mathematics* University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	**Dr. Catherine Foley** *Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

Please initial box

2.	I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	☐
3.	I understand that my consent is voluntary and that I am free to withdraw at any time up to 30th April 2022, without giving reason.	☐
3.	I give my consent for the above study to take place.	☐
4.	I give my consent for access to school documentation as detailed in the information sheet	☐

Name of Gatekeeper	Date	Signature

Appendix 6: Ethical Approval

University of Reading
Institute of Education
Ethical Approval Form A (version May 2019)

Tick one:
Staff project: _____ PhD ____ EdD _/_

Name of applicant (s): Samantha Parkes

Title of project: An exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of classroom practice evaluation and development in primary schools.

Name of supervisor (for student projects): Catherine Foley

Please complete the form below including relevant sections overleaf.

	YES	NO
Have you prepared an Information Sheet for participants and/or their parents/carers that:		
a) explains the purpose(s) of the project	/	
b) explains how they have been selected as potential participants	/	
c) gives a full, fair and clear account of what will be asked of them and how the information that they provide will be used	/	
d) makes clear that participation in the project is voluntary	/	
e) explains the arrangements to allow participants to withdraw at any stage if they wish	/	
f) explains the arrangements to ensure the confidentiality of any material collected during the project, including secure arrangements for its storage, retention and disposal	/	
g) explains the arrangements for publishing the research results and, if confidentiality might be affected, for obtaining written consent for this	/	
h) explains the arrangements for providing participants with the research results if they wish to have them	/	
i) gives the name and designation of the member of staff with responsibility for the project together with contact details, including email . If any of the project investigators are students at the IoE, then this information must be included and their name provided	/	
k) explains, where applicable, the arrangements for expenses and other payments to be made to the participants		N/A
j) includes a standard statement indicating the process of ethical review at the University undergone by the project, as follows: 'This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct'.	/	
k)includes a standard statement regarding insurance: "The University has the appropriate insurances in place. Full details are available on request".	/	
Please answer the following questions		
1) Will you provide participants involved in your research with all the information necessary to ensure that they are fully informed and not in any way deceived or misled as to the purpose(s) and nature of the research? (Please use the subheadings used in the example information sheets on blackboard to ensure this).	/	
2) Will you seek written or other formal consent from all participants, if they are able to provide it, in addition to (1)?	/	

3) Is there any risk that participants may experience physical or psychological distress in taking part in your research?		/	
4) Staff Only - have you taken the online training modules in data protection and information security (which can be found here: http://www.reading.ac.uk/internal/humanresources/PeopleDevelopment/newstaff/humres-MandatoryOnlineCourses.aspx Please note: students complete a Data Protection Declaration form and submit it with this application to the ethics committee.		N/A	
5) Have you read the Health and Safety booklet (available on Blackboard) and completed a Risk Assessment Form to be included with this ethics application?	/		
6) Does your research comply with the University's Code of Good Practice in Research?	/		
	YES	NO	N.A.
7) If your research is taking place in a school, have you prepared an information sheet and consent form to gain the permission in writing of the head teacher or other relevant supervisory professional?	//		
8) Has the data collector obtained satisfactory DBS clearance?	/		
9) If your research involves working with children under the age of 16 (or those whose special educational needs mean they are unable to give informed consent), have you prepared an information sheet and consent form for parents/carers to seek permission in writing, or to give parents/carers the opportunity to decline consent?			/
10) If your research involves processing sensitive personal data[1], or if it involves audio/video recordings, have you obtained the explicit consent of participants/parents?	/		
11) If you are using a data processor to subcontract any part of your research, have you got a written contract with that contractor which (a) specifies that the contractor is required to act only on your instructions, and (b) provides for appropriate technical and organisational security measures to protect the data?			/
12a) Does your research involve data collection outside the UK?		/	
12b) If the answer to question 12a is "yes", does your research comply with the legal and ethical requirements for doing research in that country?			/
13a) Does your research involve collecting data in a language other than English?		/	
13b) If the answer to question 13a is "yes", please confirm that information sheets, consent forms, and research instruments, where appropriate, have been directly translated from the English versions submitted with this application.			/
14a. Does the proposed research involve children under the age of 5?		/	
14b. If the answer to question 14a is "yes": My Head of School (or authorised Head of Department) has given details of the proposed research to the University's insurance officer, and the research will not proceed until I have confirmation that insurance cover is in place.			/
If you have answered YES to Question 3, please complete Section B below		/	

- Complete **either** Section A **or** Section B below with details of your research project.
- Complete a risk assessment.
- Sign the form in Section C.
- Append at the end of this form all relevant documents: information sheets, consent forms, tests, questionnaires, interview schedules, evidence that you have completed information security training (e.g. screen shot/copy of certificate).
- Email the completed form to the Institute's Ethics Committee for consideration.

[1] Sensitive personal data consists of information relating to the racial or ethnic origin of a data subject, their political opinions, religious beliefs, trade union membership, sexual life, physical or mental health or condition, or criminal offences or record.

Any missing information will result in the form being returned to you.

A: My research goes beyond the 'accepted custom and practice of teaching' but I consider that this project has **no** significant ethical implications. (Please tick the box.)	/

Please state the total number of participants that will be involved in the project and give a breakdown of how many there are in each category e.g. teachers, parents, pupils etc

12-15 participants in total

4/5 generalist primary teachers (who teach mathematics to whole classes of primary age children at least 3 times a week)
4/5 primary mathematics subject leaders
4/5 senior leaders of of infant/junior/primary schools (assistant/deputy headteachers/headteachers) with regular responsibility for evaluating mathematics teaching

Give a brief description of the aims and the methods (participants, instruments and procedures) of the project:

A study of the perceptions and experiences of those involved (as listed above) in the evaluative process of the quality of primary mathematic teaching.

The project aims to explore instances of experience and learning that influence the development of mathematical subject knowledge and professional identity limited to the views of teachers and those of professionals who conduct evaluations as part of their role within a single school.

Participants will be asked to complete a 'reflective time line' prior to a 1:1 semi-structured interview. This visual medium will ask them to reflect on their professional life from a starting point at the beginning of teacher training, through to their current role, focusing on reflecting on key moments in their career. They will be asked to focus on three timelines; mathematical subject knowledge; experiences as a teacher of mathematics; and experiences of evaluating the mathematics teaching of others. The interview will be mediated by these 'reflective time lines' and a list of questions and prompts (included with this application) will be used. The interviews will be recorded using audio software. Key sections of the data will be identified and transcribed using transcription software and analysed thematically according to the three conceptual themes (professional identity, professional knowledge and professional development).

All participants will also be asked to provide examples of any policies or proformas used as part of the evaluative process of mathematics teaching. These proformas could include (depending on the specific school's systems) school professional development policies and guidance documents, subject vision statements, and classroom planning and assessment materials and explicit consent will be sought from the gatekeeper and participants regarding the sharing of these. Analysis of these materials will draw on the same thematic coding as the interviews and explore synthesis of and/or contradictions in espoused and enacted practices.
Initially, gatekeeper consent will be sought from the headteachers of each school for members of their staff team to participate and for access to any documents that are used within the school to support the evaluation of mathematics teaching. The 12-15 participants will then be recruited through targeted sampling of a pool of local University and Academy Trust partnership primary schools according to their level of responsibility for teaching and/or evaluating mathematics, and convenience sampling according to their location, availability and obtaining the required number of participants across roles (teacher/mathematics subject leader/member of senior leadership team). Participants will be classed as 'teachers' of mathematics if they have responsibility for the planning, teaching and assessing of whole class mathematics lessons in any primary phase year group. They will be classed as 'evaluators' if their role

includes the monitoring and evaluation of mathematic teaching including the form of observations, monitoring of planning, children's work and data analysis. Due to the nature of career progression in primary schools, it is likely that all 'evaluators' will have past and potentially current experience of 'teaching' and so they will be asked to self-identity their primary role at the time of interview.

Information and consent forms will be provided to headteachers and all participants (see attached). Evaluation of the experience of participating will be sought as part of debriefing. The potential risk of harm or distress to participants is low, however the evaluation process will offer the opportunity for reflection should the interview raise any significant realisations and participants will be informed of their right to withdraw at any point without detriment.

The participants will be invited to consider their reflective time lines prior to interview within a two-week period of notice between end of November 2021 and end of April 2022. It is anticipated that the participants will spend 1 hour on the reflective time lines activity, and allow1 hour for the narrative interviews.

It is acknowledged that the two hour time commitment is a potential source of challenge for the participants. In order to mitigate the potential impact of this, the interviews will be conducted at the participants' convenience in terms of time and location.

All interviews and exchange of documentation will take place in a Covid-secure way in line with current government guidance and following the Covid risk-assessment of the school and the option to conduct interviews online will remain should this become necessary or preferable for either the researcher or the participants.

B: I consider that this project **may** have ethical implications that should be brought before the Institute's Ethics Committee.	N/A

Please state the total number of participants that will be involved in the project and give a breakdown of how many there are in each category e.g. teachers, parents, pupils etc.

N/A

Give a brief description of the aims and the methods (participants, instruments and procedures) of the project in up to 200 words.

N/A

RISK ASSESSMENT: Please complete the form below

Brief outline of Work/activity:	1:1 interviews and documentary analysis.

Where will data be collected?	In a professional workspace at the participant or researcher's place of work (school/university campus). Meetings will take place during contracted working hours.

Significant hazards:	None

Who might be exposed to hazards?	None

Existing control measures:	Data collection methods are being carried out as part of usual custom and practice and with full consent from participants.

Are risks adequately controlled:	Yes

If NO, list additional controls and actions required:	Additional controls	Action by:

C: SIGNATURE OF APPLICANT:

Note: a signature is required. Typed names are not acceptable.

I have declared all relevant information regarding my proposed project and confirm that ethical good practice will be followed within the project.

Signed: Print Name: Samantha Parkes Date 25.10.21

STATEMENT OF ETHICAL APPROVAL FOR PROPOSALS SUBMITTED TO THE INSTITUTE ETHICS COMMITTEE

This project has been considered using agreed Institute procedures and is now approved.

Signed: … Print Name…Pengchong Zhang… Date…18/11/2021….
(IoE Research Ethics Committee representative)*

* A decision to allow a project to proceed is not an expert assessment of its content or of the possible risks involved in the investigation, nor does it detract in any way from the ultimate responsibility which students/investigators must themselves have for these matters. Approval is granted on the basis of the information declared by the applicant.

DATA PROTECTION DECLARATION FOR ETHICAL APPROVAL

This document can be used to provide assurances to your ethics committee where confirmation of data protection training and awareness is required for ethical approval.

By signing this declaration I confirm that:

- I have read and understood the requirements for data protection within the *Data Protection for Researchers* document located here:

  http://www.reading.ac.uk/web/files/imps/Data_Protection_for_Researchers__Aug_18.v1.pdf

- I have asked for advice on any elements that I am *unclear on* prior to submitting my ethics approval request, either from my supervisor, or the data protection team at: imps@reading.ac.uk

- I understand that I am responsible for the secure handling, and protection of, my research data

- I know who to contact in the event of an information security incident, a data protection complaint or a request made under data subject access rights

Researcher to complete

Project/Study Title A study of the perceptions and experiences of the evaluative process of the quality of primary mathematic teaching.

NAME	STUDENT ID NUMBER	DATE
Samantha Parkes		18.11.21

Supervisor signature

Note for supervisors: Please verify that your student has completed the above actions

NAME	STAFF ID NUMBER	DATE
Dr Catherine Foley		11.09.21

Submit your completed signed copy to your ethical approval committee.
Copies to be retained by ethics committee.

VERSION	KEEPER	REVIEWED	APPROVED BY	APPROVAL DATE
1.0	IMPS	Annually	IMPS	

University of Reading

Gatekeeper information sheet

I would like to invite staff of your school to take part in a research study about the quality of teaching in primary mathematics as part of my doctoral thesis.

What is the study?

The study aims to investigate the perceptions and experiences of teachers, mathematics leaders and senior leaders across the primary age range of the evaluation of the quality of primary mathematics teaching. This will be examined through three conceptual lenses; professional identity, professional knowledge and professional development. The study will provide an opportunity to understand the current context within which improvements in mathematics teaching are set, and hopes to offer recommendations for the development of effective models of professional learning for the development of good primary mathematics teachers.

Why has my school been chosen to take part?

Your school has been invited to take part in the project because you are a primary school in which teachers are responsible for teaching mathematics, and members of your staff team hold responsibility for evaluating mathematics teaching through observations and/or monitoring planning, children's work and data analysis. You also work within a network of schools local to the researcher's work base and as such, participants can potentially be met in person for interview.

Do I have to take part?

It is entirely up to you whether you consent for your school's staff to participate. You may also withdraw your consent for them to participate at any time during the project, up to the end of April 2022 without any repercussions to you, by contacting the researcher using the details below.

What will happen if my school takes part?

Participants will be asked to complete a 'reflective time line' prior to a 1:1 narrative interview. Instructions and guidance on how to complete this will be given beforehand. This visual medium will ask them to reflect on their professional experiences in the teaching/evaluating of primary mathematics from a starting point at the beginning of teacher training, through to their current role, focusing on measuring key moments against a high/low confidence scale. It will ask them to focus on three timelines; development of mathematical subject knowledge, moments of 'learning' and identity as a 'maths teacher'. The narrative interview will be mediated by this time line and questions and prompts may be used to probe answers.

The interview will be recorded using audio software. Key sections of the data will be identified and transcribed using transcription software and analysed thematically according to the three conceptual themes.

Any time commitment they are asked to make will be within the following parameters:

They will be invited to consider the time line two weeks prior to interview, the time and location of which will be set at the participant's convenience between the end of November 2021 and the end of April 2022. It is anticipated that they will spend up to 1 hour on the reflective time line, and allow 1 hour for the narrative interviews.

You and your staff will also be asked to consent to the sharing of policies and proformas used as part of the evaluative process of mathematics teaching in your setting. Depending on your specific school context and practices, these could include school professional development policies and guidance documents, subject vision statements, and classroom planning and assessment materials. School anonymity will be ensured through the removal of all identifying names and features such as school logos, whole documents will not be reproduced and short excerpts will only be included in the final report for where key features are necessary to support analysis.

What are the risks and benefits of taking part?

The information participants give will remain confidential and will only be seen by the researcher and project supervisors. Neither they nor your place of work/schools that might be made reference to will be identifiable in any published report resulting from the study. Information about individuals will not be shared with anyone in the department/school/course/workplace.

I anticipate that the findings of the study will be useful for teachers and schools in planning how they support the development of professional knowledge, learning and identity in the teaching of mathematics. A summary of the findings of the main thesis can be made available to you by contacting the researcher.

What will happen to the data?

All information collected will be kept strictly confidential (subject to legal limitations). In order to protect the anonymity of each participant, pseudonyms will be used to ensure participants cannot be identified. The university name will also be changed. All electronic data will be held securely in password protected files on a non-shared PC and all paper documentation will be held in locked cabinets in a locked office.

In line with University policy, data generated by the study will be kept securely in electronic form for a period of five years after the completion of the research project.

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

The University of Reading collects, analyses, uses, shares and retains personal data for the purposes of research in the public interest. Under data protection law we are required to inform you that this use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research

purposes. If you withdraw from a research study, which processes your personal data, dependant on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims. We will always have in place appropriate safeguards to protect your personal data.

If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact either Sam Parkes or Alan Floyd.

You have certain rights under data protection law which are:

Withdraw your consent, for example if you opted in to be added to a participant register
Access your personal data or ask for a copy
Rectify inaccuracies in personal data that we hold about you
Be forgotten, that is your details to be removed from systems that we use to process your personal data
Restrict uses of your data
Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes.
You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.uk

You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

What will happen to the results of the research?
The data will be analysed and used in an EdD Thesis. It may also be used in future publications in appropriate academic journals and/or books. If you would like a summary copy of the research findings, these will be sent to you on request.

Who has reviewed the study?
This application has been reviewed following procedures of the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

Name, position and contact address of Researcher	**Name, position and contact address of Supervisor**
Samantha Parkes *Senior Lecturer*	**Dr. Catherine Foley**

School Improvement Specialist - Mathematics University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	*Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

I do hope that you will agree to your school staff taking part in the study. If you do, please complete the attached consent form and return it via email to s.parkes@chi.ac.uk. Thank you for your time.

Gatekeeper Consent Form

Research Project:

An exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of classroom practice evaluation and development in primary schools.

Name, position and contact address of Researcher	Name, position and contact address of Supervisor
Samantha Parkes *Senior Lecturer* *School Improvement Specialist - Mathematics* University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	**Dr. Catherine Foley** *Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

		Please initial box
3.	I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	☐
4.	I understand that my consent is voluntary and that I am free to withdraw at any time up to 30th April 2022, without giving reason.	☐
3.	I give my consent for the above study to take place.	☐
4.	I give my consent for access to school documentation as detailed in the information sheet	☐

Name of Gatekeeper	Date	Signature

University of Reading

Participant information sheet

I would like to invite you to take part in a research study about the quality of teaching in primary mathematics as part of my doctoral thesis.

What is the study?

The study aims to investigate the perceptions and experiences of teachers, mathematics leaders and senior leaders across the primary age range of the evaluation of the quality of primary mathematics teaching. This will be examined through three conceptual lenses; professional identity, professional knowledge and professional development. The study will provide an opportunity to understand the current context within which improvements in mathematics teaching are set, and hopes to offer recommendations for the development of effective models of professional learning for the development of good primary mathematics teachers.

Why have I been chosen to take part?

You have been invited to take part in the project either because you are a primary school teacher who is responsible for teaching mathematics, or because your work in primary schools includes evaluating mathematics teaching through observations and/or monitoring planning, children's work and data analysis. You can choose whether you identify primarily as 'teacher' or 'evaluator'. You also work within a network of schools local to the researcher's work base and as such, can potentially be met in person for interview. Consent from the headteacher of each participating school has been sought and gained.

Do I have to take part?

It is entirely up to you whether you participate. You may also withdraw at any time during the project, up to April 30th 2022 without any repercussions to you, by contacting the researcher using the details below.

What will happen if I take part?

You will be asked to complete a 'reflective time line' prior to a 1:1 narrative interview. Instructions and guidance on how to complete this will be given beforehand. This visual medium will ask you to reflect on your professional experiences in the teaching of primary mathematics from a starting point at the beginning of teacher training, through to your current role, focusing on measuring key moments against a high/low confidence scale. It will ask you to focus on three timelines; development of mathematical subject knowledge, moments of 'learning' and identity as a 'maths teacher'. The narrative interview will be mediated by this time line and questions and prompts may be used to probe your answers.

The interview will be recorded using audio software. Key sections of the data will be identified and transcribed using transcription software and analysed thematically according to the three conceptual themes.

Any time commitment you are asked to make will be within the following parameters:

You will be invited to consider the time line two weeks prior to your interview, the time and location of which will be set at your convenience between the end of November 2021 and

the end of April 2022. It is anticipated that you will spend up to 1 hour on the reflective time line, and allow 1 hour for the narrative interviews.

If your headteacher has given consent, you may also be asked to provide examples of any policies or proformas used as part of the evaluative process of mathematics teaching in your setting. Depending on your specific school context and practices, these could include school professional development policies and guidance documents, subject vision statements, and classroom planning and assessment materials..

What are the risks and benefits of taking part?

The information you give will remain confidential and will only be seen by the researcher and project supervisors. Neither you nor your place of work/schools you might make reference to will be identifiable in any published report resulting from the study. Information about individuals will not be shared with anyone in the department/school/course/workplace.

I anticipate that the findings of the study will be useful for teachers and schools in planning how they support the development of professional knowledge, learning and identity in the teaching of mathematics. A summary of the findings of the main thesis can be made available to you by contacting the researcher.

What will happen to the data?

All information collected will be kept strictly confidential (subject to legal limitations). In order to protect the anonymity of each participant, pseudonyms will be used to ensure participants cannot be identified. The university name will also be changed. All electronic data will be held securely in password protected files on a non-shared PC and all paper documentation will be held in locked cabinets in a locked office.

In line with University policy, data generated by the study will be kept securely in electronic form for a period of five years after the completion of the research project.

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

The University of Reading collects, analyses, uses, shares and retains personal data for the purposes of research in the public interest. Under data protection law we are required to inform you that this use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research purposes. If you withdraw from a research study, which processes your personal data, dependant on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims. We will always have in place appropriate safeguards to protect your personal data.

If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact either Sam Parkes or Alan Floyd.

You have certain rights under data protection law which are:

Withdraw your consent, for example if you opted in to be added to a participant register
Access your personal data or ask for a copy
Rectify inaccuracies in personal data that we hold about you
Be forgotten, that is your details to be removed from systems that we use to process your personal data
Restrict uses of your data
Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes.
You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.uk

You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

What will happen to the results of the research?

The data will be analysed and used in an EdD Thesis. It may also be used in future publications in appropriate academic journals and/or books. If you would like a summary copy of the research findings, these will be sent to you on request.

Who has reviewed the study?

This application has been reviewed following procedures of the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

Name, position and contact address of Researcher	**Name, position and contact address of Supervisor**
Samantha Parkes *Senior Lecturer* *School Improvement Specialist - Mathematics*	**Dr. Catherine Foley** *Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education*

University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

I do hope that you will agree to take part in the study. If you do, please complete the attached consent form and return it via email to s.parkes@chi.ac.uk, or complete a hard copy and return it at the time of your interview. Thank you for your time.

Participant Consent Form

Research Project:

An exploration of the perceptions and experiences of teachers, mathematics subject leaders and senior leaders of classroom practice evaluation and development in primary schools.

Name, position and contact address of Researcher	Name, position and contact address of Supervisor
Samantha Parkes *Senior Lecturer* *School Improvement Specialist - Mathematics* University of Chichester Bognor Regis campus Upper Bognor Road Bognor Regis West Sussex PO21 1HR T: E: th909206@student.reading.ac.uk	**Dr. Catherine Foley** *Programme Director, Primary School Direct | Lead, Postgraduate Primary ITT | Associate Professor of Mathematics Education* Institute of Education University of Reading London Road Campus 4 Redlands Road Reading, Berks. RG1 5EX T: +44 (0)118 378 2661 E: c.m.foley@reading.ac.uk

This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

		Please initial box
4.	I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	☐
5.	I understand that my participation is voluntary and that I am free to withdraw at any time, up to 30th April 2022 without giving reason.	☐
3.	I agree to take part in the above study.	☐

Please tick box

		Yes	**No**
4.	I agree to the interview being audio recorded.	☐	☐

5. I agree to the use of anonymised quotations in publications. ☐ ☐

Name of Participant	Date	Signature

Key questions/guidance for 'reflective time line' activity.

Please use the graph to plot your professional life in primary mathematics education.

Please draw onto your graph a separate timeline to represent each of the three ideas and how they have developed or changed over time:

a. Your mathematical subject knowledge;

b. Your experiences as a teacher of mathematics;

c. Your experiences of evaluating the mathematics teaching of others;'

Please annotate onto your graph key experiences and moments that shaped each of your timelines

Indicative questions for semi-structured narrative interview:

Please tell me the story of your professional life in primary maths education.

Do you consider yourself to be a professional? Why/why not?

What does the phrase professional identity mean to you? Do you identify as a mathematics teacher?

What professional knowledge do you consider to be of value for primary teachers of mathematics?

Which experiences have contributed the most to your development as a teacher/evaluator of primary mathematics?

Can you tell me about your experience of being evaluated as a maths teacher? Who was involved? What happened? How did you feel?

Can you tell me about your experience of evaluating others as maths teachers? Who was involved? What happened? How did you feel?

Do you consider autonomy to play a role in the perceptions and experiences of primary mathematics teachers? If so, in what way?

What documentation is used to support the evaluation of mathematics teaching in your experience? Which parts are helpful? Why? Is there anything you would change? Why?

Prompts for expansion on key points

Do you remember anything else about this?

And what happened after that?

Sometimes these timelines can support connections between different elements of experience. Do you think there any such connections evident on your graph?