The developing professional identity of Primary Mathematics Specialist Teachers [PMaSTs]; how primary teachers' biographical processes and experiences shape their new professional identities and career trajectories.

Doctorate in Education

Institute of Education, University of Reading.

Nasreen Majid

Acknowledgements

I would like to extend my heartfelt thanks to all twelve participants of this study, their trust in sharing their biographies of learning mathematics and their career trajectories has enabled the development of this thesis.

My thinking has been supported by the careful supervision from Dr Karen Jones and Professor Alan Floyd, I thank them for their considered feedback and coaching.

A very special thanks is extended to my friends, near and far, for your wise words and direction. Your encouragement and guidance helped me get to the finish line!

Finally, I would like to thank my parents and my family for their constant belief in me and their gentle reminders that with hard work and dedication, one can achieve great things! Your love and encouragement has empowered me to complete this thesis.

I dedicate this thesis to the beautiful memories of my nephews: Adnan and Arsalaan.

Declaration of Original Authorship

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

December 2019.

Abstract

The teaching of mathematics in English primary schools is a crucial component to building successful and confident mathematicians. Although there are established research in the field of mathematics learners and identity, little research exists on generalist primary teachers building their identity as Primary Mathematics Specialists (PMaSTs). This study sets out to understand how primary teachers in England, throughout their professional career, build their identity as PMaSTs. The study mapped out the participants' journey from learning mathematics, the part this played in shaping their mathematics identity, and their career development. Their values and future career goals that emerged as a result of becoming PMaSTs were explored to understand the shaping of a professional identity. Emerging from the literature review, the conceptual framework for this study drew on three interconnected themes: identity, Continuing Professional Development (CPD) and career trajectories.

The research adopted an interpretative, narrative life history approach to capture the lived experiences of twelve participants, who were established PMaSTs in their educational setting. Data were collected in two stages. First, through a Life Graph drawing activity, and second, a life history interview. The narrative data were analysed using three distinct stages, helping to reduce the data to develop themes and codes within the data set.

The findings show the way primary teachers learn mathematics has a profound effect on how they see themselves as mathematicians and teachers of mathematics. The data highlights how primary teachers can be supported to overcome their negative experiences to develop specialist roles through transformative learning processes, supported by leaders and coaches, throughout their careers. Therefore, the theoretical framework emerging from this thesis could be replicated to support subject leadership career aspirations of primary teachers across the primary subject range. The study, although not generalisable, adds to the canon of literature on identity development within mathematics education. The detailed understanding gained about PMaSTs' identity constructs and their professional careers trajectories aspires to help policymakers in supporting primary teachers seeking to develop into PMaSTs.

Contents

List of Tables

List of Figures

Chapter 1 Introduction

1.1 Introduction

This thesis explored the career trajectories and professional development of primary teachers who, throughout their career, transformed from novice teachers to expert mathematics teachers. Since becoming a teacher of any specialism involves much more than the acquisition of knowledge, it includes the development of a professional identity, this research seeks to explicate factors that shape this identity development process. To elicit rich insights into participants' 'lifeworld' (Berger & Luckmann, 1966), an interpretivist approach underpinned by social constructionism was employed to understand how social processes, including the acquisition of specific knowledge and skills, amalgamate in the shaping of a Primary Mathematics Specialist Teacher's (PMaST) identity (Young & Collin, 2004). The research utilised a narrative life history methodology (Goodson, 2009), with two stages involved in the collection of data: first, a graphic instrument in the form of a Life Graph, followed by Life History interviews with the twelve primary teachers.

This chapter will begin by identifying the need to develop mathematics expertise in primary schools in England, closely aligned with understanding why this is an area of importance to study. Furthermore, reference will be made to the current landscape and how this has been shaped by government policy, including curricular changes (DFE, 2013a) and teacher recruitment and retention. An understanding of the professional learning opportunities (Guskey, 2002) available to primary mathematics teachers throughout their careers is explored to discern how these support the career development of such individuals as they move from novice to expert (Borko & Livingston, 1989; Goodwyn, 2010). Therefore, the thesis also contributes to an understanding of how primary teachers can be supported with specific learning opportunities, over time, to become specialists in the field of mathematics. This, in turn, can help develop further expertise within the primary teacher workforce in England. The findings may also resonate with teachers and help them to make sense of

their identity constructs and career experiences. The chapter closes with a section outlining the organisation of each chapter in the thesis.

1.2 Personal and professional background

Before setting out the context of this thesis, it is important to share my personal and professional background to define the personal drivers for the conceptualisation of this thesis. Throughout my career, I grappled with the idea of being an 'accidental mathematician' - someone who came into teaching with no ambition to become an expert in mathematics. However, the road I took and the expertise I gained was encouraged and facilitated by notable individuals, leaders who saw my potential and invested in me to enhance my skills and therefore enabled me to become a PMaST. My first memory of learning mathematics is as a primary pupil doing my mathematics homework with my grandfather. He instilled in me the value of working through a problem in a consistent, methodical and sustained way. This memory has been strong enough to influence my career in education and give me the confidence to become a champion of mathematics.

Having trained as a primary teacher in the late 90s, I caught the changing tide in education policy under the New Labour Government (Labour, 1997). Having trained with no specialist expertise, I was noted for my strong mathematics subject and pedagogical knowledge, how I taught it and the results I achieved. This led me to become a successful Advanced Skills Teacher (AST) in mathematics and science, enabling me to make an impact on the learning and teaching of mathematics within my school and my local authority.

My current role of leading mathematics on an undergraduate teacher training programme has empowered me to evaluate how I see mathematics and the best ways to engage learners who will go on to champion mathematics in primary schools. I still grapple with trainee teachers who have deep-rooted anxiety with the subject and cannot make the measurable connections to deconstruct how they were taught mathematics to reconstruct their epistemological positioning positively and

sustainably. Therefore, I spend a great deal of time assessing and building learning opportunities that enable these nervous and reticent mathematicians to develop confident and sustainable strategies for planning and teaching mathematics in meaningful contexts.

Furthermore, part of my role at the university has been leading the Mathematics Specialist Teacher (MaST) programme, this was an M level programme for experienced primary teachers wishing to specialise in mathematics. Their collective experiences resonated with my career trajectory. As I started to reflect on my professional journey, I wanted to capture and study the career trajectories of colleagues who have had similar experiences to understand how these careers develop, over time, and what is unique about these individuals. Why they do not start with a mathematics specialism and initially have no desire to pursue this as a career but end up being experts in the field with a passion for the subject that is contagious. By understanding this transforming identity as a mathematics specialist, the thesis aims to add to the knowledge of emerging mathematics expertise in primary schools. Furthermore, the emerging theoretical understanding of the intangible interconnection between an individual's professional career trajectory, developing a mathematics specialist identity in primary education and how this shapes their PMaST identity, will give important insight into how such identities can be strategically shaped, nurtured and sustained within the primary workforce in England. A further aim of this study is to inform policy and practice relating to the recruitment, development, retention and progression of PMaSTs.

1.3 Primary mathematics in England as a context for the study

1.3.1 Identifying the problem

> *"I can remember being in secondary school and it was like someone was talking Japanese to me… and I left secondary school really failing in it (mathematics)." (Reece)*

Reece, one of the participants in this study, demonstrated an intrinsic problem in society, of the 'dread' of mathematics, ingrained from early experiences of learning the subject. Reece, now a successful mathematician, with a distinguished career leading the learning and teaching of

mathematics, had a view that is widely recognised (Cockcroft, 1982; Griffin, 2014; Vorderman, Porkess, Dunne, & Rahman-Hart, 2011). These beliefs are deeply-rooted and stem from entrenched assumptions about the subject of mathematics within society. A seminal text, entitled Mathematician's Delight (Sawyer, 1949), first published in 1943, provides insight into the underlying issues on how we perceive mathematics as a society, and how this is influenced by the way mathematics is taught in schools. The first chapter in Sawyer's book is entitled 'The Dread of Mathematics' and starts by stating: 'Many people regard mathematicians as a race apart, possessed of almost supernatural powers.' (P.7). Although it is a historical text, arguably not a lot has changed over the interim decades regarding perceptions of mathematics. However, there is now a much better understanding of how views towards mathematics can help shape personal engagement and confidence in mathematics (Çatlıoğlu, Gürbüz, & Birgin, 2014; Ernest, 1988; Olson & Stoehr, 2019). The media also plays a big part in developing these perceptions. In a television advert by L'Oreal, actor Dame Helen Mirren's remarks about 'not being good at mathematics' were questioned by the National Numeracy charity. The Chief Executive of the charity, Mike Ellicock, suggests that negative comments around mathematics are so easy to make and are prevalent in our society, yet they cause lasting damage to people's attitude to the subject (Richardson, 2015).

However, there is research informed evidence stating that positive attitudes towards mathematics support early academic success. This is noted and demonstrated in the seminal work of Lewis Aiken (Aiken & Dreger, 1961), who showed that a strong interest in mathematics enabled a sense of motivation and therefore achievement in the subject. The study was carried out with 704 students at a basic mathematics class in the Florida State University. The Taylor Scale alongside three Number Anxiety scores was used to determine outcomes. Studies such as those conducted by Chen et al. (2018); Lee, Ning, and Goh (2014); Seaton, Parker, Marsh, Craven, and Yeung (2014), were all carried out with large sample sizes of over 200 pupils and demonstrate a positive relationship between mathematics learning and motivation. These outcomes give an international context to how an interest in mathematics may help to shape future successes in the subject. This is achieved, as

demonstrated by the studies, in the way mathematics is introduced to pupils and therefore a strong understanding of the subject by teachers is essential to developing this positive relationship. This thesis seeks to further the knowledge and understanding of how novice, generalist primary teachers transform and emerge as expert mathematics specialists.

Whilst recognising the often entrenched views towards mathematics in British society (Brown, Brown, & Bibby, 2008; Cotton, 2016; Ernest, 1988; Haylock & Manning, 2019), studying individuals who trained as generalist primary teachers, with the majority often sharing negative learning experiences towards mathematics, sheds light on key aspects that impact their identity development as primary teachers, PMaSTs and leaders within their field. The understanding of how these individuals then realign their professional identities as PMaSTs through their careers, whilst undertaking the range of professional learning opportunities provided, can therefore offer new insight into their lived experiences and how these helped their transformation into PMaSTs over their career trajectories.

Mathematics continues to be in the political and media spotlight and has had extensive coverage in key government reports, such as Cockcroft (1982), Williams (2008) and Vorderman et al. (2011). The reports emphasise how our attitudes towards the subject drive expectations and, closely linked to this, the way mathematics is taught and the professional learning opportunities open to teachers

(Cockcroft, 1982; Vorderman et al., 2011; Williams, 2008). The Programme for International Student Assessment (PISA) used to measure national progress through international comparative testing, organised and developed by the Organisation for Economic Co-Operation and Development (OECD) is undertaken by British pupils at age 15. The results from this programme consistently draw the attention of the media and are often portrayed negatively. However, recent tests and analysis have indicated that the results for pupils in England are comparable to those of their counterparts (OECD, 2015; Whealer, Ager, Burger, & Sizmur, 2014), therefore emphasising the nature of societal attitudes towards mathematical achievement.

It could be suggested then, that to develop a love – or at least an appreciation – for the subject, steps need to be taken to teach mathematics in a creative and connected way from childhood. A study carried out by Askew, Brown, Wiliam, Johnson , and Rhodes (1997) sheds light on teachers' beliefs regarding what an effective teacher of numeracy identifies as'. The main findings state that effective teachers of numeracy see the teaching of the subject in a connected way, building an understanding of mathematical ideas across the range of mathematical concepts. Therefore, these teachers understand how to positively build learning opportunities and provide interventions to enable deep understanding and therefore successful mathematics learning for their pupils.

The building block of mathematical thinking develops from as early as a four-month old infant making sense of numbers and being able to count (L. B. Cohen & Marks, 2002; McCrink & Wynn, 2004). Boaler (2009), has questioned the 'status quo' around mathematics pedagogies and argues that the way mathematics is taught is a misrepresentation of the subject and to develop and create a seismic shift in how the subject is perceived, there has to be a reconceptualisation of the toolkit used to teach mathematics. Furthermore, she has developed a website (You Cubed) where she is doing exactly this, calling it a 'mathematical revolution' Boaler (2018). Boaler's work echoes the sentiments of the work of philosophers like Hersh and John-Steiner (2010) and Shapiro (2011), all of whom discuss the nature of mathematics and how, with careful teaching and coaching, the subject can and should be made accessible to all.

Given how early mathematics becomes part of learning, the embedding of 'negative attitudes at an early age can affect the opportunities for achievement and job security at adulthood'(Cockcroft, 1982, p. 101), further exacerbating individual mathematics anxiety. A study with early childhood educators by Cohrssen and Tayler (2016) provides further context into the links between primary teachers' attitudes in mathematics affecting the delivery of the mathematics curriculum. Cohrssen and Tayler (2016) discuss early childhood pre-service teachers making a conscious choice to teach in the early years because of an assumption that the teaching of mathematics at this age range will not

be challenging. Whereas, a body of in-depth work around early mathematical development (Carruthers & Worthington, 2011; Ginsburg, Duch, & Noble, 2012; Montague- Smith & Price, 2012), deliberates on the vital importance of developing strong foundations for future mathematical understanding, stemming from a strong provision in the early years. It is here that children start to make connections between aspects of problem solving and mathematical understanding. Therefore, developing teacher resilience, enabling them to teach mathematics with confidence, is an important vehicle for reducing mathematics anxiety within the early years' teacher population. Cohrssen and Tayler (2016) work demonstrate this by providing a clear intervention to develop mathematical concepts with early childhood teachers, thus reducing their mathematics anxiety and increasing their self-efficacy. This study, therefore, suggests a clear framework of career development of primary teachers, through carefully crafted learning opportunities in the shape of Continuing Professional Development (CPD), over the course of a teacher's career. The study brings together key contributions to the knowledge of how these teachers shape their identities over their career trajectories, providing a robust framework to build and develop the PMaST population in English schools. The work could further inform Initial Teacher Training (ITT) programmes, CPD and Post Graduate courses to help practitioners make sense of their experiences, strengths, weaknesses and overcome any fears, and better understand professional identity development processes.

In addition to embedding the National Curriculum 2013 (DFE, 2013a), and an emphasis on more in-depth learning of mathematics, alongside new approaches borrowed from overseas, such as 'Shanghai Maths and Mastery' (NCETM, 2017, 2018a), there has been a sustained need to retrain the primary workforce. The national appetite for mathematics education is focused on building and sustaining strong CPD structures that provide focused professional learning opportunities throughout a teacher's career. This study, therefore, provides further insight into how the professional identities of mathematics specialists are built over a teacher's career, through structured professional learning opportunities. This, in turn, continues to drive the progress and

attainment of the learning and teaching of mathematics in primary schools and explains why this remains a key priority area for Government.

1.3.2 Government policy and professional development opportunities in mathematics

An in-depth review of the mathematics provision in primary schools was commissioned by the Brown Labour Government in July of 2007. The review was led by Sir Peter Williams; it aimed to undertake a 360° overview of mathematics teaching and learning across the Primary age range. One key recommendation focused on the 'teaching workforce rather than the content of learning in primary schools' (Williams, 2008, p. 1). This is significant as the report placed value on the skills required by primary teachers to further their pedagogical and subject knowledge to teach mathematics well and hence increase the professional expertise of the primary workforce, through CPD. The problem lies in how this learning is to be achieved, the existing literature provides little guidance and support for a generalist primary teacher to move to an expert mathematics specialist. Recommendation three of the report stated:

> 'There should be at least one Mathematics Specialist in each primary school, in post within 10 years, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools. Implementation should commence in 2009 and be targeted initially to maximise impact on standards and to narrow attainment gaps.' Williams (2008, p. 23)

Eleven years on, there is now a range of Mathematics Specialist Teachers (MaSTs) practising in primary schools, whose career trajectories have evolved significantly from the time when they first entered the profession. A key aim of this study is to share their narratives, describing how their professional mathematical identities have developed through the CPD learning opportunities provided to them throughout their careers, thus offering an important understanding of this priority area and contributing to the gap in our understanding of how such identities are shaped over time.

Understanding the development of specialist teachers is emphasised by the Advisory Committee on Mathematics Education (ACME) report entitled 'Empowering Teachers: Success for Learners' (ACME, 2013). It summarised provision for CPD in mathematics as being 'skewed and fragmented'. However, one programme that has been commended as good practice is the MaST (Mathematics Specialist Teacher) programme. Ten out of the twelve teachers in this study undertook this professional learning programme. (p.8):

> 'The MaST programme is a good example of a programme that supports the development of primary mathematics specialists… it is a good example of rich professional development with its threefold aims of developing 1) mathematics subject knowledge, 2) a range of effective pedagogies and 3) expertise in supporting others. ACME (2013, p. 8)

Additionally, the Vorderman report discussed the success of the MaST programme and how 'the best MaST courses are being rated very highly' (Vorderman et al. (2011, p. 81). Specifically, the programme enabled teachers to pursue a leadership role in mathematics that is wider and more diverse than the traditional coordinator role (Donaldson, 2002). Initial impact and evaluation studies of the MaST programme suggest the course is appropriately aligned with the growing needs of developing further mathematics expertise within the primary workforce (ACME, 2012; Walker et al., 2013).

To develop mathematics expertise in primary schools, a targeted supply of teachers is essential to sustaining and developing expertise. A recent report by the Think Tank, Education Policy Institute, Sibieta (2018) highlights the serious shortage of teachers across England. The report indicates an exit rate of 8%-9% (p.6) for primary teachers. Therefore, government policy is seeking to improve rates of recruitment and retention within the profession. A strategy was set out in the recent Green Paper by the Department for Education (DFE, 2018), aligning teacher professional development as 'specialist qualification' (p.28) to provide a sustained idea of professional learning and 'complement the [newly piloted] Chartered Teacher Status' (Foster, 2018, p. 28). This thesis adds to the

knowledge of primary mathematics teachers' career development and career trajectories, through understanding their lived experiences throughout their careers. The conceptual framework of this thesis enables further understanding of how these teachers built their agency as PMaSTs throughout their careers.

Government policy on educational reform included a different model of developing PMaSTs, through ITT (DFE, 2011). This provided a route for individuals wishing to become mathematics experts for primary teaching, not dissimilar to the training provided for mathematics teachers in secondary schools. However, this policy shift could be viewed as demonstrating a lack of insight and long term sustainable thinking around developing robust approaches in training and developing PMaSTs strategically and sustainably, as it addressed training for expertise at the start of a career rather than developing an approach that enabled sustained professional learning in mathematics throughout a primary teachers' career (ACME, 2012). This Government strategy to address shortages and retain and develop the workforce, however, was welcomed by the education community. The findings of this study have implications for improving retention rates by understanding factors that enable primary teachers to remain in the profession and develop their career paths by electing to become PMaSTs.

Finally, the current policy focus on mastery teaching has established a new professional learning programme on Primary Mastery Specialist Teachers, through training by The National Centre for the Excellence in the Teaching of Mathematics (NCETM) and the Mathematics Hubs, (NCETM, 2018b). An evaluation carried out by the Education Endowment Fund (EEF) on the mastery approach indicates that schools which have established this approach to the teaching of mathematics saw greater pupil progress than those which had not adapted to this learning approach EEF (2015). This marks a trend towards the establishment of a primary teaching workforce with expertise in teaching mathematics using the mastery approach. One contribution of this thesis is to bridge the gap in knowledge of how teachers can be supported in becoming champions of mathematics through

understanding significant factors that enable their identities as mathematics specialists to be developed, nurtured and sustained over their career trajectories.

1.4 Overview of the research

1.4.1 Research aims and research questions

The overarching aim of this study was to understand how a novice primary teacher becomes an expert PMaST by understanding their lived experiences over the course of their career in English primary schools. How does this happen, what processes do they go through to transform into a PMaST and what and who are the main influences for this transformation to happen? To get to the heart of the aims of the research, the following research questions were developed and answered:

How do biographical processes and experiences shape identity development and career trajectories of primary teachers who become PMaSTs?

The following sub-questions were posed:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMaSTs?

SQ2: How do primary teachers describe and understand their experience in the role as a PMaST?

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

1.4.2 Conceptual framework

Having set the scene for this research, it is important to make a brief reference to the key ideas that frame the work in the subsequent chapters - this section will introduce these. The study is underpinned by three concepts to frame the research: identity, CPD and career trajectories. The main conceptual ideas are based on interpretivist, qualitative, narrative aspects of understanding identities (Berger & Luckmann, 1966; Luckmann & Berger, 1964; Riessman, 1993). These important conceptual and theoretical ideas have enabled a rich understanding of the lived experiences of the

PMaSTs. A narrative approach provided a micro lens to facilitate authentic data collection by understanding individual stories (Bruner, 1987; Goodison, 1992; Riessman, 1993), and therefore the participants' mathematical journey both personally and professionally. The thesis adopted a social constructionist approach to identity, where identity is viewed as an emerging phenomenon through interactions with others and therefore the experiences and growth individuals go through is a symbiotic relationship enabling further progression into the assumed role (Ibarra, 2004; Illeris, 2014). These interactions can be positive or negative, they enable the emergence of identity, through both intrinsic (constructivist) and extrinsic (constructionist) interactions, (Young & Collin, 2004). Further discussions around identity and definitions are discussed in chapter 2, where identity will be further framed within the context of mathematics and the primary teacher.

Put simply, in this thesis identity refers to subjective meanings and experience, related to an individual's sense of self and their efforts to answer the questions, 'Who am I?' and, related to this, 'How should I act?' (Cerulo, 1997). This is relevant to teaching, mathematics and this study because of how individuals perceive their relationship with mathematics, how this perception develops over time and therefore how it affects future capabilities and individual sense of self. Prior research by Askew et al. (1997); Briggs (2014); Goulding, Rowland, and Barber (2002), Palmer (2009) go towards providing insight into trainee teachers' experiences and knowledge of mathematics and their understanding of the subject within the constraints of their personal lived experiences. This thesis builds on their work by providing a narrative for how novice primary teachers broaden their mathematics expertise throughout their career trajectories.

The seminal work of Shulman (1987) on Subject Pedagogical Knowledge (SPK) is also drawn upon to understand further how professional learning builds upon and develops teacher expertise from a novice to an expert. Linked to this, the work of exploring stages of skill acquisition from a novice to an expert (Dreyfus, 1982; Dreyfus & Dreyfus, 1980) is also referenced to further develop a theoretical insight into primary teachers in England becoming PMaSTs.

1.4.3 Overview of the methodology

The thesis is firmly positioned within the constructionist approach to identity, where identity is shaped as a result of the range of lived experiences an individual undertakes within their personal and professional lives (Berger & Luckmann, 1966; Young & Collin, 2004). All twelve participants for this study are qualified primary teachers.

To capture an authentic understanding of the lived experiences of the PMaSTs, a narrative approach was used, as narratives do not simply capture individual stories - they are a window into understanding how identities are shaped over time (Rosenwald & Ochberg, 1992). Furthermore, a narrative approach was particularly complementary to understand teachers' lived experiences because of the nature of their stories and how these play out over time (Goodson, 2008). The study enabled the participants to be actively immersed in the research process through the distinctive two-step process used to collect the data. The theorist Jerome Bruner argues that a narrative approach is more than 'just' about the gathering of information from individual life experiences. He theorises that the act of telling one's life story is influenced by our environment and how we interpret our interactions within the space, thus shaping our lived experiences (Bruner, 1987). Therefore, narration can give important insight into the meaning and importance individuals attribute to events.

The two-stage data collection process consisted firstly of a unique graphical tool - a 'Life Graph', specifically developed for this research (figure 1 and appendix H). The Life Graph was analysed, in detail, to develop interview questions linked to the participants' personal and professional trajectories, taking a life history narrative approach (Goodson, 2008, 2009; Goodson & Sikes, 2001). An example of a Life Graph was developed to share with participants, which can be seen in figure 1.

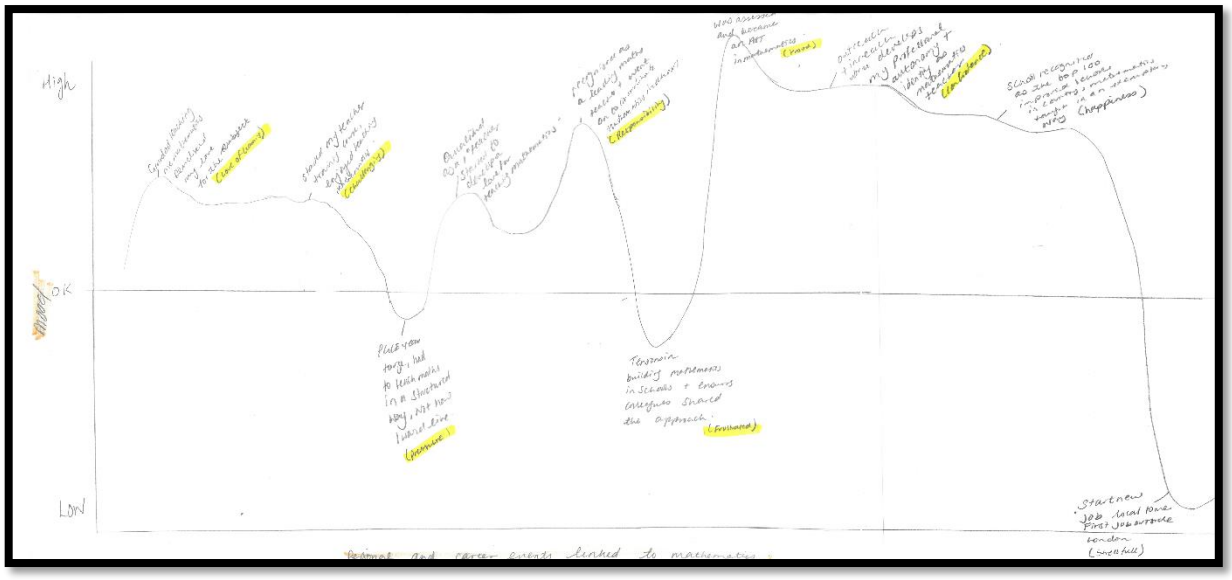


Figure 1 Extract from my own Life Graph developed to understand the process and share an example as part of the pilot study.

The Life Graphs were returned to the researcher, who studied them and prepared topics for further exploration in face-to-face narrative interviews. Also, a schedule of semi-structured interview questions (appendix E) was prepared, covering important common themes (e.g. educational experience, career development). A total of twelve interviews were completed. The interviews were transcribed within 48 hours by the researcher to ensure that the transcript could be sent back to the participant for a read through and accuracy check. Finally, the data was coded and categorised and the themes which emerged were analysed.

1.4.4 Significance of the study

This thesis will expand the literature in mathematics identity, specifically teacher identity development and provide further narrative in the field of primary teachers in England, as they develop into PMaSTs through the course of their careers. The thesis aims to add to the current literature (Gaunt, 2008; Walker et al., 2013) of the shaping of a PMaST identity, providing a deeper insight into identity work as part of the development of a PMaST.

Furthermore, the unique methodological approach taken in the shape of a graphical, narrative style has enabled a rich data collection process. This, in turn, will add to the existing canon of methodological literature in understanding how teachers transform into mathematics experts throughout their careers. Deploying a two-part method of data collection, with the first being driven by the participant, has shown the power of sharing stories of mathematics learning and the shaping of careers. The life history interviews, expanding on the analysis of the Life Graphs, added a deeper dimension to the data collected. This methodological approach contributes to the rich diversity of techniques within the field of narrative research.

Using the concept of identity, career trajectories and CPD, the study provides a distinctive lens to the shaping of an identity as a PMaST. Therefore, the thesis aims to understand how mathematics identities emerge and change over time and identify factors that can contribute in a positive way to identity development, hence providing further insight and respectfully contributing knowledge in this little-researched area of Primary Mathematics Specialist identity in English schools.

1.5 Structure of the thesis

The thesis has eight chapters altogether, including the introduction. The chapters are as follows: chapter 2 reviews the literature in the field of mathematics identity construction, career trajectories and professional development. Additionally, the literature sheds light on the frameworks used to construct the boundaries for this study, the conceptual framework is discussed and defined within the boundaries of this study.

Chapter 3, sets out the methodological approach undertaken to answer the research questions. Here the research's ontological as well as epistemological positioning are communicated, shedding light on the approach taken and its importance for this study.

Chapters 4, 5 and 6 share the data analysis, broken down into three distinct stages of the PMaSTs' career trajectories, namely: beginning, being and future trajectories as a PMaST. This structure fits

within the frame of the research in understanding the professional career journeys of the PMaSTs and adds a unique context to the way the data is represented.

Chapter 7 brings the findings and literature together discussion of the data sets, linking them to the frames used within the study. The new knowledge created is highlighted whilst providing clear answers to the research questions.

Finally, chapter 8 provides a summary of the findings and the original contribution of knowledge that this research has unearthed. Further proposals for professional practice are put forward and policy suggestions are made for developing a sustainable PMaST workforce.

Conclusion

This chapter has sought to set the context for the study and provide the conceptual and methodological framework used to carry out the research. The following chapter will provide a context of the current literature in the field to understand a wider view of mathematics in English schools and the place for a PMaST.

Chapter 2 Literature Review

This thesis sets out to understand how novice teachers over the course of their career become PMaSTs and explicate, through narrative life history approaches (Bruner, 1991; Kaasila, 2007), factors that mould their identities. Understanding how PMaSTs' identities develop over time, might prove helpful to policy-makers and educators to understand and therefore build and sustain a workforce of mathematics champions in English primary schools.

This chapter offers a review of the current theoretical and empirical literature. The review draws upon UK studies as well as international work on the teaching and learning of mathematics. The chapter begins by framing the research, bringing together key theories, conceptualising identity, at the heart of this study and linking these to the concepts framing the research, namely CPD and career trajectories.

Although sparse literature exists specifically on the identity development of PMaST in England, literature from other countries has been drawn on to build an understanding of factors that influence the development of professional identity within the field of primary mathematics specialist teaching and more generally, the teaching profession. By what means teachers build a specialist professional identity within their situated context and through working alongside colleagues is discussed. This begins with framing research around the main identity theories- Illeris (2014); Lave and Wenger (1991) and Ibarra (2004) that constitute a key part of the conceptual framework for the study followed by an exploration of identity and mathematics, the influence of teacher training on identity development, through research on the training of primary teachers, following this, the notion of teachers' career trajectories are defined and explored, alongside CPD, to understand how CPD practices enable the development of expertise and professional career progression and the identity work involved in that process. Taken together, the chapter seeks to show how mathematics identity is shaped over time by a multitude of situational and contextual factors. As illustrated by Ibarra (1999a, 2004), Lave and Wenger (1991); Wenger (1998, 2000) and Illeris (2014), identity is

layered and developed in line with an individual's social interactions as well as the creation of identity through the process of learning. The chapter will conclude by outlining the scope of the study.

2.1 Framing the Research

The thesis adopted an approach to identity, whereby identity is viewed as an ongoing process, shaped by multiple social interactions in the professionally situated and cultural contexts in which a person lives and works (Allen, 2005). This is supported by Giddens (1991), who suggests that identity 'is the self as reflexively understood by the person in terms of her and his biography'(P.53). This does not occur in a vacuum, as Burr (2006) explains, the position from which we view ourselves is shaped by social interactions with others:

> 'Our self-narrative, and indeed any account we may offer of ourselves or actions, therefore must inevitably be a negotiated one, a joint product which emerges from social interactions' (P. 140)

Thus, it can be suggested that the acquisition of a professional identity is not simply achieved through gaining a new role or position, it is a multi-faceted phenomenon, shaped by many layers of social interactions in the life of a PMaST. This process begins in the formative years through early lived experiences in the family, and learning mathematics in school, followed by teacher training (McMullen & de Abreu, 2011; Mohr-Schroeder et al., 2017; O'Sullivan, Yung-Chi, & Fish, 2014; Schnee & Bose, 2010), and experience in the place of work; with pupils, teachers, school leaders, and other actors in a person's professional learning space. Therefore, as Illeris (2014) demonstrates identity is layered and develops over a person's life through personal, social and professional interactions. Thus, the community of practice in which a person works has a role to play in the development of their professional identity (Wenger, 1998), and changes that occur throughout a person's career typically involve changes in working identity. In parallel, experiences acquired

through CPD undertaken throughout an individual's career provide opportunities for professional identity construction (Osteen, Owen, Komives, Mainella, & Longerbeam, 2005).

However, while individuals have some space for agency in the construction of their professional identities, it is important to note their capacity for an agency is rooted in dynamics of power, control, resistance, race, gender, and skills (Jaros, 2012). Furthermore, it is suggested that how skills are developed and knowledge acquired can play a part in the construction of identity, since organisational expectations of identity development may not necessarily fit in with an individual's self-concept of organisational structures. (Alvesson, Lee Ashcraft, & Thomas, 2008; Alvesson & Willmott, 2002). In the context of this study, the participants were working within schools, therefore this space and the social interactions within this space shape the development of their professional identity, over time. The concept of control in this context can be imagined as workplace culture, leadership and management styles that can influence the development of an individual's identity. Thus, being able to negotiate the boundaries of schools is important since these have very established institutional patterns (Berger & Luckmann, 1966). The principles framing the research, (Silverman, 2010) and their interactions, are illustrated in figure 2.

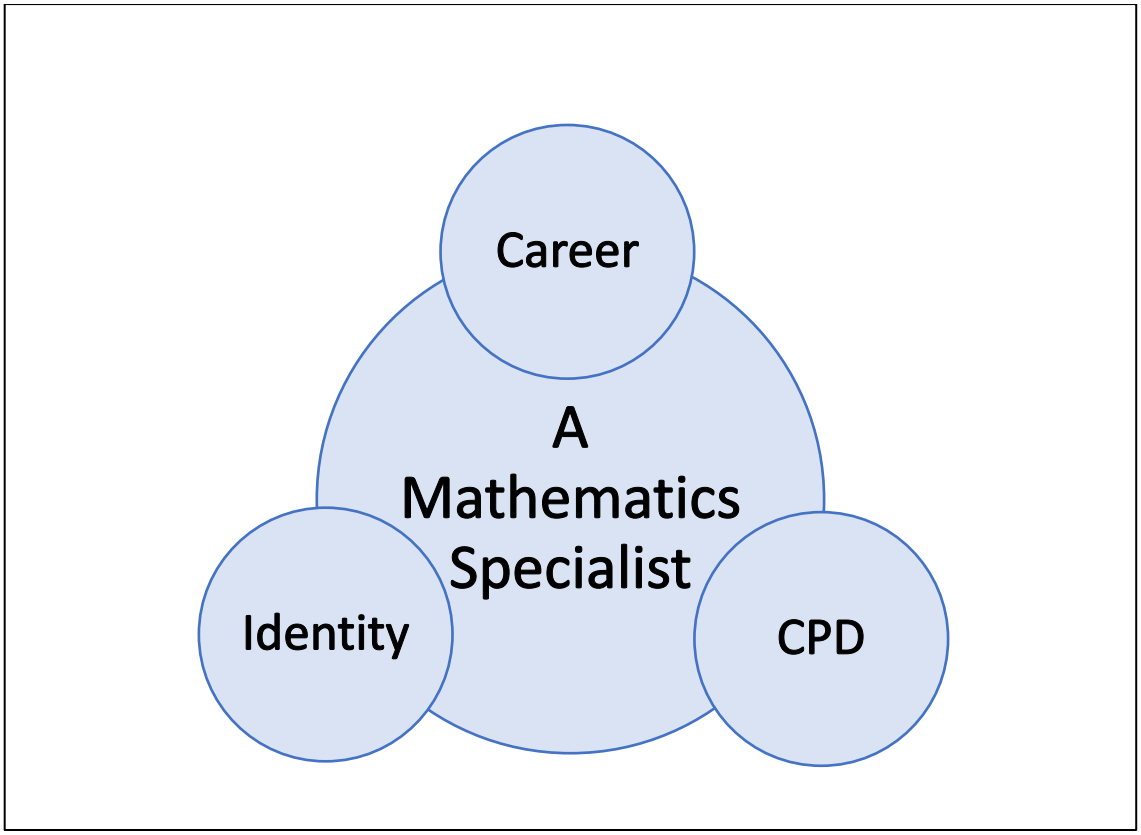


Figure 2 Diagram showing the conceptual framework for the study

2.1.1 The shaping of a personal and professional identity

The three main theories of identity (Ibarra, 1999a, 2004; Illeris, 2014; Wenger, 1998, 2000) that this thesis draws on will be discussed in turn.

First, the work of Illeris (2014) explains the many layers of a person's identity and importantly, takes account of how learning shapes and transforms individual experiences, to enable an understanding of how professional identities are developed over time. From this perspective, no single experience is a defining factor in developing an identity but as Illeris (2014) suggests identity is broadly made up of the following components seen in figure 3:

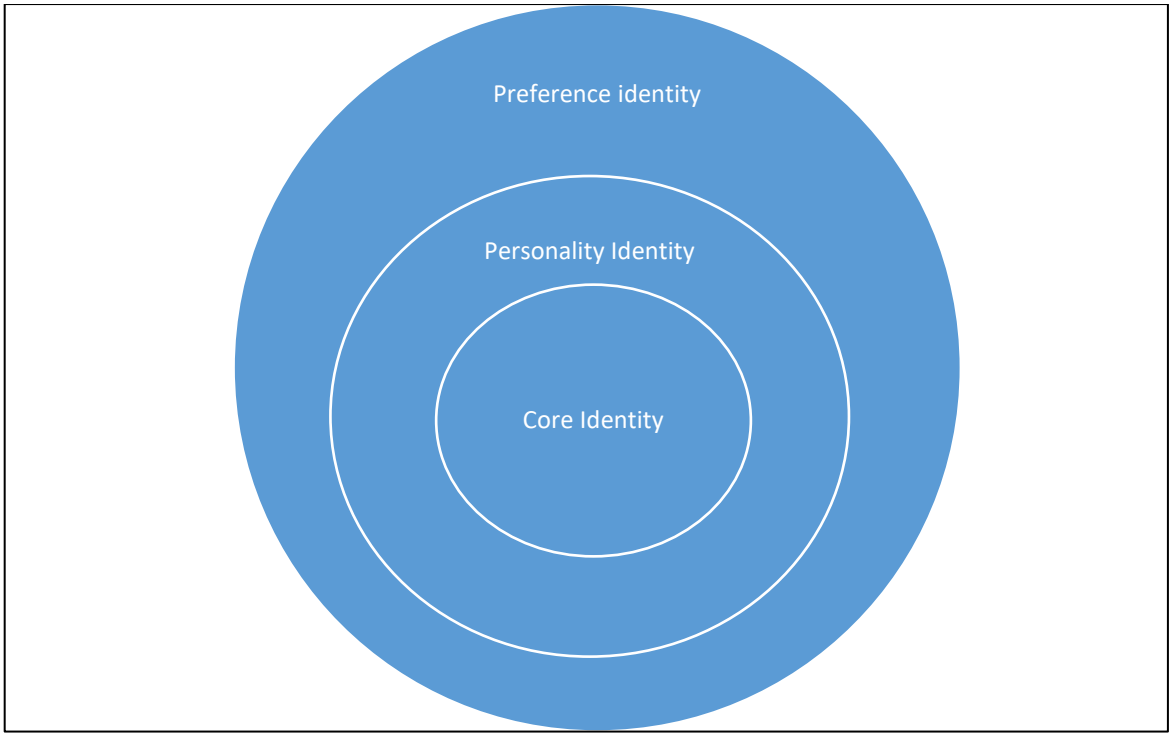


Figure 3 Identity development (Illeris, 2014, p. 71)

The core identity develops as we start to make sense of the world around us. This, core identity needs to be and indeed is 'relatively stable' (Illeris, 2014, p. 71) because of the limited influence this layer has with the 'outside'. Learning influences the core identity in a sustained and often transformative way, as the core identity varies in line and is reconfigured with the learning opportunities that individuals encounter throughout their life. Within the parameters of the core identity, changes take time and are gradual, enabling a sense of agency, stability and autonomy for the individual. This layer of identity is 'developed and changed during the life course' (Illeris, 2014, p. 72). This has relevance to PMaSTs since they experience opportunities for learning mathematics and building an agency as a PMaST through the course of their life and professional career. It could be suggested that Illeris' s (2014) core identity is driven by an individuals' understanding of self, however, Illeris (2014) points out that the core must be considered from the perspective of how the core identity is transformed through 'learning processes during the life course' (P,72).

For Illeris (2014), the personality layer is how we wish to be seen by others. It is argued by Illeris (2014) that these habits are relatively stable and they do not change over time unless there are some key defining reasons to do so. However, he goes on to caution the vulnerability of this layer by explaining that societal circumstances influence the development of personality and are not, therefore, always within the control of an individual. In consequence, for PMaSTs, the development of the personality layer of identity would be highly dependent on how they make sense of their social spaces and build agency. How they see their role and how their school would want them to work within the role, may pose limits to individual agency and tensions within the role (Jaros, 2012). In the case of PMaSTs, further constraints to an agency may be felt in how their values, attitudes and understanding of their role are questioned because of government policy and the changes in policy and practice do not align with their values or are incongruent with their identity as a PMaST.

Illeris (2014) named his final layer as preference identity. This is defined as being a more 'unstable and changeable layer of identity elements' (p.73). He argues that this is the preference layer because the individual is flexible in reacting to situations as they see fit. The change in this layer is dependent on our perceptions of the change occurring and 'whether we in the situation have the energy to make such changes' (Illeris, 2014, p. 73). Further explanations of this layers changeable feature are discussed as to how we are immersed in situations that we naturally get used to and expect change. Therefore, from a PMaST's perspective, this can be illustrated by the interchangeability of teaching roles and how teachers become accustomed to and expect changes on a day to day basis within a classroom pedagogical perspective or the expectations put upon then on a local school level and national level by government policy.

2.1.2 Identity and the community

The community in which an individual is situated plays an important part in identity development. First proposed by Lave and Wenger (1991), situated learning in the workplace, is embedded within

Communities of Practice (CoP), whereby participants assimilate norms and behaviour, values and practices, they negotiate and renegotiate experience through constant interactions with other participants in the social and physical context in which they work. Illeris (2014) drew on Wenger's (1998) notion of situated learning, through the now-seminal CoP theory to argue that participants become 'integrated elements of both the learning process and the learning taking place' (P.58). By this, Illeris (2014) was arguing that participants, come to understand their world through constant interaction and participation in CoP, which results in situated learning through and with others. In other words, individuals both negotiate meaning and they contribute to the construction of it.

A CoP is defined by Wenger, Trayner, and De Laat (2011) as:

> 'a learning partnership among people who find it useful to learn from and with each other about a particular domain. They use each other's experience of practice as a learning resource. And they join forces in making sense of and addressing challenges they face individually or collectively'. (p. 11)

This definition, therefore, sets out an understanding of what a CoP entails and how members within a CoP experiences are mapped out. These experiences help shape individual identities over time.

Wenger (1998) identifies five areas that are significant to developing an identity within a 'CoP', these components are:

- Identity as Negotiated experiences - we identify ourselves through how we participate in different situations and how we perceive others to see ourselves within these situations
- Identity as Community membership - we define who we are through familiar situations and also how we react and deal with unfamiliar situations.
- Identity as a learning trajectory - we identify who we are by where we have been and where we are going.

- Identity as nexus of multi-membership - we define who we are by reconciling our various forms of membership into one identity.
- Identity as a relationship between the local and the global - we define who we are through local ways of belonging to broader styles and discourses.

(Wenger, 1998, p.149)

The dimensions of identity, set out by Wenger (1998), are appropriate for this study since they provide a framework for understanding how a primary teacher can transform into a mathematics specialist as a consequence of participation in PMaST CoP. For example, Wenger's (1998) identity structure see the development of identity through social interactions and these different definitions of identity development within a community can be compared with Illeris's(2014) ideas of a layered identity such as the 'negotiated experiences' can draw parallels with the 'core identity' because even though there is community involvement, how a person interprets these ideas are very personalised and hence assert some personal control and agency over the outcomes. Whereas Illeris's (2014) personality layer can be compared with 'community membership and 'learning trajectory' where the identity has elements of individual agency and decision making within a community but there are elements of unfamiliarity that individuals have to face and make decisions around. Finally, Wenger's (1998) identity as 'nexus of multi-membership' and 'relationship between local and global' can be compared with the preference layer, as these identity constructs within a CoP are more fluid and interchangeable, depending on how individuals deal with extreme changes and hence realign their identities within the community. Since Wenger's (1998) dimensions of identity enable greater consideration of situated learning processes offered by Illeris' s (2014) framework of identity development, Wenger's work is drawn upon, where relevant, to provide a richer theoretical insight into individual experiences within their CoP.

2.1.3 Identity and professional learning

Professional learning, through CPD, plays a significant role in developing expertise. By understanding the range of professional learning that PMaSTs undertake and how these professional learning opportunities impact the PMaSTs, conclusions can be drawn on the role CPD plays in constructing identities as PMaSTs. Ibarra's (1999a) work on career development conceptualises how professional identity is intrinsically linked with career transitions and career change. Ibarra (1999a, 2004) argues that individuals encounter many changes throughout their careers hence, professional identities develop through the experiences encountered and the actions taken whilst experiencing and navigating new knowledge and skills to adjust and transition into new roles. Therefore, career transition is a meandering path, bringing with it a series of 'possible selves' (Ibarra, 2004, p. 14).

Parallels can be drawn with the construct of identity theorised by Ibarra (1999a, 2004) and Illeris (2014). Both illustrate the nature of identity construction is an immersive, transformative and lifelong process with layered dimensions. The genesis of these identities takes place on an individual level, over the space of one's life, as illustrated by Illeris (2014) and a professional level, as demonstrated by Ibarra (1999b, 2004). Both theories are driven by how individuals interact within their social spaces on both a personal and professional level to build agency and construct their new emerging selves.

Wenger's (1998) CoP creates a helpful approach to augment both the work of Ibarra (1999b, 2004) and Illeris (2014) because it emphasises the importance of situated learning experiences within a CoP. Wenger (2004) shares the notions of a domain, the community and practice as three distinct components for a successful CoP. The domains link to the knowledge being discussed, shared and learnt within a community, the community is the group for whom the knowledge is relevant and the practice is how the knowledge is shared. Thus bringing together the key principles for a successful CoP where professional learning takes place over some time and supports the learners within the community to transform their identity through learning. Wenger (2000) argues that learning is not

simply an accumulation of knowledge and skills, it transforms who we are and therefore identity plays a key role in understanding our interactions in CoP. Furthermore, Wenger (2000) uses the two terms: boundaries and brokering to illustrate that within a single space in time, individuals can belong to more than one CoP, therefore the move between boundaries and thus broker elements from one community to another. In the case of PMaSTs, distinct community membership could be that within a mathematics CoP, a primary teacher CoP, a year group CoP, a leadership CoP etc. Thus the professional space where individuals exchange and develop their practice within a community is a complex and fluid idea and dependent on how individuals see themselves as learners and the transformational nature of learning.

Ibarra's (1999b, 2004) ideas are explored in more detail by the work of Guskey (2000), who defines CPD as 'those processes and activities designed to enhance the professional knowledge, skills and attitudes of educators so they might, in turn, improve the learning of students' (p.16). Whereas, Clarke (1991) provides a succinct definition of professional learning as: 'Any activity or process intended to change any combination of the following: teachers' beliefs and attitudes, teachers' knowledge and teachers' classroom practice' (p.1). The core of these definitions focuses on teachers and their beliefs. However, it is important to note that for professional growth through CPD other factors are also at play, namely the cultural settings within the organisation and how the interaction occurs with the recipient of the CPD and their organisational culture (Sparks & Hirsh, 1997).

Day (1999) developed a detailed definition that takes into account the role professional learning plays in the transformation of individuals and the communities in which they serve, over time:

> 'Professional learning consists of all natural learning experiences and those conscious and planned activities which are intended to be able to be of direct or indirect benefit to the individual, group or school and which contributes, through these, to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purpose of teaching; and by

> which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives.' (p.4)

The definition by Day (1999), illustrates the transformation teachers go through whilst undertaking a range of professional learning. Through the use of the phrase 'change agent' (Day, 1999, p. 4) suggests the interconnections between developing their agency as teachers and thus their emerging identity from a novice to an expert teacher (Dreyfus, 1982; Dreyfus & Dreyfus, 1980), over the course of their careers. This emergence of a professional identity is nurtured through the professional learning opportunities afforded to individuals throughout their careers and the communities they belong in and serve.

The value of professional learning opportunities is illustrated well through the seminal work of Lee Shulman. He illustrates how Subject Pedagogical Knowledge (SPK) broadens and expands how a teacher visualises their self-schema over time (Shulman, 1987). This places importance on how teachers experience transformation through skill acquisition (Taylor, 2009), to successfully share and develop concepts with their pupils and act as agents of change through mentoring and coaching colleagues. In doing so, there is a dimension of sustained learning and developing their SPK. Professional learning can be sporadic and merely operational, and may not benefit the individual in the long term. Therefore, this thesis aims to add to the knowledge of how successful PMaSTs emerged through long term and sustained professional learning opportunities.

The idea of developing from a novice to an expert teacher(Dreyfus, 1982; Dreyfus & Dreyfus, 1980) aligns with the principles underpinned by the work of Shulman (1987), achieved through meaningful professional learning opportunities, teachers emerge from novice to experts in their field. This model is of interest to understand how a primary teacher emerges from a novice to an expert PMaST, throughout their career and how professional learning enables this change.

2.1.4 Teacher Identity

The literature on identity is vast but becomes sparse when focusing on mathematics and identity and then on mathematics, identity and primary teaching and specialist teachers of mathematics in primary schools in England. Therefore, the literature on teacher identity is explored first.

Within the literature on teacher identity, context is argued to play an important role in identity development. As Philipp (2007) points out, teachers are grounded within their context and therefore this supports their identity growth. As argued by Lave and Wenger (1991), Philipp (2007), asserts that identity is, therefore, a social, cultural construct, developed within the surroundings and through the interplay of the teacher with his/her environment.

Earlier work on teacher education highlights self-perceptions regarding how teachers see and know themselves plays an important role in developing their teacher identity (Kelchtermans & Vandenberghe, 1994). Teacher identity is not only constructed through development of skills (e.g. subject and pedagogical knowledge) and how this interconnects with their personal lived experiences (Hargreaves, 2001; Nias, 2002; Sumsion, 2002), but also through social interactions with their personal and professional lives. Thus social interactions play an important role in emerging professional identities (Lave & Wenger, 1991).

Hargreaves (2001); Kelchtermans and Vandenberghe (1994); Nias (2002); Philipp (2007); Sumsion (2002) conceptualisation of teacher identity share parallels with the work of Illeris's (2014) notion of a preference identity, where a teacher's identity is shaped through their interactions with their surroundings and each teaching situation is fluid, constantly changing to fit and accommodate its surroundings. It can also be argued that some elements of the personality layers, as defined by Illeris (2014) are shared by Collopy's (2003) definition of identity where self-efficacy plays a part in how a teacher sees themselves, their own beliefs and values, their subject knowledge and therefore how they develop their identity as a teacher of mathematics.

2.1.5 Identity and career trajectories

The way career is defined and how we perceive career trajectories has had a significant move in the post-industrial and post-modern era, (Peavy, 1993). Therefore, the notions of a career and how individuals define, align and realign themselves within their career trajectory informs and constructs their identity. Gysbers and Moore (1981) discuss the notion of a career being defined by a range of variables that surround an individual. These variables consist of locality, the roles that individuals undertake and the circumstances that individuals encounter. They argue that these interactions are complex and therefore a new approach needs to be taken in defining a career path; they suggest the term 'life career development' to be used instead of simply career.

The notion of career is further expanded upon by Herr and Cramer (1992), they emphasise that the nature of a career is defined by intrinsic factors from an individual as well as extrinsic factors that individuals are surrounded by. They argue that the nature of these factors and the interaction of individuals is a dynamic process rather than being static. Therefore, the way individuals make decisions and how they interact within their surroundings has a measurable effect on the definition of themselves and their career paths across their life spans.

The idea of developing from a novice to an expert (Dreyfus, 1982; Dreyfus & Dreyfus, 1980) teacher throughout a career is a key component in understanding how teacher identity emerges as a result of developing expertise, over time. Chen (2006) illustrates constructs of community and how these ideas combine to suggest that one's career cannot be understood in isolation, to understand career development, there need to be an understanding of: 'one's life experiences and career experiences as a whole entity, or in other words, as a balanced and co-related human way of being' (p.439). Therefore the notions of a career change being an emotionally driven phenomenon and hence enabling a lasting change in one's identity (Ibarra, 2004). These ideas will be used in chapter 7 to shape an understanding of how PMaSTs link career development and personal lived experiences to fully understand how biographical processes and experiences shape identity development and

career trajectories of primary teachers who become PMaSTs. Illeris's (2014) identity layers can be compared and constricted to conceptualise how a career develops as a co-construction between an individual and their personal and professional environment.

2.2 Identity and mathematics

2.2.1 Mathematics identity, teacher identity and community of practice - the values of situated learning

Mathematics researchers looking into the professional identities of mathematics teachers, attempt to frame their research by 'drawing' and adapting ideas from frameworks such as CoP (Wenger, 1998) and situated learning (Lave & Wenger, 1991). Skott (2013) suggested that simply repeating ideas can be problematic as they can become diluted and lose the essence of the original ideas. Therefore, these ideas are worthy of note when adapting a theoretical framework for exploring PMaST identities.

Research undertaken by Palmér (2016) with seven novice teachers in Sweden explored the 'professional identity development' of 'novice primary school mathematics teachers' (p. 682). A case study approach was adopted by Palmér (2016), using self-recording as well as observations and interviews to elicit identity development over time. Palmér (2016) used the work of Lave and Wenger (1991); Wenger (2000) to illustrate community learning in practice, as well as the work of Skott (2013) showing how patterns of participation can be analysed to further understand how identities are shaped over time.

Palmér (2016) concludes the importance of a community of practice and patterns of participation, where the teacher engages with tasks individually and interacting with others, helps shape their identity.

Further exploration of communal identity is explored by the work of Goos and Bennison (2008), in a study with 19 secondary teachers in Australia, who had an online community to interact and share ideas with whilst training to be teachers. They were encouraged to continue this virtual community after the course ended. Goos and Bennison (2008) observed that the teachers continued to participate in the online community even though they had finished the course. These interactions, although more sporadic, illustrated the sense of community developed through the online platform. The study concluded that the way the teachers realigned themselves within the online community once in full-time jobs varied but they continued to benefit from the experience of mutual group history. This study demonstrated that the benefits of a CoP is a dynamic process and does realign itself, depending on the context it is operating within (Goos & Bennison, 2008).

Wenger's (1998) CoP, was used by Graven (2004) who focused more specifically on its components of meaning, practice, identity and community. This was an ethnographic study with 10 teachers in South Africa, over two years. The researcher was also the coordinator of the in-service training for the participants. One limitation of this study was having the coordinator of the training conducting the research, thus creating insider bias. Graven (2004, p. 177) shared the notion of 'Learning as mastery' arguing that mathematics is a subject that involves a continuum of learning and mastering, so individual primary teachers have different levels of mastery of the subject throughout their careers, thus shaping their mathematics identity, over time. The more they develop, the further their learning enables them to master the subject. Her work demonstrated that teachers were able to have confidence in sharing, with other teachers, aspects of mathematics that they still needed to develop. The study shed light on identities of teachers of mathematics and how they gained confidence through mastery of the subject within their communities of learning.

2.2.2 A teacher's mathematics identity - research in the field.

This section will shed light on research into teacher identity in the field of mathematics. The literature search has identified sparse research in this area within the UK, therefore international studies of teachers of mathematics are drawn upon to build a narrative on how a PMaST identity is constructed, over time.

In a qualitative study carried out by Collopy (2003) where two upper-elementary teachers in the USA were given professional development material, with instructions and asked to independently use these materials to develop their mathematics instruction. The study concluded that one of the teachers' gained more out of this independent learning opportunity, illustrating a change from their initial beliefs in how mathematics should be taught, thus enabling a change in their practice. Whereas, the second teacher, who was already a confident mathematics teacher and taught traditionally, did not change their beliefs in how to teach mathematics and thus little change was observed in their identity as a mathematics teacher. Thus Collopy (2003), suggested that teacher identity is a 'constellation of interconnected beliefs and knowledge about the subject matter, teaching and learning as well as personal self-efficacy and orientation towards work and change' (p.289). It can be argued that the PMaSTs construct their working identity with their experiences, thus there are parallels to what Collopy (2003) defines as the beliefs that create a teachers' identity and the construction of knowledge primary teachers cultivate by becoming a mathematics specialist. However, this study's major drawback is the sample size and similar studies would need to be carried out to consolidate the findings from this study.

Anderson, Boaler, and Dieckmann (2018) empirical, quantitative study with 40 teachers in eight schools districts in the USA, over one year, aimed to challenge the mind set of being born to 'be good at mathematics'. Through a structured programme of professional learning, the teachers' transformed the way they thought about how mathematics is learnt, thus having a ripple effect on the mathematics achievements of their pupils.

An empirical, qualitative study with 22 twelve to thirteen-year-old pupils and their teachers (18) was carried out in New Zealand by Darragh (2015). The data was collected over three years and consisted of lesson observations as well as individual interviews with both the pupils and teachers. The analytical framework developed by Darragh (2015) termed as 'performative lenses' (p.83), involved exploration of how 'we become a mathematical learner in a performative manner and it is the repetition of performances in mathematics learning contexts that generate our recognition of ourselves in certain ways as learners of mathematics' (p.85). These performances can range from putting hands up, to solving complex mathematical problems. Darragh (2015) further signposts that the performances are affected by where the performance is taking place, e.g. in the classroom, in isolation, in the library or at home etc. As such, the place can either enable or hinder the performance, therefore concluding that the constraints act as barriers in developing complete control over our emerging identities, allied to our performance in mathematics. However, the notion of complete control over an emerging identity is questionable because of the many actors involved in its emergence, over time. This is further illustrated by the work of Jaros (2012) who discussed that people can exercise agency but there are limits to this, as external factors are fluid and therefore affect one's ability to completely control how we shape our emerging identity. Although the work of Darragh (2015) is positioned in the teaching of mathematics to pupils, the theoretical understanding of the development of agency whilst learning mathematics are significant ideas connected with building an identity as a mathematician and thus will be drawn upon to illustrate the findings of this study. These ideas dissect with the theoretical framework of identity, community and career of this study as they focus on the crosssectionality of developing an identity as a mathematician and knowing that a wider sphere of influence enables individuals to recognise and understand their capabilities as a mathematician.

A qualitative study by Hodges and Cady (2012) with one middle-grade mathematics teacher in the USA, argued that school leaders play a big role in how mathematics is taught and this may be in conflict with how a mathematics specialist might perceive it to be taught best. Additionally, the

wider 'community of practice' teacher interactions and the influence of collective experiences are essential in shaping ideas of an identity as a mathematics teacher (p.114). However, it is important to acknowledge that this research was conducted with one participant and thus has its limitations for generalisation.

Recent research by Skog and Andersson (2015), who studied the learning journeys of trainee teachers and the development of their mathematics identities, concluded that the positioning of a mathematics specialist is vital and this is a 'dynamic phenomenon as it changes according to the point in a teachers' career', (Skog & Andersson, 2015, p. 71). Furthermore, they argued that how the subject is positioned and therefore the power structures of the subject within social strata need to be taken seriously if an in-depth understanding is to be made of emerging identities of mathematics teachers. This share parallels to the research of Hodges and Cady (2012) where a range of influences interact and seek to inform the identity of mathematics specialists.

The conceptual framework of Wenger (1998) and Shulman (1987) is drawn upon by Van Zoest and Bohl (2008) to create distinct domains to explore mathematics teacher identities. Van Zoest and Bohl (2008) research with secondary mathematics specialist teachers in the USA illustrated the relationship between thoughts and actions – what teachers learn and what they do in the classroom. This is framed within the importance of having the subject knowledge to make autonomous decisions (Shulman, 1987) and the important role a learning community plays in developing these processes (Wenger, 1998). The research sought to illustrate the complex nature of an emerging professional identity, how it is shaped over time through individual interactions and decision-making process.

Although Van Zoest and Bohl (2008) use Wenger's (1998) theories of situated learning, the conceptualisation of how teachers build their agency as specialist teachers of mathematics is not drawn out. Therefore, this study aims to build on this further by understanding how the participants

of this study inform their developing professional identity through the support of their community of practice and their professional learning opportunities.

The way we think about the learning of mathematics cannot be seen as an island where there are no contacts between the nodes of connections, namely individual interactions between self, community and environment, over time. To enable a refined understanding of how learning takes place, one has to consider not just the act of learning but the ways this learning is linked to the social context. Within the context of this research, it is the PMaSTs' interaction with self, with each other and within their school and wider communities, over time. This is because one could argue that with new ideas, thinking and learning is constructed within these communities (Lave & Wenger, 1991; Wenger, 1998, 2000).

An empirical study by Bjuland, Cestari, and Borgersen (2012) on the identity development of teachers conducted in Norway, used a narrative approach over three years. The paper focused on one teacher and the emergence of her professional identity. The research uncovered four identity indicators, found both from the teacher action and reflective narrative, linking these reflections to professional learning opportunities. This work suggests insight into factors that enable the development of professional identity, e.g. changes in the way a workshop is delivered, is noticed through the course of the study, showing a realignment in the teacher's understanding of the mathematical concepts and therefore a change of approach. The leadership of the school and the influence this had on the development of one's professional identity is also one of the conclusions from the study. Both ideas of refining CPD structures and support from school leaders are important factors in successful identity transformation into a PMaST. Bjuland et al. (2012) conclude that the importance of their research is the development of dialogue created around professional identities of teachers and therefore this can continue to look at how the identity of teachers emerges and shape over time. Identity is a transformative concept and it is context specific to the individual, or the interaction of the individual within their community (Bjuland et al., 2012).

Although ability grouping and identity links more to pupil mathematics identity, it is worth noting that ability grouping, as illustrated by a wide body of literature indicates the negative impact it has on pupil outcomes. Mathematics teachers have within their power to teach outside of ability groups to develop agency within their class and thus foster positive relationships with mathematics. Ability groupings have the power to make or break individual mathematics identities as they set out to 'label' individuals (Boaler, 1997, 2009, 2014; Boaler, Wiliam, & Brown, 2000; Francis et al., 2017).

The body of literature has enabled an evidence-based insight into identity and how it is developed. Particular attention has been paid to teachers of mathematics and how identity is conceptualised within mathematics education. Although the identity literature is sparse about mathematics specialists in primary schools in England the research that does exist includes a recent comprehensive review of the 'research on mathematics learner identity' and on identity research in mathematics education (Darragh, 2015; Radovic, Black, Williams, & Salas, 2018). The review concludes that although there continues to be a steady increase in articles published on the topic of mathematics learner identity and mathematics teachers, there is a gap in identity research of primary teachers who become PMaSTs. Therefore, it is hoped that this thesis will add to the growing literature on identity in the field of teacher expertise in mathematics. This will therefore further shed light on how novice, non-specialist primary teachers in England can be supported to emerge as PMaSTs, throughout their careers.

2.3 Primary ITT in England, early career development and the place for a Primary Mathematics Specialist Teacher (PMaST): the problematic nature of developing mathematics teachers.

Although mathematics anxiety is not directly within the scope of this thesis, it is valuable to draw on research in this area to set the context of primary teachers and their mathematics learning throughout their lived experiences. It is well-documented that many people grow up with mathematics anxiety (Dowker, Sarkar, & Looi, 2016; Grays, Rhymer, & Swartzmiller, 2017; Moustafa et al., 2017; Skagerlund, Östergren, Västfjäll, & Träff, 2019). These anxieties develop over time and, if not tackled during the early stages of learning, become an obstacle to successful learning of mathematics. Carey, Hill, Devine, and Szücs (2015) suggest that the influence of mathematics anxiety on mathematics performance can lead to a 'bi-directional relationship', (p.1) leading to a vicious circle of underachievement in the subject.

Perhaps unsurprisingly, a body of empirical research showed many trainee teachers similarly start with such anxieties towards mathematics (Çatlıoğlu et al., 2014; Cotton, 2016; Griffin, 2014; Haylock & Manning, 2019; Mizala, Martínez, & Martínez, 2015) stemming from early experiences of learning mathematics and achievement in the subject (Picker & Berry, 2000). It is now well-established from a variety of studies that teachers bring a great deal of 'baggage' acquired through their own educational experiences in mathematics into adulthood and their professional teaching career. This is illustrated in research by McCulloch, Marshall, DeCuir-Gunby, and Caldwell (2013), undertaken with kindergarten and grade two teachers in the USA:

> "My teacher was very mean… she would say a math fact and point her ruler at the person to give an answer. If the student did not answer, she would whack the back of a student's hand with a ruler… it does not take a trained psychologist to deduce that this is the root of my math anxiety." (McCulloch et al., 2013, p. 385)

The authors of the study suggested that teachers often opt to work with younger year groups (kindergarten to grade 2) precisely because they believe this will not involve teaching 'challenging' mathematics. However, it is still not known whether teachers make decisions around their career development due to their own experiences around mathematics or a genuine desire to build a career within a particular age range.

In a study by Wilson (2018) based in Australia, the author suggested that twelve trainee teachers had transformative experiences through attending and engaging with workshops that enabled deep reflection into their perceived mathematics anxiety through using the framework of 'Quality of Life', first developed in a health department at The University of Toronto (Renwick & Brown, 1996). The framework consists of three domains listed in figure 4:

Domain	**Attribute**
Being	Individual Attributes
Belonging	The individual in their environment
Becoming	Life Goals

Figure 4 Domains for the Quality of Life Conceptual Framework (Renwick & Brown, PP. 82-84 1996)

The study provided further insight not only into approaches that enabled trainee teachers to move beyond their previous lived experiences around mathematics, but also permitted a lens in understanding the development of a mathematics identity. The framework allowed for insight from three different perspectives, namely: self, social belonging and community belonging (Wilson, 2018, p. 171). The framework is relevant for this study as it developed notions of identity through intrinsic and extrinsic factors and how these built, over time, through personal and professional interactions. For example, what does a teacher perceive their self-identity as a mathematician to be and how do they see this developing over time within their learning space? Furthermore, Wilson's (2018) study drew upon the notions of the CoP through the work of Wenger (1998, 2000), to provide a framework

for teacher development through community activity. Therefore, even though authors such as Cockcroft (1982); Haylock and Manning (2019); Olson and Stoehr (2019) highlight the impact mathematics anxiety has on trainee teachers' confidence, there is empirical evidence demonstrating that through appropriate professional development opportunities, a positive approach to mathematics can be developed and achieved.

As anxiety can develop through a lack of subject knowledge, government policy has sought to tackle this, by creating professional learning opportunities to develop teachers' confidence and understanding of mathematics teaching and learning. One such strategy was recommended by Sir Peter Williams in a review of teaching in the early years and primary settings:

> 'It is firmly argued that most ITT does not in itself constitute a sound basis for a deep subject and pedagogical knowledge in mathematics, and this report, therefore, lays great emphasis on continuing professional development (CPD).'(Williams, 2008, p. 3)

The review put the nature of expertise in mathematics in context and elevates it to a Masters level qualification for primary teachers in England. This is important, as it raised the status of professional expertise in mathematics teaching and learning for primary teachers in England. Therefore, government policy has been mindful of the need to develop and sustain mathematics expertise through high-quality CPD, to elevate the status of mathematics teaching and learning in the primary sector. Furthermore, this assertive policy decision showed the government taking teacher career trajectories seriously by creating high-quality professional learning opportunities.

Using empirical data in the field, the next sections of the literature will explore the key concepts driving the research, namely, career trajectories and CPD.

2.4 Teacher career trajectory and professional space

This section will focus on career trajectories, one of the concepts framing this research, and how they develop over time.

Primary teachers are generalists, meaning that they do not come into their career with a specific specialism. The demands of the primary curriculum (DFE, 2013b), mean primary teachers have to be confident and competent in developing all aspects of the curriculum requirement with their pupils. There are routes into primary education with a mathematics specialism but these are rare, therefore not many primary teachers start their career as qualified PMaSTs.

Little research exists on the career paths of primary teachers and especially teachers who either choose or are encouraged to take a PMaST role. This section takes a look at current research that examines career trajectories and its links with professional development. The Advisory Committee for Mathematics Education's (ACME) evaluation of the professional development opportunities for mathematics across English schools recommended three key principles that should drive a national policy for professional development ACME (2013). It states that:

> 'Professional development should be accessible to all teachers of mathematics. It should be specialist, supported and sustained and be of the highest quality.' (ACME, 2013, p. 16)

This vision, mapped out in 2013, has borne some fruits in the development of new Mathematics Hubs that provide appropriate training, but the opportunities are only available to those who have links with the Mathematics Hubs in their local area, (NCETM, 2017). There are, however, opportunities here for expert teachers of mathematics to develop their careers by being involved in these Mathematics Hubs. This is being facilitated by developing a new generation of specialists in primary mathematics. There are no current independent evaluations of the Hubs to quantify their impact on the teaching of mathematics.

There is something that happens in primary schools that have not been researched to date but can only be explained as 'talent spotting', whereby teachers are picked for the expertise they exhibit in class. Many primary mathematics specialists discuss 'stumbling' into the role of developing mathematics across the school because they found the teaching of mathematics challenging and therefore to teach it well, spent significant time planning and preparing lessons. Not specific to

mathematics but worth noting, the research of Draper, Fraser, and Taylor (1998) with a range of primary and secondary teachers, demonstrated that teachers are ambitious in developing their leadership roles and therefore are keen to take on opportunities to apply for and develop roles that sustain them professionally and inevitably take them out of the classroom. Therefore, it can be suggested that primary teachers, even though they may not feel confident in the teaching of mathematics, will take on leadership roles in the subject to develop their knowledge and understanding in the subject and more importantly, leadership to support their career progression.

As a result of becoming subject leaders, many opportunities open up to these individuals, such as Masters level mathematics specialist qualifications. In a national drive to develop mathematics, a range of strategies such as the national strategies (DFEE, 1999) or the more recent Mastery programmes, developed by the NCETM, (NCETM, 2017) gives professional development opportunities for primary teachers, providing greater learning opportunities. However, a qualitative study, conducted in Australia by McCormack, Gore, and Thomas (2006) with 16 early career teachers, demonstrated that although early career professional development provided valuable career progression, the 'additional responsibilities and unrealistic teaching expectations' proved burdensome. Although, early career teachers do place value on their career development, be it via traditional ways such as having a mentor or non-traditional ways such as peer collaboration projects, the 16 participants in this study did find the unrealistic targets, the demands of extra responsibilities and the lack of appropriate professional feedback and time to develop their careers a real barrier in career progression. However, what McCormack et al. (2006) fail to do is to distinguish teachers' careers and their developing identity as mathematics specialist teachers or the identity work involved in that transition. Another weakness is that the study does not explain how the challenges identified might be overcome.

Career trajectories are not static; they are fluid, dynamic phenomena, varying in their context according to the place and situation they exist within. Chen's (1998) review of literature outlines

three explanations for any career, these are: 'career as a life process, a career as an individual agency and career as meaning-making.' (p.437). Each distinction of a career will be expanded upon below, whilst expanding upon the theory underpinning the stages. These explanations provide a useful framework to explore aspects of career development and trajectories in further depth.

2.4.1 A career as a life process

The notion of a career is ever-expanding and changing in the fast-paced world that we live in. Therefore, the belief of a career as a life process where it evolves, in line with the stages that an individual goes through across the span of their career are worthy of note. In an essay by Peavy (1993), there is a clear emphasis on the nature and definition of a career as a life process evolving and changing within the 'post-modern and post-industrial' (p.123) era that we live in. The processes that one goes through whilst developing a career are defined and developed through their interaction with the personal and professional environment in which they are embedded. Therefore, their identity constructs around aspects of their career are part of their development trajectory. Chen (1998) defines three core characteristics in developing a career as a life process, these are:

> '1) attends and goes across one's total lifeline
>
> 2) represents a changing process rather than a static state, and
>
> 3) calls for the person to become an active agent who constantly builds constructive bridges between oneself and one's work-life environment.' (p. 440)

These core characteristics demonstrate and provide some structure to how careers are moulded and developed across the span of an individual's career. These developments are situated and socially engineered through interactions with the individuals and their environment.

2.4.2 A career as an individual agency

At the heart of Chen (1998) review of literature in this area is that the construct of one's career is rooted in agency and self-development; the notion of planning a career and developing it over time.

Although teachers are seen to be in charge of their individual career development, there are certain tensions they have to negotiate that are extrinsic and therefore out of their immediate control. Day, Kington, Stobart, and Sammons' (2006) work with 300 teachers in 100 schools demonstrated that teacher identity showed fragmentation at different times, depending on a range of factors that are not only linked to personal circumstances but also to specific factors such as policy alterations that they cannot directly control. However, the policy changes create uncertainty and instability within the workplace and may have an impact on career development and progression. An example of this could be the announcement of a government budget and how schools fare in this, as well as significant policy changes such as stopping funding for specialist programmes such as the Advanced Skills Teacher (AST) title (Fuller, Goodwyn, & Francis-Brophy, 2013; Fuller, Goodwyn, Francis-Brophy, & Harding, 2010). These changes affect career trajectories as a lack of funding could mean that an expert PMaST might decide that they would rather develop their career by pursuing a senior leadership role, rather than continuing as a PMaST.

2.4.3 A career as meaning-making

Perhaps, for a PMaST, the most significant component of Chen (1998) idea is that of a 'career as meaning-making' (p.448), in that the work one undertakes in a career is very much aligned with the philosophy of why an individual is undertaking such a role, involving both extrinsic factors and intrinsic motivational factors. In a PMaSTs' case, they promote and champion mathematics in primary schools because they understand the value of the subject.

These conceptualised ideas of career development shed light on how a career is perceived and developed in a post-modern and post-industrial era. Although the focus of this study is not around gender, it is important to note the primary teaching population in England is skewed by having more females than males. As Correll (2001) suggested, societal norms around gender are so entrenched that females sometimes perceive themselves to be of lower competence in subjects such as mathematics and these later lead to career choices that are below where their actual capability lies.

The way a school is structured and how leadership works within a school setting plays a significant role in how an individual's career is developed. Rhodes (2006) discussed the notions of the impact of professional development and the importance this plays in developing a powerful 'creative professional identity' (p.157). This type of identity pays a higher rate of return by creating confidence and autonomy in developing a rich and rewarding career path as opposed to an 'instrumental technical identity' (p.157), that can lead to dissatisfaction with the job and inevitably leaving the profession. Rhodes (2006) emphasised the point that to develop a 'creative professional identity', a key role is played by leadership and how they develop talent within their school.

It can be concluded that the way a primary teacher's career develops is not linear, it varies depending on the learning environment and the opportunities that arise. There are many factors at play that are either personal or are linked to policy and the dynamics within the working environment.

The focus of the next section is on CPD and the role it plays in career and identity development.

2.5 Continued Professional Development (CPD)

It can be argued that the notion of career and CPD go hand-in-hand, as a career cannot develop and flourish without sustainable structures of professional learning opportunities. Therefore, this section will provide some additional context on CPD and its place in the development of a career. Literature is drawn from teacher professional learning opportunities as well as mathematics CPD to build a picture on the role CPD plays in developing specialist mathematics teachers.

A study carried out by Hodgen and Askew (2007) researched the motivations that enabled teachers to continue with their professional learning. The study looked in depth at five teachers who took part in a four-year longitudinal study around a mathematics professional development programme in England. The main findings of the study demonstrated the growth teachers experienced as a result of undertaking additional training. The participants experienced a change in attitudes in how their mathematics was received and therefore how they then used their new-found confidence and

mathematical knowledge with individuals within their learning communities. In this research, teachers went from having low confidence in mathematics to leading professional development and presenting to a wider audience. Hodgen and Askew (2007) related this to Povey's (1997) ideas of going from a 'position of silence, or disconnection with mathematics, to a position of authority, a belief in his/her active role in the construction of mathematical knowledge' (p.471). However, they noted 'tensions between caring and nurturing aspects of primary teachers versus the strong disciplinary focus in mathematics' (Hodgen and Askew (2007, p. 482). There is a divergent indicator of career development here and the tensions that primary teachers face in being generalist teachers and developing a pastoral and nurturing role, not just with their pupils but with their colleagues as well. The role of a mathematics specialist within this research suggested that, due to the very nature of the subject, developing as a PMaST proved problematic. Therefore, through understanding the role of CPD in tandem with the development of a professional identity, further light can be shed on understanding how PMaSTs develop their professional identities, through the course of their careers. Furthermore, the role of a community of learners' played will help shape a deeper understanding of how the primary teacher developed their identity as a successful mathematics specialist.

Many professional development models for mathematics are designed to enhance teacher subject and pedagogical knowledge and thus aim to improve pupil outcomes. In a study by Harris, Stevens, and Higgins (2011) in the USA with 65 middle school mathematics teachers, a structured model of professional learning was evaluated. The model consisted of courses that developed both subject and pedagogical knowledge to advance the effectiveness in the teaching and learning of mathematics. The findings demonstrated an improvement in teacher pedagogical and curriculum knowledge, this, in turn, had an impact on teacher confidence and pupil outcome in mathematics. The study also concluded that any professional learning opportunities needed to be not only a monetary investment but, more importantly, an investment of individual time to gain measurable returns on the investment.

A study exploring how confidence impacts on the teaching of mathematics by McCullouch (2016) illustrated that knowledge was a major component for teachers developing confidence in the teaching of mathematics. This study was done with a range of four mathematics teacher groups in England. McCullouch's (2016) work further demonstrated the importance of developing mathematical knowledge: pedagogical, subject and curricular to confidently teach the subject and as a result of this confidence have likely impact on pupil outcomes.

A longitudinal study undertaken in the USA illustrated how a group of 24 teachers, ranging from Kindergarten to grade eight showed measurable growth in teacher knowledge of both subject and pedagogical knowledge of mathematics (Copur-Gencturk & Lubienski, 2013). These results indicated how teacher confidence grew from sustained professional learning courses, delivered throughout a teacher's career. In a further study, a sample of 542 teachers was used by Copur-Gencturk, Plowman, and Bai (2019), to understand 'key features in professional development to bring about changes in teachers' mathematical knowledge for teaching', (p.1590). These features hone in on specific and personalised learning opportunities, directly linked to the curricular content that the teachers were expected to deliver. Furthermore, the study concluded that teachers also benefited from understanding the interconnectivity between the mathematics subjects being taught and the progression within the subject matter, this in turn enhanced and impacted upon the learning outcomes of their pupils. A final powerful outcome of the study showed how teachers learnt from their pupils, through careful analysis of pupil work as well as deep discussions with pupils about their mathematics learning. These findings are significant in understanding the importance of high-quality professional learning opportunities and how they enhance and empower the learning of both teachers of mathematics and pupils of mathematics. The focus of this study was on the impact of a CPD intervention on learners' knowledge and confidence. It has made a useful contribution in that regard. However, it does not tell us if the effects continue long term into the future. This thesis sets out to add to this area of knowledge, in addition to how CPD plays a part in the emergence of a professional identity, over time.

Subject knowledge is significant in all professional learning courses developed for teachers of mathematics. Bibby's (1999) research with a group of four generalist primary teachers has some parallels with this study. Firstly, the methodological approach is designed to capture stories of mathematics learning and the participants are generalist teachers who develop their subject knowledge in mathematics. The study concluded that for generalist teachers to develop and take advantage of CPD opportunities, they must first address past relationships with mathematics. All the participants in the study revealed negative feelings. Brown et al's (2008) study with 16-year-olds, suggested the notion of a 'conceptualisation of mathematics' (p.230) needs to be deconstructed for a healthy relationship to develop with the subject.

The notion of trust in professional learning communities is explored by the work of Sztajn, Hackenberg, White, and Allexsaht-Snider (2007). The importance of trust cannot be underestimated, especially within the context of mathematics learning because trust is fundamental to developing working relationships and therefore success in mathematical understanding. This qualitative study with 27 teachers, took place alongside university-based educators. Workshops in school and meetings at the university formed the structure of this professional learning opportunity. The results indicated the following:

> 'They (professional development initiatives) allow trust among members of the community to go from provisional to identity-based, from being based on the reputation of teachers and mathematics educators to being based on the understanding and appreciation of each other's interests and needs.' Sztajn et al. (2007, p. 981)

The research highlights the importance of developing collaborative practices within a CPD community and the value of understanding each other's needs to maintain and sustain successful learning communities and learning goals. However, the study could have further developed its scope, had it continued to track the teachers throughout their careers to understand how this professional learning helped them develop their professional identities, over time.

One final aspect worthy of note in the CPD space is the use of coaches and coaching approaches to achieve successful learning goals in mathematics CPD. A review of literature by Obara (2010) offered an overview of coaching practices in schools in the USA. The literature review demonstrated parallels to the concept of coaches as defined in the USA and PMaSTs, as defined in England. Both coaches in the USA and PMaSTs in England are defined as experts in the field of primary mathematics. Their expertise is utilised on a day-to-day basis to develop confidence in the teaching and learning of mathematics (Williams, 2008). The importance of coaches being on-site, having strong knowledge of mathematics (both subject and pedagogical) as well as skills that enable collaboration, are cited as key attributes to this approach to CPD. Additionally, further value and importance are placed on the willingness of leaders both within school districts and schools in supporting and enabling the coaches to do their jobs in the way it was designed. To conclude, coaching, as discussed in the context of the USA, has parallels to professional learning opportunities designed and developed to build expertise in mathematics in the shape of programmes such as the Mathematics Specialist teacher programme, suggested by the review of Sir Peter Williams (Williams, 2008). The programme evaluation demonstrated the biggest contributor to the successful implementation of the programme has been the development of coaching with the participants (Walker et al., 2013). This, in turn, suggested that coaching provided a sustainable tool empowering teachers in developing key skills to impart mathematics knowledge and understanding to others.

2.6 Conclusion

This review has explored theories and empirical research on identity, CPD and career trajectories within the field of mathematics teaching and learning. The available literature has enabled an understanding of identity, through the lens of mathematics education and highlighted the gap in literature within the domain of primary teachers who, throughout their careers, construct an identity as a primary mathematics specialist. The review of the literature highlighted that:

- Very little is currently known about primary teachers in England developing into PMaSTs and how they build this identity and agency, over time.
- There is limited understanding of how primary teachers choose their career paths and therefore decision-making regarding subject leadership roles such as PMaST and how these roles build over time.
- There is a gap in theorising primary teachers' mathematics identity through professional learning and career pathways.
- Currently, no data sets are gathered on an annual basis to determine the number of mathematics specialists in primary schools in England. This data is beyond the scope of this study but would enable a clearer picture of the provision of PMaSTs in England, and support forecasting needs

Having identified the conceptual framework for the study and current gaps in knowledge, the research questions the study seeks to answer and the methodology and methods adopted are discussed in the next chapter.

Chapter 3 Methodology

3.1 Introduction

This chapter aims to set the philosophical positioning of the research undertaken. To understand the philosophical positioning, the chapter describes the research paradigm, framework and methods used to understand how primary teachers in England developed their professional identities as mathematics specialists.

Studying the professional identities of those primary teachers in England whose personal and professional decisions, over time, enabled them to become PMaSTs is at the heart of this study. Furthermore, the study aimed to investigate the factors that influenced the decision-making processes leading to each participant becoming a primary teacher and then to becoming a mathematics specialist. The intertwining of their professional identity with the subject of mathematics was a key exploratory factor; do they identify themselves as primary teachers first or as mathematics specialists? Or are both factors of equal importance? Finally, clear links from the findings were made as to how a better understanding of this rarely studied group of primary teachers in England, can help inform and develop a policy towards enhancing and championing mathematics provision in primary schools.

Therefore, by focusing on the personal and professional mathematics experiences of this unique group of participants, the research design aimed to answer the main research question:

How do biographical processes and experiences shape identity development and career trajectories of Primary Teachers who become PMaSTs?

The following sub-questions were posed:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMaSTs?

SQ2: How do primary teachers describe and understand their experience in the role of a PMaST?

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

The conceptual framework for this study (figure 2) was developed to illustrate the interconnectivity between continuing professional development, career trajectories and identities. The development of identity is influenced by and shaped through social interactions. These social interactions can be enablers or disablers in the construction of professional identities (Alvesson et al., 2008; Alvesson & Willmott, 2002; Ibarra, 1999b, 2004; Illeris, 2014). Professional learning opportunities (CPD) can provide spaces for identity formation through learning specific skills, in this case how to become a PMaST (Kempster, 2006).

3.2 Paradigm rationale and justification for the chosen methodology

Since this study is concerned with the life world of individuals (Berger & Luckmann, 1966; Luckmann & Berger, 1964) it is underpinned by a methodological approach that helps to understand the human actions (Bryman, 2008) and an individual's realities. As the research is embedded in understanding human experience, behaviour and action, as well as how people make sense of those experiences and their sense of self through these behaviours and actions, the study is aligned within an interpretive perspective and social constructionism.

An interpretative approach raises questions regarding the notion of objectivity and subjectivity and its role in research. Objectivity is open to debate (May, 2001). Eisner (1992) discusses the importance placed on objectivity within the field of educational research, calling it a 'most cherished ideal' (Eisner, 1992, p.9). However, he argues the 'meaning [of objectivity] is not particularly clear' and concludes by stating that the world and how we view it changes through time and is heavily influenced by social actors; therefore the idea of objectivity is truly a myth. Arguably, there can

never be a pure, objective view of any reality, as, through the act of understanding the phenomenon, individual views bring subjectivity to the debate (Cohen, Manion, & Morrison, 2017; Robson, 2011; Silverman, 2010). Since this research is concerned with identities, and these cannot be formed in isolation of their social context, eliciting insights into identities is complex. Ultimately, identity development occurs through a myriad of social interactions that are best understood through storytelling, (McCulloch et al., 2013; Van Zoest & Bohl, 2008). The lives of individuals, as told through their own stories, enables a profound understanding of individual experiences. The nature of lived experience processes and changes the self and representations of the self over time. As noted, social reality is not an 'objective truth', it is continuously reinterpreted by social actors. Through the stories people tell, insights can be gained into the meaning they give to their experiences, at different time points, and the sense they make of past experiences in the present (Elliot, 2011).

The key ontological and epistemological principles are discussed in a summary table 1, bringing together how these ideas link with the research carried out for this thesis.

Interpretivism/ Constructionism	**Aspect**	**Present research intentions**
Ontology	Relativist - the reality is constructed within a range of social situations and interactions. At the core of these interactions is the individual (primary teacher), and the nodal points are developed through space and time. These interactions are, at their core, dependent on the individual and their view of the world. Therefore, each construction is individual and unique - it can have parallels to another individual experience but it cannot be identical.	The study examined how primary teachers develop their professional identity as mathematics specialists. The understanding of these identities was interpreted by considering the subjective experiences of the participants, and how these experiences shape an identity throughout their professional careers.
Epistemology	Subjectivist - there is a symbiotic relationship between the subject and the researcher to understand and jointly construct a new idea. In other words, interpreting lived experiences and constructing new meaning within it, through co-constructing the phenomenon being studied.	The main research question, along with the sub-questions, helped understand the lived experiences of individuals and interpretations of an identity as a mathematics specialist in primary schools.

Table 1: Paradigm justification, adapted from Guba (1990).

3.3 Approach: Narrative Research

This section provides an understanding of the methodological approach. There are key distinctions between the five qualitative inquiry approaches, as defined by Creswell (2013). These approaches are 'narrative research, phenomenology, grounded theory, ethnography and case study' (Creswell, 2007, p. 53). Each has its merits and can fit appropriate frameworks of research methodologies. However, for this study, a narrative research approach was best suited to understand the lived experiences of the participants, as the conceptual framework had been constructed so that detailed data were collected to understand individual stories and career trajectories of the participants. Furthermore, the importance of collecting data through the structures of narrative methods was of value and provided richness and depth of data that enabled a close and deep insight into the PMaSTs. According to Elliot (2011):

> 'A narrative can be understood to organize a sequence of events into a whole so that the significance of each event can be understood through its relation to that whole.' (Ibid, p.3).

This definition captures the need for a narrative approach to be iterative, where the structure of the interview is inevitably defined by the participant and their story and being able to understand the whole by a structured analysis of the life and career events of all the participants involved within the study (Elliot, 2011). The narrative being communicated encapsulated how an aspect or sequence of the participant's life is perceived by them and therefore how it affected their career path to becoming a PMaST. Furthermore, Connelly and Clandinin (1990) share the merits of narrative inquiry as to the way 'humans experience the world' (p.2). They add that this is especially pertinent within the education context as both 'education and educational research is the construction and reconstruction of personal and social stories' p.2). Therefore, the ideas of both Connelly and Clandinin (1990) and Elliot (2011) further support the merits of using narrative methods to collect data for this thesis.

To define a specific method of narrative research, the life history method was explored to form a conclusion on whether this was an appropriate way to collect narrative data. Goodson and Sikes (2001), suggests that to study teachers and their lived experiences, the best approach is using narrative life history.

There is a real interest in narrative storytelling as a methodological approach to understanding professional identity (Ibarra, 1999a). Therefore, it is suggested that constructive development theory can be used to understand the construction of identities of teachers through storytelling (Kegan, 1982). It is argued that this is a very helpful operational tool for understanding teacher identity as the storytelling can bring to life key snapshots and critical incidents within a teacher's career that showcase the transformation that teachers go through in their careers, explored through their biographical identity across a period of time. The richness of data collected through exploring these narratives gives a detailed account to further analyse identity constructs of participants, making this approach appropriate to capture the identity constructs of PMaSTs in this study.

A life history narrative approach comes under the qualitative methodological approach. It is seen to be a reliable and appropriate method to collect the depth of data that is needed to explore the complex issues around identity and career development. As a methodological approach, life history has been around since the 1920s. It fell from favour in the 1960s when a more quantitative approach to data collection in social science research was deemed favourable (Goodson & Sikes, 2001).

In previous research with teachers, Goodson (2008) argued that using a narrative approach enables the researcher to delve deeper into the teacher's life and therefore sees the 'teacher as an active agent making his or her own history' (Goodson, 2008, p. 4). Floyd (2012) describes the use of narrative [life history] as 'particularly suited to studies whose research questions are based around perceived, subjective experiences of individuals or groups of individuals' (p.224). Bryman (2008) describes life history as an approach that 'emphasises the inner experience of individuals and their connections with changing events and phases throughout the life course' (p.695). The 'inner

experience' was fundamental to understanding how the professional development undertaken by the primary teachers facilitated their developing professional identities as mathematics specialists.

Goodson and Sikes (2001) suggest that the life history methodological approach is a way of finding out about the participant. They suggest that the following questions are used to frame the participants' experiences:

> 'Who are you? What are you? Why are you? Why do you think, believe, do, make sense of world and the things that happen to you, as you do? Why have these particular things happened to you? Why has your life taken the course that it has? Where is it likely to go? What is your total experience like in relation to the experiences of other people? … How do you story your life? Why do you story it in this way? What resources do you employ in assembling your life story?' (p.1)

Bryman (2008, p. 696) describes life history as a type of research that 'emphasises the inner experience of individuals and their connections with changing events and phases throughout the life course'. The use of life history in this thesis has highlighted a range of experiences that individual PMaSTs encountered that would not have been captured through traditional interview approaches. Furthermore, through the use of life history, the participants' views on the events and phases throughout their personal and professional lived experiences linked to mathematics, have elicited deeper analysis of their identity constructs (Bryman, 2008).

The life history interviews differ from any other unstructured interviews (Goodson & Sikes, 2001) because they are rooted in understanding the 'historical influences that a person's biography has on their current experiences and perceptions' (Floyd, 2012, p. 224).

Goodson and Sikes (2001, p. 2), explain this as:

> '1. It explicitly recognizes that lives are not hermetically compartmentalised into, for example, the person we are at work (the professional self) and who we are at home

> (parent/child/partner selves), and that, consequently, anything which happens to us in one area of our lives potentially impacts upon and has implications for other areas too.
>
> 2. It acknowledges that there is a crucial interactive relationship between individuals' lives, their perceptions and experiences, and historical and social contexts and events.'(p.2)

Through constructing the life histories of the primary mathematics specialist participants, the major influences and key motivations for pursuing a career as a PMaST, the significance of professional development and therefore the career development since becoming and being a PMaST were mapped. The interactive nature of lives, as mentioned by Goodson and Sikes (2001) was vital, especially in the teaching and learning of mathematics and the participants' journey in the learning and teaching of mathematics.

Finally, as Goodson (2009) illustrates, the life history narrative approach has had a resurgence and is being adapted and used in the field of education. It is therefore hoped that this approach has enabled the collection of data that is temporal and rich in context within the social phenomenon that is being tested, to facilitate a new emerging understanding of the developing professional identities of primary teachers who develop their careers as PMaSTs.

To summarise, the approach taken for this study was embedded in the framework of socially constructed knowledge. To support this construction of knowledge, the narrative and life history approach was used to get to the truth of the problem. Finally, as the in-depth data was a representation of twelve participants sharing the common thread of becoming and being a PMaST, it was important to understand the commonalities between the twelve participants and what critical moments led to the development of their careers. The ideas underpinning this section are summarised in figure 5.

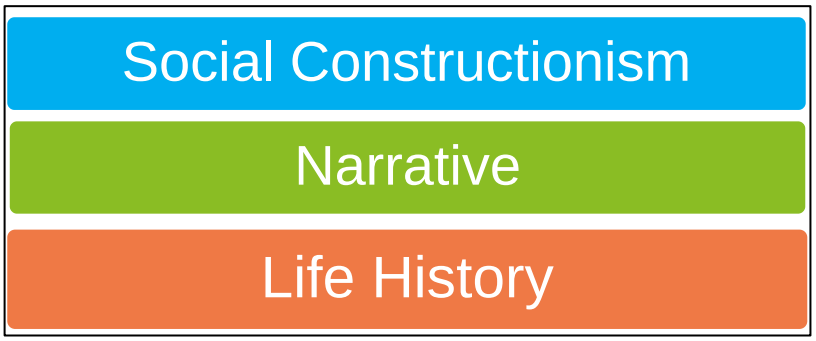


Figure 5 showing the methodological approach

3.4 Participants

It is clear that 'you cannot study everyone, everywhere, doing everything' (Miles, Huberman, & Saldana, 2014, p. 27). It was appropriate to select the study sample using the principles of purposive sampling; in other words, deliberately choosing a sample from the population who represent aspects of the experience being researched (Bryman, 2008). Silverman (2010, p. 141) describes the value of choosing purposive sampling as it: 'allows us to choose a case because it illustrates some features or processes in which we are interested. In addition to purposive sampling, snowball sampling was used by gaining further sample PMaSTs through the original contacts. The purposive sampling was combined with snowballing to achieve the target of twelve participants for the study. Snowball sampling is described by Gobo (2007) as:

> 'Picking some subjects who feature the necessary characteristics and, through their recommendations, finding other subjects with the same characteristics.' (p.419)

The participants were first contacted via email. The emails were sent to all contact primary schools and mathematics networks across the region. Additionally, Mathematics Hubs across the country were contacted either via email or Twitter, in the first instance, and the Hubs passed on details of the research to PMaSTs within their networks. The scoping for participants generated interest across the country and therefore helped widen the research radius.

Selecting the sample to study was a key driver to the success or demise of this study (Cohen et al., 2017). All the participants selected for the study were either working as PMaSTs at the point of data collection or had experiences of leading mathematics within primary schools. A good range of teachers and educators were drawn upon, including ones who had formal mathematics specialist qualifications. It is of significant importance to justify who is being included within the research and why, as this provides further validity to the research being carried out (Wilson, 2013). The selection of participants was considered carefully to ensure that the sample represented a cross-section of primary teachers and educators who have had a significant role in championing mathematics in their careers to date. Hence, the range of participants in the sample includes educators who had taken specialist qualifications in mathematics such as the Mathematics Specialist Teacher Programme (MaST), the Every Child Counts (ECC) professional development qualification and the National Centre for the Excellence of the Teacher of Mathematics (NCETM) professional qualifications, to name a few. Out of the twelve participants, six have moved on from their school level mathematics roles but their current roles still allowed them to play a considered role in the teaching and learning of mathematics within their educational setting.

The total number of twelve participants proved to generate a wealth of rich data. This allowed for theoretical saturation, ensuring that there was enough data collected to certify both breadth and depth within data sets collected (Strauss & Corbin, 1998). Bryman (2008) suggests the importance of noting that theoretical saturation does not mean that the:

> ‘researcher develops a sense of dèjá vu when listening to what people say in interviews but that new data no longer suggest new insights into emerging theory or no longer suggest new dimensions of theoretical categories.’ (p. 421)

The importance of the selection of the sample was imperative to the developing research design. Therefore, it was strategic to start with the principles of purposive sampling and follow this up with the principles of snowballing sampling (Mile, Huberman, & Saldana, 2014).

3.4.1 Data collection cycle

The whole data collection cycle, including the pilot study, took a total of six months. The study had full ethical approval through the University of Reading's ethics committee. The pilot was conducted over a month, the data collected was evaluated and the data collection methods refined. Full details of the pilot process and its implications in adjusting the remaining data collection cycle can be read in section 3.4.2 of this chapter. Two distinct stages were deployed to collect the data. This approach was developed to ensure that the narrative questions for the interview were driven by and bespoke to each participant. To enable comparison, the themes within stage one were defined with the participants. The data collection stages are represented in figure 6.

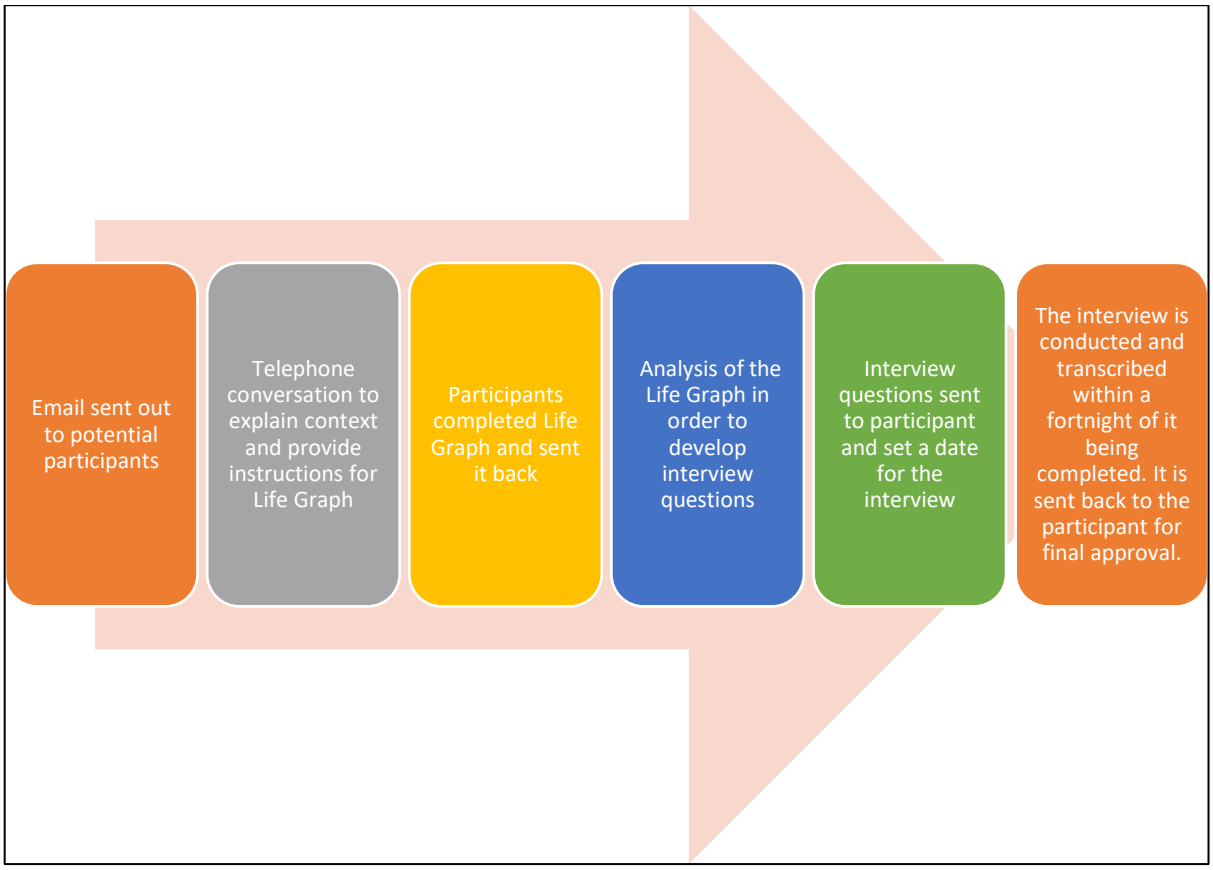


Figure 6 Structure used to collect the data.

All participants were sent an email (see figure 7) inviting them to take part in the research.

Dear Nicola,

Hope that this email finds you well. I am getting in touch because I am currently undertaking an Ed.D and the subject of my study is Primary MaSTs. My working research question is:

How do primary teachers in England develop their professional identities as mathematics specialists?

I would really value your participation in my study.

The details for the work are set out in the attached letter. If you do feel you have the time to participate, please let me know and we can then arrange a telephone conversation to talk things through.

Attached is:

- My ethical approval form
- Information and consent form for participant
- Template for developing your Life Graph
- Example of my Life Graph, (please note that this is scanned but hopefully you get an idea of how to develop one) Just to note, I put together pieces of A3 paper, please let me know if you would like me to send you some.
- Template of Life Graph with the headings.

Many thanks in advance for considering this

Kind regards,

Nasreen

Figure 7: Example of email sent out to all participants

Once the participant agreed to take part in the research, a telephone conversation was arranged to talk through and explain the stages of the research and data collection. These stages will be discussed in detail in the next section.

All twelve participants were either currently leading mathematics in their place of work or had recently done so. The total of twelve included two individuals who participated in the pilot study. All twelve participants had gained additional qualifications to develop and champion mathematics in their educational settings. Out of the twelve participants, ten had the M level qualification as Mathematics Specialists Teachers (MaST) this was a direct policy incentive by the Department of

Education (DFE) after the publication of the Williams Review (Williams, 2008). Two participants out of the twelve had higher level qualification at M level, one was an Every Child Counts (ECC) teacher and the other had developed her expertise with the local Mathematics Hub, through professional development in mathematics teaching and learning. The breakdown of all participants can be seen in table 2.

Name	**Gender**	**Mathematics Qualification**	**Current Job description**
Nicola	Female	MaST	SENCO
Gregory	Male	MaST	Mathematics freelance consultant
Reece	Female	MaST	Deputy Headteacher
Thomas	Male	MaST	Mathematics co-ordinator KS2 phase leader
Sharon	Female	MaST	University Lecturer in Primary Mathematics
Sally	Female	MaST	Mathematics co-ordinator-leading on Mastery at her school
Sandra	Female	Every Child Counts (ECC) teacher	ECC teacher and School Centred Initial Teacher Training (SCITT) trainer for mathematics.
Emma	Female	Mastery work (mathematics) And Masters in Education	School teacher at KS1 and Mathematics co-ordinator at KS1.
Roseanne	Female	MaST and UK Mastery Lead.	Deputy Headteacher and NCETM Mastery Lead. Local Hub manager
Daisy	Female	MaST	Headteacher
Belinda	Female	Undergraduate course in Mathematics and MaST	University Lecturer in Primary Mathematics
Michelle	Female	MaST	Class teacher and Leading Mathematics Teacher (LMT). Michelle is currently on maternity leave.

Table 2 Profile of Participants; pseudonyms have been used

3.4.2 The Pilot Study

The approach to data collection took two distinct stages/ phases, these were trialled through the pilot study (Cohen et.al 2017; Rugg & Peter, 2007; Thomas, 2017) to ensure any design miscalculations were ironed out before the study was launched. The pilot study took one month to complete.

The pilot aimed to first test out the data collection tools, namely the Life Graph and the narrative life history interview, and secondly to understand where the possible challenges might occur in the data collection process so that these could be eased. The researcher was conscious of the sensitive nature of the data being collected, therefore, one role of the pilot was to develop a trust between the researcher and the participant through clear lines of communication throughout the process. The significant learning points from the pilot study were used to further refine the data collection tools to minimise the risk to the integrity and depth of data collected for this research. The pilot involved two participants. It was decided that this number would suffice as the research involved gathering in-depth data from a small group of individuals. Once the pilot study was completed, it was also decided that the data collected through the pilot process would form part of the final data set because the data collected provided enough clarity and detail to make it comparable to the data sets collected from the remaining ten participants.

The pilot was launched by contacting Nicola and Gregory via email, using the email structure in figure 7. Telephone contact was made with both participants in the pilot to discuss the research and for them to complete a Life Graph. One of the significant things noted from the telephone conversation was for the researcher to develop a set of notes and key points to get through as part of the initial telephone conversation. These were written out and used for subsequent interviews. Furthermore, it was also noted from Nicola's Life Graph, (figure 8) that further detail could be elicited firstly by providing a more detailed set of instructions and secondly by looking into feelings that the participants were going through at different stages in the Life Graph and the individuals

who either influenced or hindered their careers or participants' learning of mathematics. These changes were influential in the depth of data collected in subsequent Life Graphs. The second Life Graph was that of Gregory (figure 9). The depth of detail is enhanced in his Life Graph.

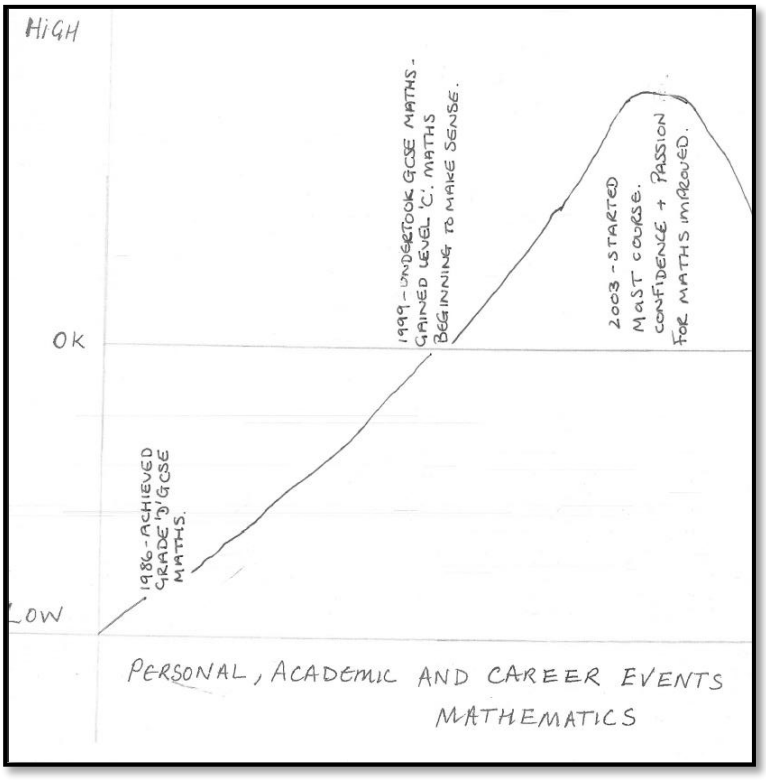


Figure 8 Pilot Study Life Graph of Nicola

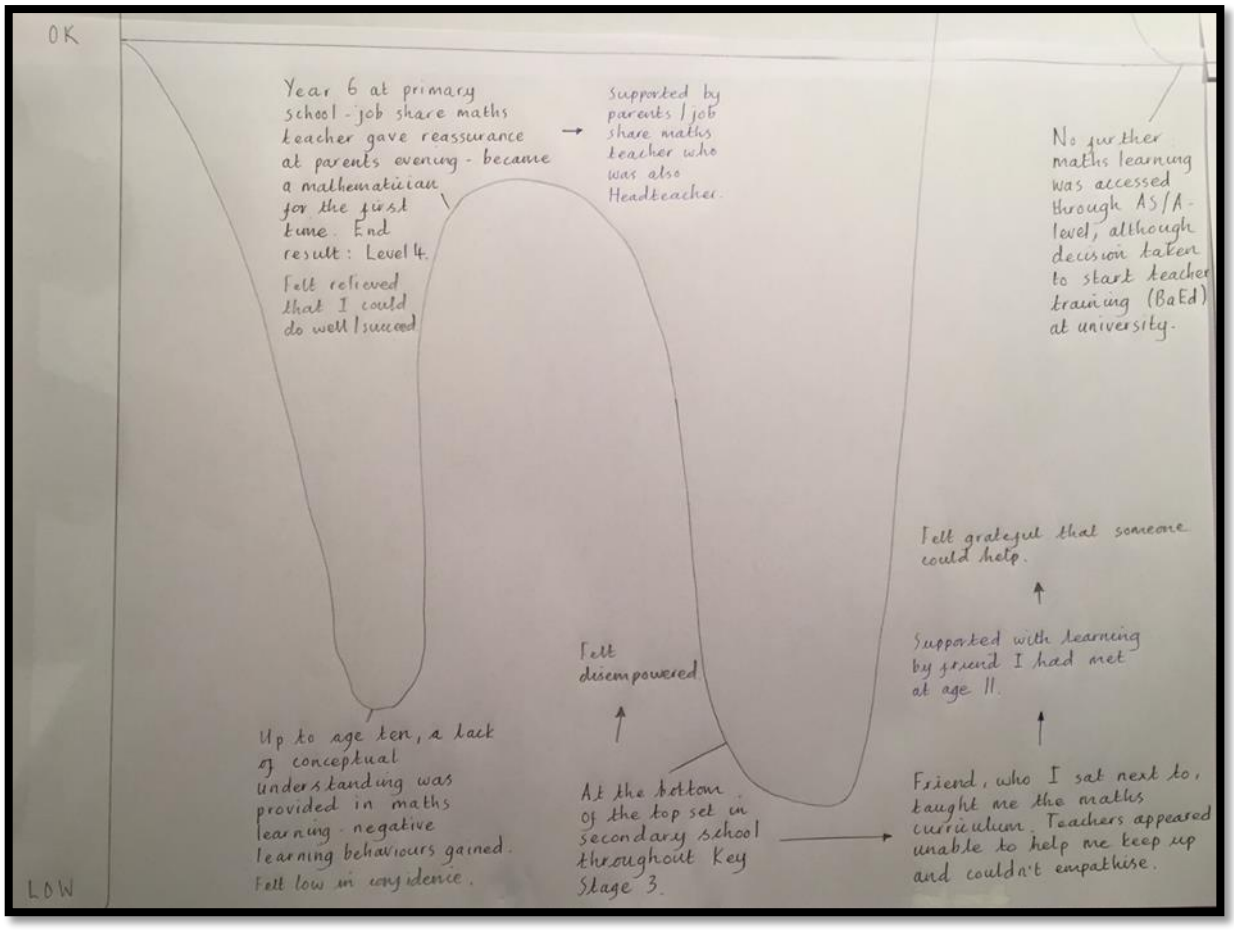


Figure 9 Pilot study, Extract from Gregory's Life Graph

The Life Graphs were analysed in-depth, to develop the interview questions. There were several risk factors to consider: firstly, although the research explored individual lived experiences, some common themes needed to be included to compare and contrast the whole data set (Cohen et al., 2017; Creswell, 2013; Silverman, 2010; Thomas, 2017). Therefore, a set of topics in the form of open questions was prepared. For example, each participant was asked about their early experiences of learning mathematics, each one provided individual contexts but the data was still comparable because of the common themes set out.

The first pilot interview (Nicola) lasted a total of 35 minutes. The depth of data collected could have been further enhanced by sub-questions around the themes explored. This was noted and

subsequent interviews were adjusted. One final alteration after the pilot was to agree on timings for the return of the Life Graph, to keep the data collection schedule as accurate as possible. No stipulation on time was made for the return of the Life Graph in the first pilot interview, therefore, it took longer than desirable, leading to a delay in the overall data collection schedule. With the second pilot interview, this detail was emphasised during the telephone conversation and times put into the diary for the return of the Life Graph and subsequent interview date. This approach was later adapted and used for the remaining ten participants.

Overall, the pilot study enabled the researcher to fine-tune the planning of the main data collection cycle by including these valuable lessons:

1. Develop clear notes for the telephone conversation after the initial email to ensure that no detail is missed out by the researcher. Furthermore, creating the notes provided a consistency of approach to the messages being relayed to all participants.

2. Ensure that the themes of the interview questions were kept consistent across all participants with room to gather individualised data through additional questions.

3. Agree on a clear, mutually-agreed timeline for the data collection process to ensure that this was kept within the schedule factored in for the research.

4. Having clear opportunities within the interview process for participants to elaborate on their answers to add contextualised detail to the data collected.

5. Ensure that the researcher had a copy of the interview questions and a copy of the Life Graph when conducting the research.

These lessons helped redefine aspects of the data collection to gather the two-staged data for this research project. The next section will provide further details on the data collection stages.

3.4.3 Stage 1- participant Life Graph

Once the participant agreed to take part in the research, a telephone conversation was arranged to talk through and explain the stages of the research and data collection.

As the telephone call was the first point of contact, clear instructions were provided to complete the first stage of data collection - the Life Graph. The participants were provided with an agreed time frame to return the Life Graph to the researcher - this typically took up to two weeks. However, due to the time commitments of some participants, this process took longer than the two weeks factored into the original time line of data collection. Rich data emerged from the Life Graphs that provided an in-depth understanding of the participant's lived experiences. One example is shown in figure 10.

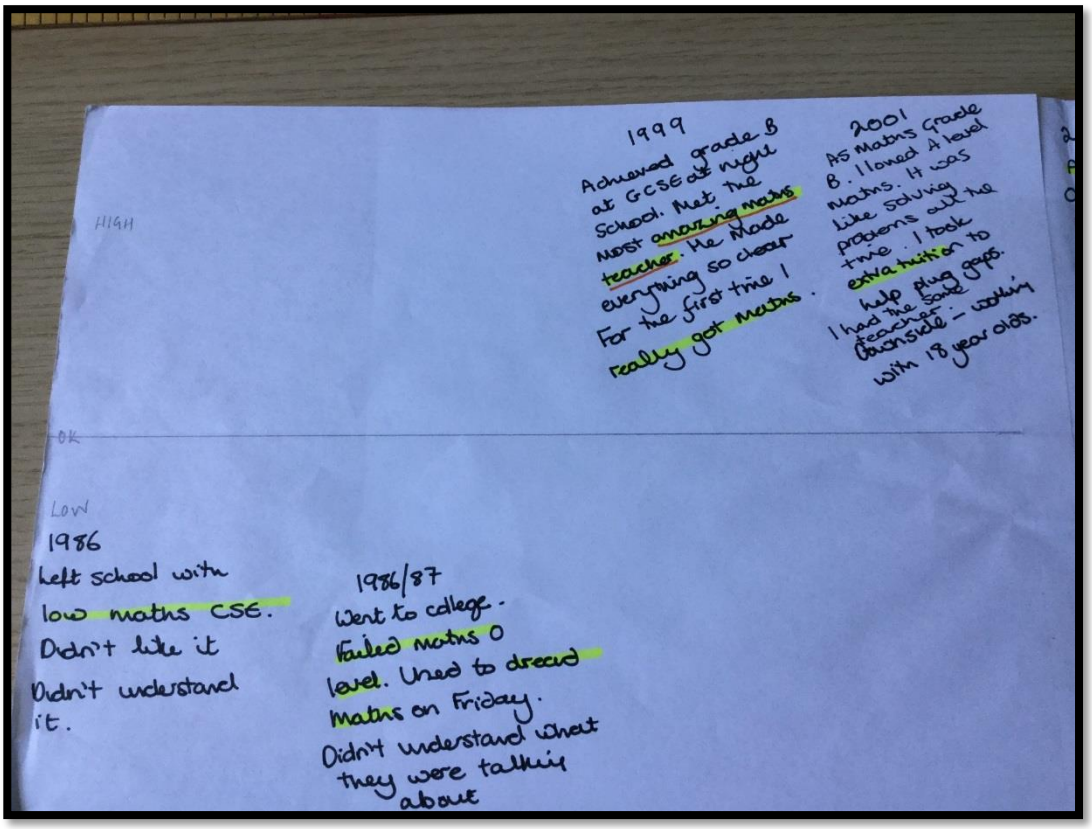


Figure 10 Extract from Reece's Life Graph

It is thought that to elicit deep insight into identity development over the life and career paths of primary teachers, understanding of and the importance placed on self, and how the self-interacts with individuals and the professional and personal spaces around them is key to unlocking their professional motivations and factors that led to their emergence as mathematics specialists (Illeris, 2014). Therefore, the design of stage 1 of data collection reflects this and starts with the participant using a reflective coaching tool - the Life Graph.

The work of Ibarra (1999a) on identity with bankers undertook a preliminary interview to understand some key themes that could emerge from the participants. In this study, the Life Graph played a similar role to that of Ibarra's (1999b) tool. These graphical mappings of the participants' lives become blueprints to analyse and were used to develop the semi-structured life history interview questions (stage 2 of the data collection cycle) that became part of the narrative, biographical (McCaslin & Scott, 2003) interview. The rationale for this approach was to elicit authentic insight into the lived experiences of primary teachers, starting with the participant, to fully understand the decision-making processes and therefore understand how a PMaST emerges throughout an individual's career trajectory (Elliot, 2011; Goodison, 1992).

3.4.4 Stage 2 - Narrative Interview, a Life History Approach.

The second part of the data collection was carried out using interviews. The interviews started by asking the participants to reflect on the process of developing their Life Graph. This allowed the participants to settle into the interviewing process and feel at ease and enabled them to provide context to the chronology of the responses. The semi-structured, life history interview followed a standardised, themed format (see appendix E). The copy of the Life Graph, developed by the participant, was placed on the table before the start of the interview and was referred to throughout the interview process, this enabled a deep and reflective data collection process. As Holloway and Jefferson (2000) suggest, a range of techniques need to be deployed to get the participants to share

experiences in-depth, thus allowing for spontaneity of responses from the participant as well as ensuring that all aspects of the participant's life history and career trajectories were captured.

Using interviews to gather data has long been a tradition in educational research (Curtis, Murphy, & Shields, 2014). Although there is a range of approaches to interviewing participants, for this research, a semi-structured, narrative, life history approach was deployed (Floyd, 2012; Goodson & Sikes, 2001; Grey, 2004). Chirban (1996) argues that an 'interactive relational approach (I: R)'(Chirban, 1996, p. xiii) provides an authentic interaction between the interviewer and interviewee, thus enabling a rich and genuine discussion and exchange of information. As the interview was based around stage 1 (Life Graph) of the data collection process, it proved to be an authentic way of facilitating discussion about the lived experiences that led to the participants' identity as mathematics specialists. The interview process therefore broadly followed the I: R approach of using previously elicited biographical detail to develop more in-depth information regarding the lived experiences of the PMaSTs. Although some may argue that having a personalised approach to data collection creates a bias and therefore a weakness within the methodological approach, in the case of this study, the first stage of the data collection enabled the participants to reflect and refine how they wanted to capture their life events leading up to the present time and hence created a level of trust, authenticity and engagement in the interview that would not have been achieved if the interview was conducted as the only data collection tool (Chirban, 1996).

Similarly, Weiss (1995) argues that we develop, in-depth, insight into the lived experiences of individuals through interviewing:

> 'The nature of social life can learn about the work of occupations and how people fashion careers… and about the challenges people confront as they live their lives. We can learn also, through interviewing about people's interior experiences… We can learn meaning to them of their relationships, their families, their work, and their selves. We can learn about

> all the experiences, from joy through grief, that together constitute the human condition. (1995:p.1)

All interview questions were sent to the participants in advance. The interviews were conducted in a space agreed by the participant - these were mainly places of work for the majority of the participants. Three interviews were conducted, through mutual agreement, in public places and one was conducted at the participant's home. All the interviews, with the agreement, were recorded and later transcribed. The typed transcript was subsequently sent to each participant for a final review before the data was analysed.

3.5 Data Analysis

The data sets were analysed in three distinct stages, one stage enabling the next stage to happen. For the data to be reduced, principles of data analysis pertinent to the Life History approach were drawn upon to gain the depth of analysis needed to bring the individual stories to life (Goodson & Sikes, 2001). The act of data collection and subsequent reduction and analysis of the data to conclude was a cyclical, iterative process (figure 11), where one aspect of the cycle informed the other (Mile et al., 2014)

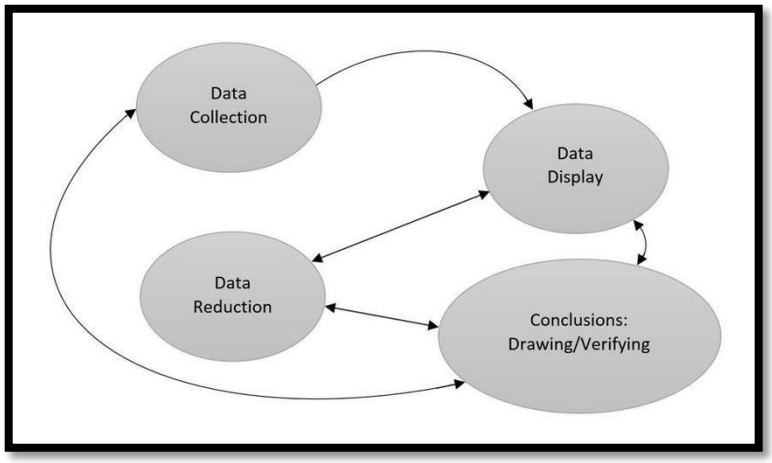


Figure 11 showing components of Data Analysis, an interactive model Mile et al. (2014, p. P.12)

The three distinct stages utilised for the data analysis are illustrated and expanded on below:

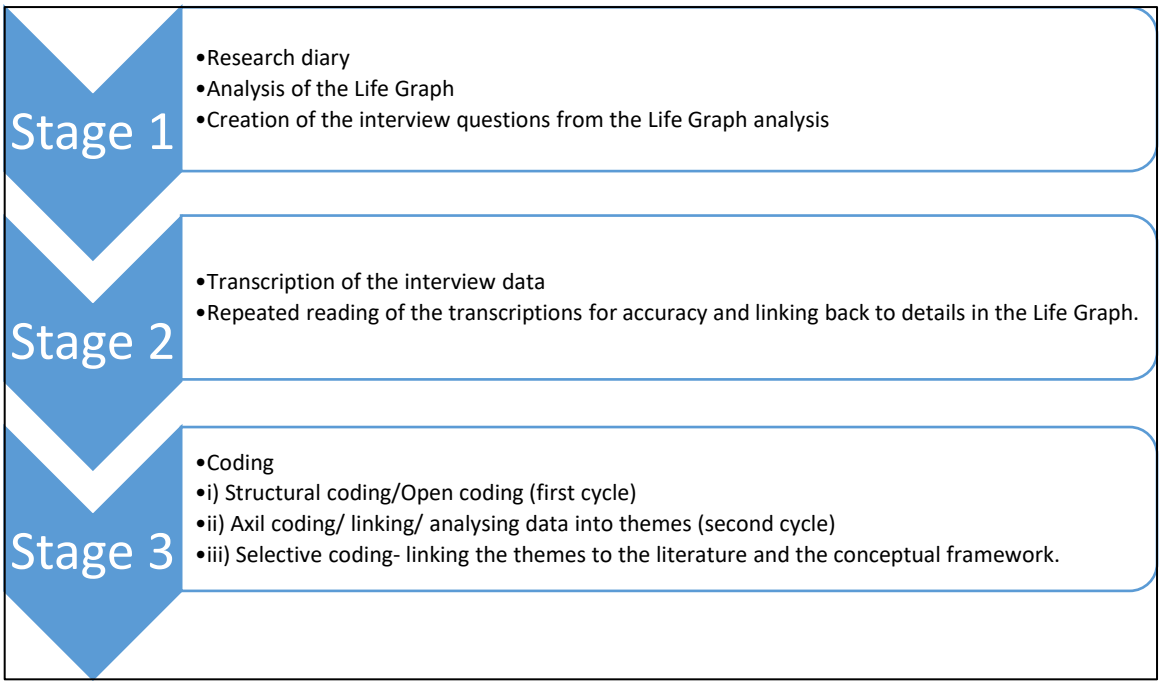


Figure 12 showing the stages of data analysis (adapted from (Goodson & Sikes, 2001; Mile et al., 2014; Saldana, 2013)

3.5.1 Stage 1

A research diary was kept to document all aspects of the data collection and the research processes. This proved to be an important, reflective tool in documenting thoughts and key aspects of the research process.

The analysis of the Life Graph was an essential first step to the data analysis process. This was done by firstly visually assessing the number of entries and then linking them to positive and negative experiences. The details were broken down into themes, the themes were based around schooling, primary and secondary, home influences, training to become a Primary teacher, early career development, professional learning, and career development into a PMaST, current role and future aspirations. The themes linked the chronology of the participants' experiences with mathematics, starting from their primary school and leading to their current job status. The themes were collated to ensure comparison across the data sets could be made.

3.5.2 Stage 2

Stage two involved transcription of the interviews; this was done verbatim to ensure that all aspects of the answers were captured and the data maintained its integrity from the way it was explained by the participants. Additionally, the interviews provided an opportunity for the participants to reflect on drawing the Life Graph and how this enabled the deep reflection of their lived experiences of learning mathematics and building their agency as mathematics specialists in primary schools. The transcripts (see example in appendix F) were read through for accuracy and links made back to the Life Graphs to make direct comparisons on the expansions of ideas from the Life Graph of the participants. This process enabled a deep insight and understanding of the main themes emerging from the data and therefore helped in developing data themes for a robust analysis at stage 3.

3.5.3 Stage 3

One interview can generate a great deal of data and therefore the analysis processes were carefully designed to ensure that key themes were documented systematically to enable an appropriate analysis of the data to take place.

Floyd (2012) states that there is no 'right way' (p.5) of analysing data collected through the life history interviews; the approach is ultimately determined by the way we look into the data collected and how the themes emerging ultimately define the order of analysis. Floyd (2012) goes on to list two possible ways that life history has been traditionally analysed - one reduces the data to a set of codes and then themes are determined from the coding. The second method tries to analyse the data as a whole. There are tensions with researchers in using either method to analyse the data as the depth and detail of the argument made can be lost through the reduction of data (Lichtman, 2010). One way forward suggested by Seidman (2006) is to merge both methods of analysis and create a multi-analysis approach. Finally, whatever approach is decided upon to analyse the data,

the key to rich data analysis will ultimately be defined by the consistency within the approach/es (T. William & May, 1996).

Three distinct stages were used to develop a systematic approach to the data analysis process as advised by Jones, Sambrook, Henley, and Norbury (2012). ***Step i*** consisted of open or structural coding (Saldana, 2013) where large segments of the data were provided with codes. This was highlighted within the transcripts and was analysed manually. This first stage of coding permitted the data set to be reduced into key structural codes that allowed transcripts to be compared. An extract of this can be seen in figure 13.

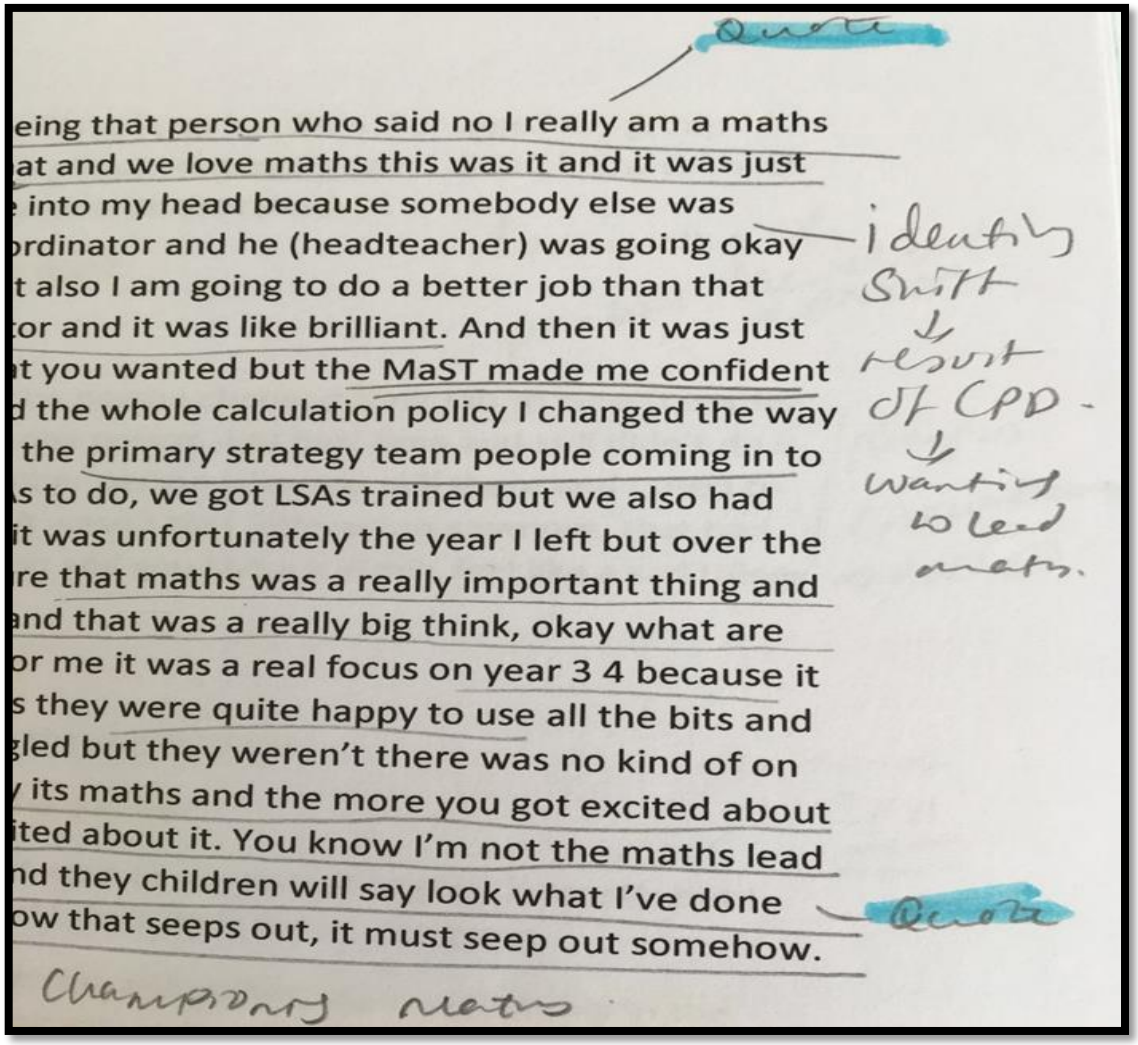


Figure 13 Extract from transcript showing initial structural/ open coding, (Saldana, 2013)

Step ii- Once the initial analysis phase was complete the interview transcripts were analysed using axial coding. Axil coding can be defined as 'one way to construct linkages between data' (Allen, 2017, p. 2). The rationale for analysing the data at this level was to synthesise the data further to understand the themes emerging from the data sets (Clarke & Braun, 2013) . This involved both inductive and deductive approaches to reduce the data further (Maguire & Delahunt, 2017). This level of analysis enabled a varied, iterative analysis of the data, driven both by the conceptual and theoretical framework and the data itself, therefore ensuring the voice of the participants continued to emerge as the data was further reduced into themes.

Table 3 illustrates the systematic three-stage process used to reduce the data sets. Once this was completed, the coded data were analysed, in detail to separate the data into emerging themes. This worked example below is an extract of data analysis where participants were asked about their home and school experiences of learning mathematics. Therefore, the emerging themes from this worked example were used to answer research sub-question 1, the emerging identity as a mathematician and a future PMaST. Richards and Morse (2013) discuss the notion of moving 'up' from the sheer volume and diversity of data sets to start shaping the data into themes, helping manage the data sets further. This was integral for this thesis as the sheer volume of the data that emerged from both the Life Graph and the interviews were initially overwhelming and hence the importance of systematically reducing the data into clear themes. The themes were further refined, linking back to the conceptual framework for this study. Therefore the data were analysed using both a 'bottom-up approach, driven by the data (inductive) and top- down approach, driven by the conceptual and theoretical framework and research questions (deductive) (Maguire & Delahunt, 2017, p. 3354).

Structural coding/ open coding (first cycle)	Axil coding/ linking/ analysing data into themes (second cycle)	Selective coding- linking the themes to the literature and the conceptual framework.
Enjoying mathematics at primary school	Love for mathematics Developing mathematics resilience through developing independence in mathematics	Identity as a learner of mathematics The core layer of identity
Gifted mathematician		
Self-motivation		
Teacher believing in potential	Being influenced by teachers (Positive and negative)	Identity as building confidence in the learning of mathematics Personality layer of identity
Teacher lack of confidence to work with confident mathematician		
Teaching approaches led to negative attitudes towards mathematics		
Interactive, practical mathematics teaching at school, enjoyed learning		
uninspiring teachers and 'bland' mathematics lessons		
Placed in a low set for mathematics		
Working with family on homework	Home and personal influenced positive and negative	Identity core layer with elements of personality layer
Parents playing a positive role in mathematics development		
Seeing parents gain mathematics qualifications- positive role models		
Could not relate to mathematics- like a foreign language	Anxiety about learning mathematics	Identity as a preference layer- influenced by learning experiences
lacked confidence in learning mathematics at grammar school		
Being picked upon to answer questions in class		
Mathematics tests in class		
Left to learn mathematics via a textbook		
Peer group influence		

Table 3 Illustrating examples of themes emerging from one extract of the coding process.

Finally, ***step iii,*** involved further reducing the data, linking the themes to the literature and the conceptual and theoretical framework of the study. As table 3 shows, the links with literature and the conceptual and theoretical framework were made, in this extract the codes represent the emerging identity as a learner of mathematics (Cohen et al., 2017; Mile et al., 2014; Saldana, 2013).

Although Nvivo was not used for the data analysis process, it was used to organise the data sets. Furthermore, the data in Nvivo was managed to develop word diagrams to slice the data differently. A further reason Nvivo was used was to validate the manual organisation of the data set to ensure the accuracy of the coding approaches used.

3.6 Reliability and Validity

The methodological approach taken to capture the lives and experiences of PMaSTs provided in-depth data for the research. Using Life Graphs as a tool to gather data at the first stage of the data collection process allowed the participants to provide a structured timeline of experiences leading to them becoming PMaSTs. The advantage of this approach was the ownership the participants took in developing the Life Graph, enabling an authentic interpretation of their lived experiences. This approach assisted in gaining in-depth data and, because the participants did this independently, helped to reduce research bias (Cohen et al., 2017); Masley and Allison-Love (2017). Additionally, as Kearney and Hyle (2004) research shows, participant-produced drawings are more likely to accurately represent experiences in a reliable and trustworthy way. However, it is important to acknowledge the risks of enabling a key part of the research data collection to be done independently of the researcher, as the data collected may not fulfil the research brief. As noted by Matthews (2011), whilst using drawings as a data collection tool, participants can get engrossed in doing a good job, so that what they end up depicting may not represent the reality and therefore create a threat to the validity of the research. To promote a cohesive, valid and reliable approach to the data collection and minimise this, participants discussed the meaning of the drawings, including deep reflection into the process of developing their Life Graphs through the narrative, semi-

structured interview process. The transcribed interview data were read, reread and sent back to the participants for a final read-through to minimise errors that may have occurred. Errors were further minimised by having a structured pilot process, enabling the refining of instructions to gain data at a greater depth as well as using the Life Graph to draw upon whilst the narrative interview was conducted for all participants.

A final thought to consider whilst undertaking research using qualitative methods is the notions of internal and external validity questions (Grey, 2004). Internal validity simply means what the research captures and whether the findings represent the true nature of the research being conducted, as there is a danger of researcher bias (Flick, 2014). To minimise this, Hall and Callery (2001), recommend a dynamic model of engaging with the data sets where there were constant reflection on the findings and re-examining and evaluating to form meaningful and valid conclusions. The research has enabled this level of validity by examining, interpreting and reinterpreting the data sets throughout the data analysis process to gain the depth of understanding that has been achieved by the stages of data analysis.

External validity relates to generalisability - in other words, to what extent can the results and findings of this thesis be used to make generalised statements about PMaSTs in England and their identities (Grey, 2004). The data collected here was purposively gathered to highlight, in-depth, and bring to life the lived experiences of a group of PMaSTs and how they shape their identities from being a primary teacher to becoming a PMaST. Therefore, it was never the intention of this research to enable generalisability but to gather data from a small group of participants to explore their professional decisions in depth.

3.7 Ethical Issues

The research framework is firmly embedded within the constructivist, interpretivist framework with data collected within a qualitative methodological position. It is therefore of utmost importance that all necessary and potential ethical considerations are highlighted to minimise any concerns that may surface (Stutchbury & Fox, 2009). One of the most important considerations to make whilst undertaking ethical approval for a research project using the narrative and life history approach is to be mindful that 'Each participant's story is still being lived before and after the interview has taken place.'(Floyd, 2012, p. 231) The notion of trust was carefully considered to understand how the act of collecting personalised data of individual experiences with mathematics, could affect the participants. Goodson and Sikes (2001) discuss the notion of a life history interview being akin to counselling and therefore being aware of such occurrences is necessary whilst going out in the field. In the process of collecting data, many things can come to light, such as bereavement or tensions with peers, as well as sensitive issues around workplace difficulties (Goodison, 1992). It is therefore important to develop trust between the researcher and the participant to maintain integrity. Furthermore, it is necessary to maintain anonymity throughout the whole research and publication process by protecting the identity of participants in transcription, during data analysis and in written reports, while having a duty of care in sharing their story with integrity (Bryman, 2008; Cohen et al., 2017; Silverman, 2010). This included maintaining participants' anonymity throughout the research process, as well as within their places of work, among associates and considering any other factors that might identify participants. Thus, pseudonyms have been used throughout this thesis.

The participants were provided with a letter of invitation, along with an information sheet explaining the purpose of the study, what would be required of them, how the information they provided would be used. They were advised on how to opt-out (BERA, 2018), should they have wished to do so (appendix A, B, C).

Another factor to consider within a narrative, life history approach was how to deal with participants sharing personal and sensitive information around their lived experiences. In the process of collecting data, many things can come to light, such as bereavement, tensions with peers as well as sensitive issues around workplace difficulties (Goodison, 1992).

It is important to acknowledge the potential bias that can occur due to the researcher being a mathematics specialist and therefore a professional insider and the methodological approach inevitably delved into the subjective nature of interpretation of findings. Kumar (2011, p. 246) discusses this as 'a deliberate attempt to either hide what you have found in your study or to highlight something disproportionately to its true existence'. This was minimised by ensuring that the questions asked were directly linked to the participants' experiences and standardised in line with the decided themes being explored with all participants. Furthermore, five out of the twelve participants were former students of the researcher. Although this brings about notions of bias (Bryman, 2008; Silverman, 2010), the participants, at the time of conducting the research were no longer students at the institution and had willingly agreed to take part in the research, and secondly, the ethical paperwork and all subsequent correspondence made it clear to the participants that they could withdraw from the research, at any point, should they wish to do so.

A further aspect of insider research to consider here is the nature of being a practitioner research. Floyd and Arthur (2012) discuss two key components that practitioner-researchers' negotiate when researching within their institution or their field. They term these as 'external and internal ethical engagement' (p.171). The former covers procedural processes, such as gaining ethical approval and provide less challenge that the latter. Internal engagement, from the perspective of this research, gave the researcher much food for thought in considering how the researchers' actions and the data collected would affect the participants. As some of the participants were know by the researcher, there was an added sense of responsibility to interpret and authentically share their lived experiences. Saidin (2017) argue that although there are many ethical dilemmas to consider whilst

being an insider researcher, such as the need for objectivity and this being potentially compromised whilst being an insider, there is also value in researching as an insider. This is discussed further by Bonner and Tolhurst (2002) who provide three advantages to being an insider researcher: enabling a better understanding of the issue, minimise disruption, in understanding the social norms as the participant is known to the researcher and gather authentic data because the context is familiar and known to the researcher.

Moreover, the principles of 'The Hawthorne Effect' were considered whilst undertaking the study for two reasons: firstly, because interest is being taken in the participants, therefore the participants could provide answers that they feel the interviewer is looking for; secondly, as some of the participants were known to the researcher, a potential element of bias could develop as a result (L. Cohen & Manion, 2011; Punch, 2014; Thomas, 2017; E. Wilson, 2013).

Finally, the participants were kept informed at all stages of the data collection process, including sharing the interview questions before the scheduled interview, as well as sharing the interview transcript, once completed. Therefore, the participants could, if they felt uncomfortable, withdraw from the process at any stage.

3.8 Conclusion

This chapter has set out the position of the researcher and the ways the research has been carried out, as well as the rationale for the data collection methods and sampling technique used. The validity and reliability of the research have been explored alongside consideration of ethics. The chapter defined the core of and integrity in the data collection and analysis processes. The next three chapters report on the findings from the data analysis.

Chapter 4 - From experiences of learning mathematics at school and home to becoming a Primary Teacher and a PMaST.

4.1 An Introduction to chapters 4, 5 and 6.

This thesis explores the career trajectories and professional development of teachers who, over time, become PMaSTs. The exploration of identity is at the heart of understanding how these individuals transformed from a novice to an expert teacher of mathematics. The following three chapters (4, 5 and 6) report the main findings for this study.

The three chapters are structured as follows: chapter 4 is broadly organised to align with the chronology of life and career stages that emerged in the data, beginning with formative experiences of learning mathematics, through to higher education, followed by the first steps into teaching and subsequent experiences of continuing professional development, learning mathematics as an adult and becoming a PMaST. At the same time, this chapter seeks to answer the first of three research sub-questions examined in this thesis: *What are the professional and personal circumstances that lead to primary teachers becoming PMASTs?* The chapter begins to reveal themes relating to the conceptual framework, namely: *identity, CPD and career trajectories.* Furthermore, aspects of the data linked to themes in the literature emerge, such as experiences of learning mathematics in school and at home. Related themes, such as training to be a primary teacher are explored alongside the opportunities the PMaSTs experienced, leading to them becoming a future teacher of mathematics. Excerpts of Life Graphs and segments of verbatim narrative data are included in the chapter to provide insight into the transformation of a mathematics identity, revealing the influence of formative family, educational and career experiences and CPD in shaping and constraining identities.

Chapter 5 picks up the theme of identities and explores this in greater detail. It seeks to answer research sub-question two: *How do primary teachers describe and understand their experiences in*

the role of a PMaST? In doing so, it examines the notion of emerging identities, showing how identities are constructed through professional learning opportunities experienced by the PMaSTs, the opportunities available to PMaSTs whilst in a role of mathematics leadership and the challenges faced in the role of a PMaST. Some of the themes emerging from the data included the value placed on sustained professional learning opportunities and the notion of community in building confidence as a PMaST. Further themes included the empowering role being a PMaST played in career development and finally, the constraints faced by the PMaSTs whilst in their role are explained and explored. This chapter, therefore, develops notions of identity work, of process and change over time, through career paths and CPD experiences. These themes were explored in the literature review (Chapter 3, section 2.4 and 2.5), in the form of career trajectories and professional spaces shaping a PMaST identity and identity development through structured and sustained CPD experiences, which formed part of the conceptual framework for the study.

Chapter 6 continues on the theme of identities, CPD and career trajectories and explores these in greater detail, with an emphasis on future career trajectories of PMaSTs. It seeks to answer research sub-question three: *How do PMaSTs' professional identity developments reshape values, practice and future career goals?* In doing so, it examines how identities as an established PMaST have helped shape the career goals of the participants. The factors shaping career development are examined in more detail, such as the opportunities gained as a PMaST during their career and the professional learning opportunities afforded to them. The chapter concludes by exploring how the PMaSTs see mathematics now and how this has shaped and changed through their career to date. This chapter, therefore, develops further insight into changes over time regarding career goals.

These chapters provide the foundation for the discussion that follows in chapter 7, which includes a more detailed analysis of the findings of prior empirical research and the conceptual framework. It also provides the basis of the conclusions, and recommendations that will follow in chapter 8.

This chapter explores and analyses how early experiences of learning mathematics, alongside training to become a primary teacher and early career development influenced and enabled the development of a mathematics identity. As discussed in the literature chapter, identity is developed over time through a range of intrinsic and extrinsic factors. Therefore, this chapter sets out to understand how early experiences of the participants influenced their thinking, choices and career aspirations.

The chapter summarises the data collected from using the graphic tool of a Life Graph and the narrative life history interview data from twelve PMaSTs, to provide an answer to the first sub-question:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMASTs?

The data was collected and analysed in two phases, as illustrated in figure 6. The data was themed and the results of this analysis are summarised using the following sub-headings:

- Mathematical experiences and power relations in school
- Experiences of mathematics at home
- Training as a primary teacher
- Early career development and critical moments in building a mathematics identity

4.2 Mathematical experiences and power relations in school

4.2.1 Memories of learning mathematics and the role of the teacher; positive and negative memories.

Out of twelve participants, only four recollected learning mathematics and enjoying it. Another four participants revealed significant critical moments that hindered their progress in the subject and the

remaining four showed a neutral stance on the subject at school. Out of the four who communicated positive views of mathematics education in school, some also spoke of tensions with their peer groups through being seen as 'good at mathematics' (Belinda).

First, referring to enjoyable experiences, early memories of four participants (Michelle, Belinda, Sandra and Emma) illustrated a comfort and familiarity with mathematics and mathematical processes. Michelle recalls:

> *The only memories I have are … sitting down, having a list of sums on the blackboard and … copying them out in my book and I found that quite safe and comforting because I was given the formula, I knew what to do and I could … finish off my sums quite neatly and I quite enjoyed doing that.* (Michelle)

> *So maths at primary school … I was always the furthest ahead… and that just as simple as that… I don't remember being taught maths I don't remember maths lessons I just remember working through the books and I remember being able to explain to other people who got stuck on pages, how to work it out.* (Belinda)

Both Michelle and Belinda's responses suggest ease (a familiarity and comfort) with mathematics learning, suggesting they found mathematics 'fun' and easy to negotiate. Due to their mathematics ability, they were encouraged to help others within their peer groups, therefore perhaps providing them with an early introduction to teaching. A key memory described in the data were being left to do their mathematics rather than having distinct memories of 'learning' mathematics through interactions engineered by the teacher. This suggested that the confidence in the learning of mathematics for both participants had developed through manipulating and accessing mathematical content independently to be successful learners of mathematics.

A major theme within the data was memories of critical moments. Most participants discussed critical moments within their schooling that demonstrated a perception of 'not being good' at

mathematics. This perception came as self-reflection when comparing their work with that of peers or the realisation that the pace within lessons was not sustainable for them and therefore the gaps in their mathematical knowledge and understanding just got bigger and bigger as time progressed.

Four participants communicated a negative experience with mathematics learning at schools. They went as far as describing critical moments where their negative attitudes developed. All of these incidences involved learning a mathematical concept and how their teacher dealt with the participants' lack of understanding of mathematics. Nicola revealed this moment:

> *I loved maths at primary school, really enjoyed maths my father spent a lot of time with me at home teaching me his strategies, in year 3, and I can be really specific, I can go right back to that day, negatives stick with you don't they…, my teacher had shown us how to do long multiplication, as it was known then and I didn't get it. I went home and my Dad showed me how you did it, so I filled up a whole note book because I got it, how my dad showed me, the method, not the understanding of the number but I got the method and so I was so excited and so eager to please my teacher, I took it [notebook] in and she… ripped it up because I hadn't used the method she had shown. She told me I was stupid because I didn't get it and from then on that was my default I didn't get maths so….maths stopped making sense because I believed I couldn't get it and it was my lowest subject I got at GCSE.* (Nicola)

This incident illustrated a moment in Nicola's life when she moved from confidently developing her mathematical skills, at her own pace, to not 'bothering' with the subject because of the way her teacher dealt with the incident. This critical incident led to Nicola creating a barrier between her and any further mathematics learning. These barriers, as the data suggests, were created by a teacher whose actions were interpreted as negative. Nicola went on to say that the 'teacher' took her passion away and she stopped bothering, not just with mathematics but with all aspects of school and as a result, did not gain her qualifications until she went back into education as a mature student.

Gregory discussed having clear anxiety of learning mathematics both in primary and secondary school:

> *With the maths creating a greater level of anxiety, it's very hard to say precisely where the anxiety came from … possibly enforced by the self-perception that I wasn't one of the higher attainers in the class so I possibly in comparison with social peers gave that feeling.* (Gregory)

Gregory's experiences of secondary mathematics demonstrated a dramatic low as the mathematics became more demanding.

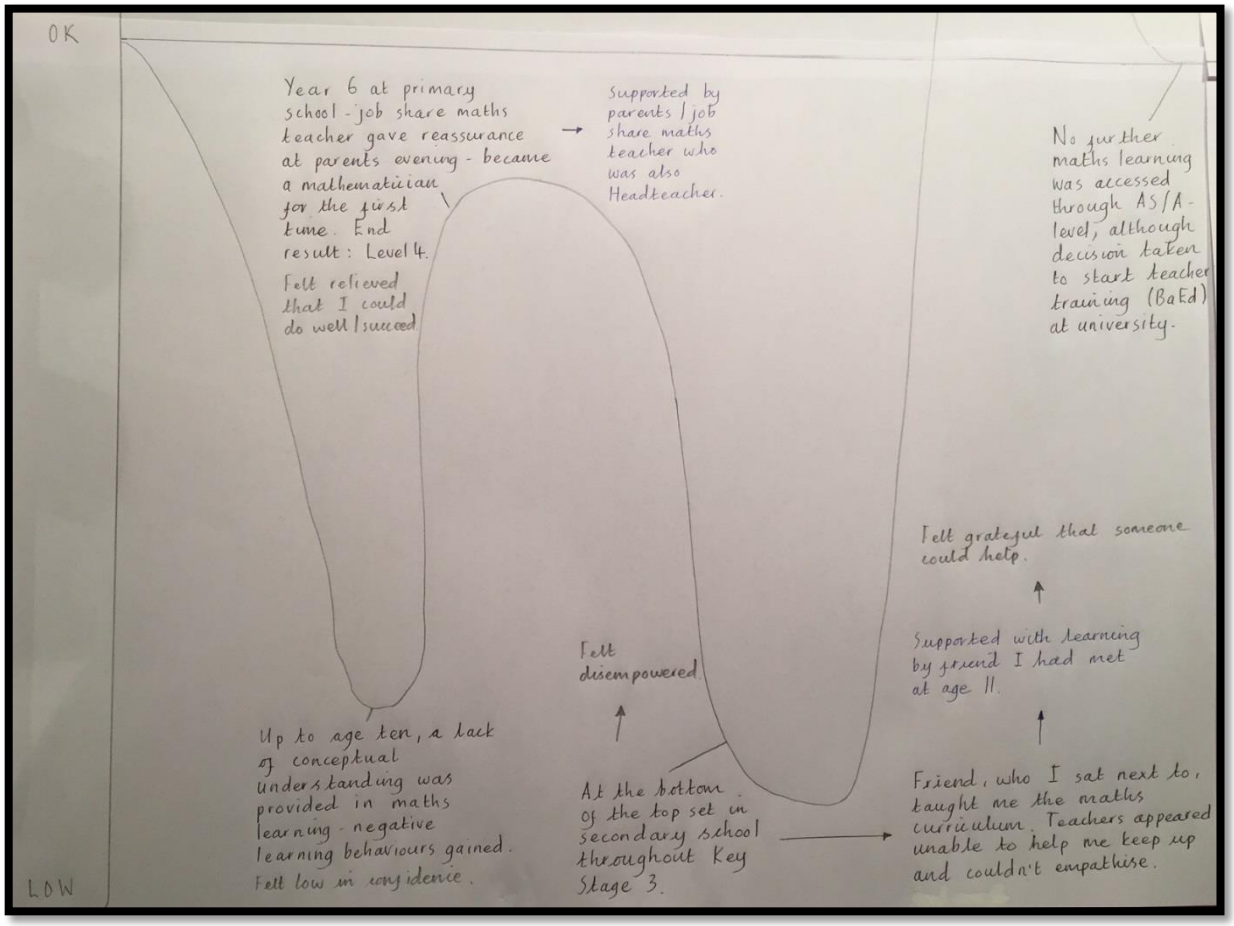


Figure 14 Gregory's Life Graph Extract, showing low points

> *So my self-perception remained that I wasn't particularly a competent mathematician even though within the terms of having three sets, I probably would have been in the top third.* (Gregory)

There is a juxtaposition of how Gregory felt about his high mathematical achievements at the end of primary school and being subsequently put into the top set in secondary school, where he struggled and this knocked his confidence.

Sharon expressed similar anxiety around learning mathematics with a memory of not understanding concepts at secondary school:

> *… I remember maths fairly early on and thinking okay, I am keeping up with this and then quite soon after a few lessons where I didn't understand and I don't remember whether I asked maybe I did maybe it was explained but I still didn't get it and that I think began a little bit of a downward spiral for me.* (Sharon)

Further illustrating this theme in the data is Reece discussing the mathematics content as:

> *… I can remember being at secondary school and it was just like someone was talking Japanese to me, I couldn't understand, I just didn't know anything about it at all and I left secondary school really failing in it and I went onto college for a year and I took maths and it was on a Friday and in the end I just bunked off because I just hated it. (Reece)*

This significant theme in the data revealed unsustainable relationships with the mathematics that filled the PMaSTs with a fear of the subject and led to them not engaging with it. The content not being made accessible at the secondary level, illustrated in the data sets, suggested a lack of confidence in the subject that was developed during secondary schooling. The data puts forward the notion that lack of confidence developed as a result of how participants experienced the teaching of mathematics.

The data also provided an insight into how some of the participants perceived themselves when they were singled out as being good at mathematics. This, from their perspective, gave them exposure with their peers that they were not comfortable with and therefore spent the majority of their

schooling hiding their mathematical understanding. Belinda identified as a gifted mathematician and reflected on how she engaged with a mathematics task at the start of her secondary schooling:

> *… So I remember my very first maths lesson when I was in year 7 and the question we were asked was how many squares are there on a chessboard. And I immediately went about it… and the teacher highlighted me to the rest of the classes being the only person who had thought it through systemically … okay I am not used to being publicly being good at maths I think at Primary school I was just, I quietly felt achievement because I was further ahead with the book (scheme book) but nobody else knew that, and then so that was my very first maths lesson in secondary school,… and I got teased a little bit for it and that set me feeling well actually no you don't do that again you can quietly do your stuff but you don't show anybody that you have done your stuff. … I was in all the top sets and so forth… but I distinctly remember pretending that I didn't really know what was happening and pretending that I was too kind to fit in with my peers and then going home and doing it properly and yeah, quite a few of my friends who I still have from that top set maths said to me, you know we went through the exams and you completely aced it and we didn't, and we sat next to each other and how did you keep that hidden all that time.* (Belinda)

Belinda's open reflection on developing a guarded approach to publicising being 'good at' mathematics demonstrated how Belinda struggled to openly share with her peers, the affinity she had with mathematics. Furthermore, Belinda pretending not to be good at the subject but ensuring that she caught up with the learning on her own suggested a resilience on her part, ensuring that the school circumstances did not hinder her progress. This ties-in with the major theme of teachers and their influence on how mathematics is perceived and understood.

Similarly, Michelle reflected on being a successful mathematician at secondary school and being able to sit her GCSE early. However, within this positive there is a negative memory she shares:

> *I felt quite proud to take my maths GCSE early there were only a few of us that did. I do have a memory of when the results were announced the maths teacher came into my literacy lesson and said, sort of announced to everyone 'oh the results are in everybody has got a grade B except for (named student) who got a C', I just felt so terrible for her, though that was a really awful thing to do.* (Michelle)

This reflection, firstly highlighted the pride of doing an exam earlier than the expected age but it also brings to light the importance of teaching approaches and dealing with key aspects such as illustrated here, in a sensitive way.

Overall, the themes in this section demonstrated that the majority of the participants had negative attitudes towards mathematics, many of these built over time in schools, through the way participants experienced the teaching of mathematics.

4.2.2 Grouping in schools

Grouping of pupils at secondary and primary schools came up frequently as a theme in the data, showing the links between grouping and mathematical achievement. Gregory's comments summarise this well:

> *A significant factor in that disempowerment was the grouping in the sense that I was 'setted' in the top set yet within that group of students was very clearly at the lower end of understanding …so my self-perception remained that I wasn't particularly a competent mathematician …* (Gregory)

This use of language such as 'disempowerment' suggested tensions linked to setting/grouping in mathematics early on in secondary school and shows how this shaped self-perception of mathematics ability. Gregory left primary school achieving highly in mathematics, so having a sense of 'disempowerment' at secondary school suggests more careful considerations for the transition to minimise the development of negative relationships with mathematics. The data suggests one

positive aspect of Gregory's experience; the help from his friend (figure 16 Gregory's Life Graph). In Gregory's words 'felt grateful that someone could help' a positive peer role model who stepped in to support Gregory's mathematics learning. Gregory further reflected on this when he was moved from the top set/group into the top of the second set, which enabled him to firstly manage the mathematics learning better, as the work was pitched to his level, but, more importantly, he was able to 'assume the role of his friend' by helping his peers.

> *… I had things to offer to them [peer group] and so the role I had had before was taken over by them and so I was able to get into the role of my friend to do the teaching.* (Gregory)

These reflections show early indications of Gregory taking the role of a teacher and possibly sowing the seed of future career aspirations.

Sally, Belinda and Michelle discussed doing mathematics in primary schools by following a scheme, essentially following a textbook and solving problems set in the textbook. There is no recollection of actually being taught mathematics. This is verbalised by Sally as:

> *Yeah, so it's quite interesting actually because being a summer born I was actually put in the bottom group … for most of my primary education … and it's only when I got to year 5 that I had a teacher who decided to group us due to our ability and it was really odd because then in year 6 they didn't know what to do with me and my friend so they ended up just giving us a textbook and putting us in the corridor and just saying 'have fun' off you go … they didn't know what to do with us because actually like you are really bright and you have done all the work so go in the corridor.* (Sally)

Sally reflected on the dynamic change of moving from the bottom set to the top and then the teachers not knowing what to do with her. A similar experience is echoed by Belinda, sharing her experience of being given a textbook and being expected to 'just get on with' the work.

Overall, the data demonstrated that the PMaSTs experiences of grouping are negative. The data illustrated this dissatisfaction with grouping even when PMaSTs were in the top groups. As individuals who enjoyed and were successful mathematicians, they felt an unease to be associated with this because of the negative connotations they faced from their peers, leading to them not wanting to show their ability.

This section has illustrated one of the major themes within the data set, therefore concluding that the school environment, including the way mathematics is taught, by whom it is taught had a lasting impact on how the subject was perceived by the participants for this research. The role of structuring learning through grouping was a sub-theme and showed the harm grouping and setting caused to the majority of participants. A surprising aspect of grouping was that, even when a PMaSTs were in the top group, they did not feel comfortable to show their ability. Furthermore, when they did need help with mathematical concepts, they elected not to ask for help because of the pressure they felt from their peer group. The PMaSTs indicated that they were intrinsically aware of the groups they were in and hence felt empowered or disempowered by these imposed organisational structures.

4.3 Mathematical experiences at home

Out of the twelve participants, 11 highlighted memories of mathematics at home. This was a major theme in the data sets and this section is organised to incorporate the thematic analysis undertaken. These memories provided an insight into spaces of mathematical learning that the participants experienced in their homes with their parents, carers and siblings.

4.3.1 Application of mathematics at home

Nicola, Sharon and Daisy reflected on the application of mathematics within their households and getting to understand the practical nature of knowing and understanding arithmetic skills. Nicola discussed her mother's role as being the homemaker and having expert budgeting skills but not having the confidence to help with schoolwork:

> *My mum didn't help me academically because she had no self-belief in herself, although if anyone could manage a budget, it was my mum…. My dad … was the only breadwinner in the family, but he would give … the money to my mum and keep a little bit for himself ... So although my mum had no self-belief in herself, she was amazing and she taught all of her children how to manage our money and to prioritise.* (Nicola)

Two things can be suggested from this segment: first, that Nicola continues to be inspired by her mother's understanding of a household budget and the mathematics involved in that, and second, as Nicola used the phrase 'mum had no self-belief' three times, she appears to believe her mother felt inadequate in mathematics. There is a dichotomy in the narrative of a role model that helped Nicola shape her understanding of mathematics as a life skill but appeared to lack confidence at the same time. Daisy voices her mother's lack of confidence in mathematics but that learning how to make clothes with her mother, she illustrated key practical mathematical skills:

> *She (mother) did teach me to make clothes, we used patterns, cutting, measuring … I think that is a mathematical skill … and also with my father … I used to use tools. I remember very, very well the rulers that he had … a wooden ruler that extended … a metal ruler for cutting certain things … that experience I think, without a doubt is sort of gone through my life in terms of practical understanding of maths.* (Daisy)

Daisy's reflection, on the other hand, shows an immersion in mathematics through practical skill sharing with her parents.

Sharon discussed learning the application of mathematical skills by shopping and adding up totals and subtracting for change:

> *… I don't really remember maths being discussed as being part of homework or asking my mum and dad for help … I do remember as a young child going to the shops really clearly … so I did have quite a good understanding of addition and subtraction and calculation perhaps*

that's why I liked the fruit and veg stall idea so much because it was maths in a familiar context for me, I hadn't thought of that. (Sharon)

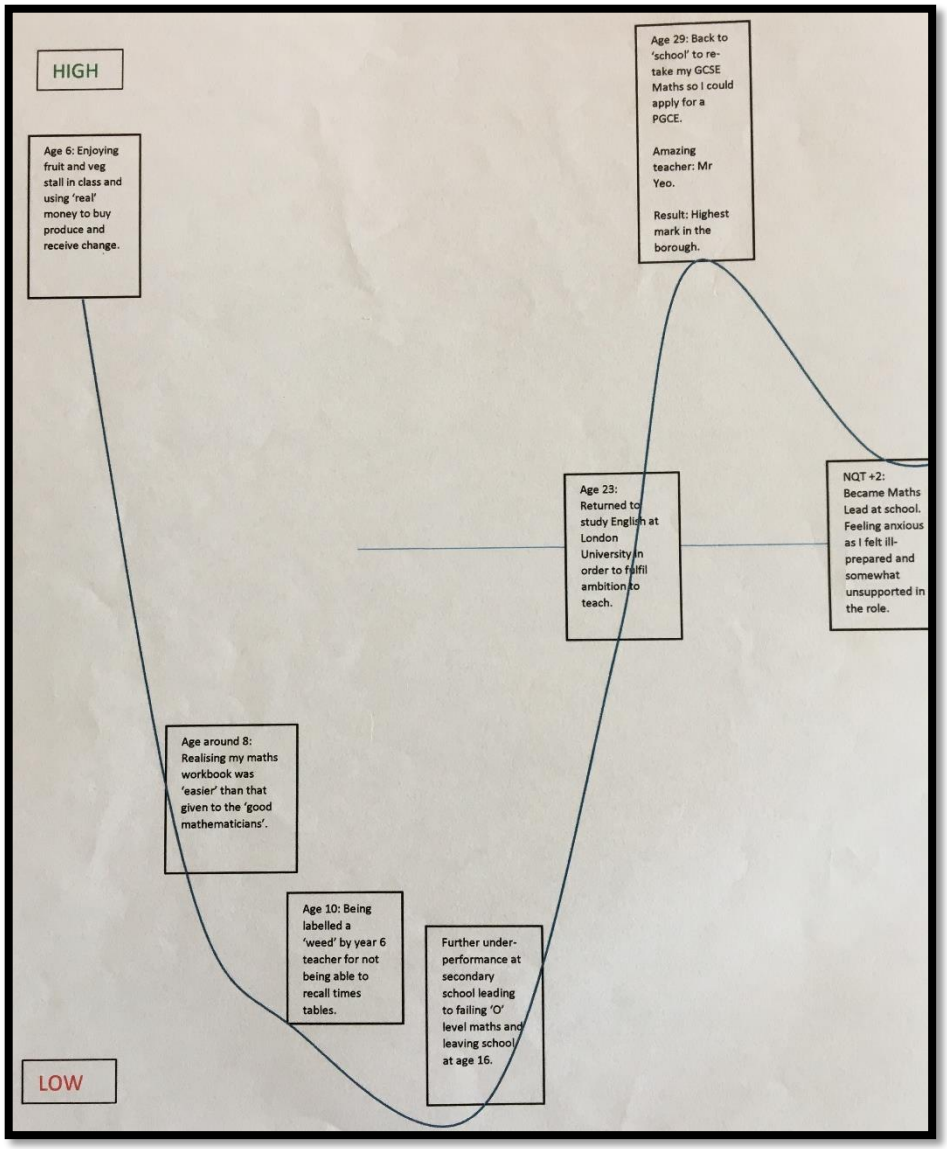


Figure 15 Extract of Sharon's Life Graph

Sharon's observations about home influences and her only positive memory of being taught mathematics through a 'fruit and veg' stall illustrated how positive mathematical immersion in the home environment possibly helped her develop mathematical understanding.

4.3.2 Parental jobs and parental support in enabling positive mathematical learning

Within the theme of parental influences, the sub-theme of parental jobs emerged from the data. Sally, Roseanne, Michelle and Belinda revealed memories of their parents' jobs and being immersed in a mathematical environment, shaping their mathematical knowledge and understanding. Sally's parents are both mathematicians and her mother is a secondary mathematics teacher.

> *… for as long as I can remember I have always seen my parents doing their maths homework as it were …I think my mum becoming a maths teacher was very interesting she started training when I was at the end of year 5 going into year 6 and it was really positive actually I think for me because again I could see that kind of there is that progression … she was able to help me more because she understood better what was needed […] I remember sitting with my dad while he is doing it (problem-solving booklets) and kind of pretending that I was doing it too … and then him just kind of going "yeah it's alright".* (Sally)

Immersion in mathematics could have supported Sally to recognise mathematics as a possible career. The segment revealed parental influences played a pivotal role in Sally's love for the subject. It is of note that Sally remembered 'pretending' to undertake mathematical problem solving, and recalled a desire to 'be like her parents' and at the same time learning about mathematical processes.

Similarly, Roseanne describes her parents' jobs as:

> *My dad … is an engineer and a metallurgist, so he worked in industry for a while but then he has also done lecturing at university and FE as well on the engineering side so obviously his maths was always pretty good. So I knew if I did have any problems I could go to my dad for maths, strangely enough my mum comes from a very small place in Wales and her education was quite lacking … but she worked in a special school as a support worker there but her maths was very good […] They were both school governors and supported me with*

> *schooling… My sister was sort of academic and she went into teaching straight away after school.* (Roseanne)

Roseanne, in a similar way to Sally, set out her experiences of being in an immersive mathematical space at home. The segment revealed Roseanne's interpretation of the support she could receive from parents who showed, through their work, confidence with mathematics.

Belinda's recollections of home influences suggest an enduring connection to mathematics developed through her father's love of the subject. She revealed an admiration for her father and recalled being influenced by him in the decisions she made to pursue mathematics to degree level:

> *My dad is much more mathematical … but he had an accident when he was young and so although he was following a mechanical engineering career he had to stop … he wasn't really able to help me with maths but I looked up to him in the career he had chosen even though he had not been able to continue with it … so he would still sit with me and we would enjoy doing homework together but he wasn't really helping me as such but he definitely influenced the decisions that I had made.* (Belinda)

Michelle recollected a low point on her Life Graph (figure 16) when she went from GCSE to 'A' Level and the demands of the mathematics learning being elevated. The support she received from her parents was in the shape of a tutor. Michelle recollected the tutor supporting the regaining of confidence in the mathematics content for 'A' Level, for her to complete her course. Although this example is not strictly related to parents' jobs, it demonstrated the support provided by Michelle's parents for her to complete her course.

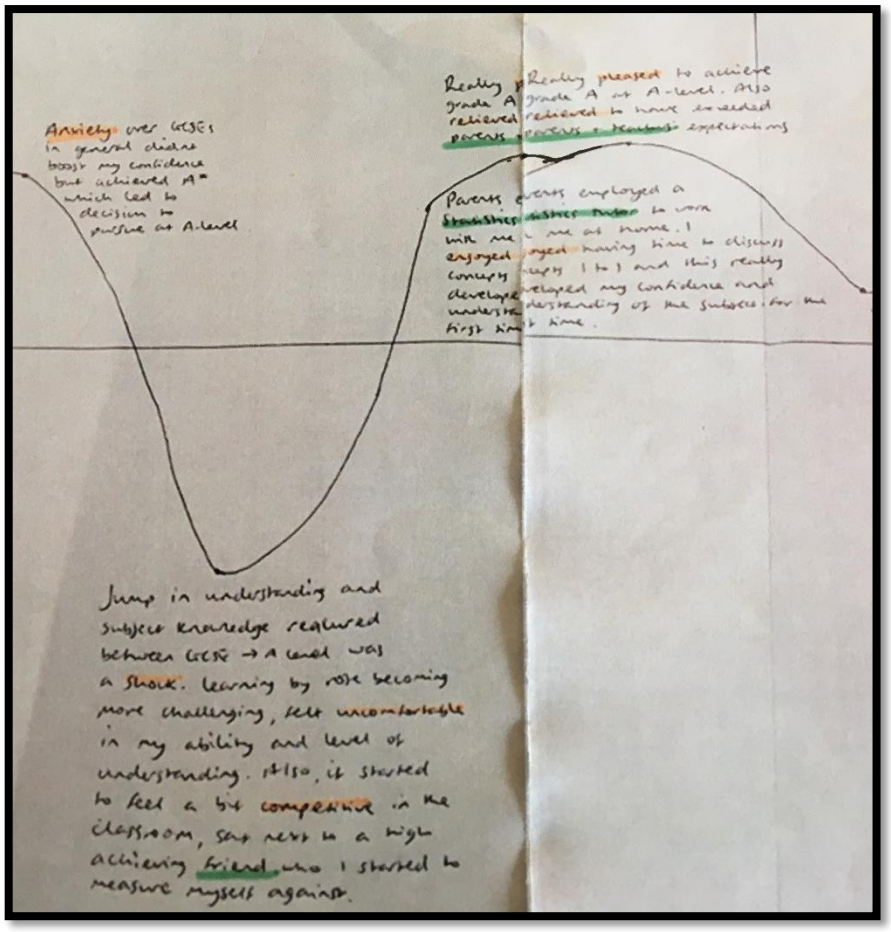


Figure 16 Extract from Michelle's Life Graph.

The data demonstrated that the job of a parent/s is very influential in positively developing a mathematics identity. All the participants who highlighted positive home influences from an early age went on to develop a confident outlook towards mathematics across their schooling as well as across their teaching careers.

4.3.3 Pressures at home and a lack of help with mathematics

Some of the participants provided insight into little or no support provided at home for the learning of mathematics. Gregory reflects on this as:

> *Yeah, homework was a stressful time in terms of the maths because I knew that there wouldn't necessarily be a level of understanding from my parents that could give me the support and hence the pressure increased to know what I needed to do.* (Gregory)

Thomas revealed getting no support from his parents. He did, however, remember his brother being good at mathematics:

> *So home influences … I knew my dad was a good at figures but again, never got any support … My brother was very good at maths so maybe that pushed me in some way … but no it's very much on my own*. (Thomas)

The extract does not share exact examples of help with learning mathematics here but the influence and achievements of a sibling appear to have spurred Thomas on.

Emma discussions revealed a lack of aspirations at home, as even though she had attended a grammar school, the extract indicates there was no expectation for her to attend university:

> *So I don't think there was any high aspirations let's put it that way I think they were happy as long as we were happy but I think it was … you are more likely to go and start a family and … it didn't seem to be even though I had gone to grammar school there was no expectation of university or anything.* (Emma)

These views, expressed by Emma, provided evidence that she felt no expectation to pursue further study. Emma left school and went onto an FE college to undertake a course in catering.

Overall, home influences shaped, both positively and negatively, the participants' formative experiences and developing identities as mathematicians. The data also suggested that those participants who did not get support from home found this added to the challenges they already felt with mathematics.

4.4 PMaSTs moving into a Teaching Career

4.4.1 Learning mathematics as an adult

Out of the twelve PMaSTs interviewed, half (Gregory, Sally, Sandra, Daisy, Belinda and Michelle) pursued a career into teaching using traditional routes such as going into higher education straight from school and either doing an undergraduate teacher training course or following an undergraduate course with a Post Graduate Certificate in Education (PGCE).

Learning mathematics as an adult to gain appropriate qualifications to pursue further studies was highlighted by half of the participants. This section will shed light on the participants who followed a non-traditional route into teaching (Nicola, Reece, Thomas, Sharon, Emma and Roseanne) and how their mathematics identity was shaped as an adult learner.

Of the six PMaSTs, three (Nicola, Reece and Sharon) learnt mathematics either at night school or as part of an access course because of the need to have a mathematics qualification to pursue a route into teaching. All six participants provided details of critical moments and accounts of their experiences of learning mathematics as a process that influenced their subsequent perception of mathematics. This theme allowed a further window into PMaSTs' identity as a learner of mathematics to understand the differences between the PMaSTs' perceptions of learning mathematics as an adult and as a pupil. Extracts of data from the six participants have been used in this section to illustrate these points.

All three discussed their teachers using powerful descriptions:

> *I did evening classes and I had a really good teacher, she was approachable, she would break things down so to make it relevant …* (Nicola)
>
> *Oh my goodness, I actually, there isn't enough room on the Life Graph where my feelings went. So I was 17 when I left college and this was how many years later I had had my child … So went to this night class and this teacher was just amazing and it wasn't even, I can't even*

> *say what he did he just made it, it was just like … this is maths, this is what you do this is it! … then I flew … I absolutely loved it and I could not understand why I had never loved it before. And, he was just the most amazing person.* (Reece)

> *It was a real breakthrough moment … I went to college on a Saturday morning for a year and … this teacher is very quiet, very unassuming, very kind patient positive and he just made me believe in myself, laughs … It really is as simple as that. He taught the concepts really clearly … I can't remember what type of GCSE it was but the way it was structured you didn't sit one exam in the summer … I missed the Saturday when he handed out the results and when I went back for the first Saturday … when everybody else was working he passed me a piece of paper I looked for it last night and I know I've got it that's how special it is … on this little piece of paper were my two grades for my tests and one was I think it was 98 and 96 something like that percent and underneath he's written "highest results in the borough, truly outstanding" … that was confirmation that I actually could do it and now someone believed in me I believed in myself.* (Sharon)

These extracts from three participants show how the experiences of learning mathematics as adults can impact on a person's confidence level in the subject. The language used by Nicola, Sharon and Reece to describe the experience of learning mathematics as an adult suggests a change in how they perceived themselves as learners of mathematics, showing they gained a sense of achievement and belonging. All three studied at night school, and the data suggested that their experiences of working within a community of learners, all of whom were there to gain an essential qualification, to help further their life goals, allowed for a unique experience, leading to a strong sense of belonging to a CoP. Additionally, they described the teachers at night school having an approach that allowed for a more relaxed way of learning mathematics. The teachers were described as 'amazing', 'this is maths', 'real breakthrough moment' 'kind, patient, positive', thus enabling the PMaSTs to re-think their relationship with mathematics. The data demonstrated this by the final grades the participants

achieved after completing their night school courses. The notion of kindness filters throughout the data, e.g. Sharon explained the 'kind and gentle nature of her teacher' and how this helped in feeling a sense of belonging in the class.

Reece reflects on the types of people who took night classes and her feelings towards this:

> *Yeah, but he [teacher] just made us, and it was all of us I remember, you know we were all in night school because we hadn't done maths we were all mature students and we hadn't got maths and … I suppose [we were] quite frightened of it I think that's a real fear there is and you know I see it, there is a real fear of maths and I had it then and all of a sudden it was just like he [teacher] opened my eyes and it was just amazing, it was absolutely amazing.* (Reece)

The data provided insight into how the PMaSTs' experiences of learning mathematics as adult learners, at night school, was an empowering and positive experience because of the teacher and the positive learning communities they developed – the teachers developed mathematics in such a way that it demystified the subject and made it accessible, manageable and enjoyable.

4.4.2 Going into Primary Teaching

Out of the twelve PMaSTs, six followed a traditional pathway into teaching. The data suggested that three PMaSTs who went into teaching as mature students decided to enter the teaching profession after time either volunteering or working as teaching assistants in schools. The narratives suggested that they felt their skills were recognised by teachers and leaders in schools and hence the PMaSTs were encouraged to develop a career in teaching. Nicola's extract describing being noticed by an Ofsted inspector illustrates this point well:

> *…OFSTED came in and said… they kept talking to me as if I was a teacher and I said I'm not a teacher but I was teaching a group when they came in and it was maths … we were doing singing Hot Cross Buns in Polish, they pulled me aside and said, you need to go into*

> *teaching … I said, "oh no, I can't do it". They [Ofsted] said to our headteacher, you need to get that lady to become a teacher. (Nicola)*

One common sentiment emerging from the data was that all twelve PMaSTs had a desire to become successful teachers and a determination to achieve this goal. An excerpt from Nicola's narrative, below, provides an example of this. First, she had to update her qualifications in mathematics and science, then pursue a foundation degree course before she could complete an honours degree. Once this stage was complete, she started her teacher training.

> *Then I went to do a Foundation degree and my maths and my science because I had to get them up to where they needed to be so I did that and then I did my Honours Degree and my Graduate Teacher Programme [school based ITT programme] to get my Qualified Teacher Status.* (Nicola)

Roseanne had a similar trajectory in becoming a teacher; starting in schools as a lunchtime supervisor and climbing up the ranks through access courses and then doing the Graduate Teacher Programme.

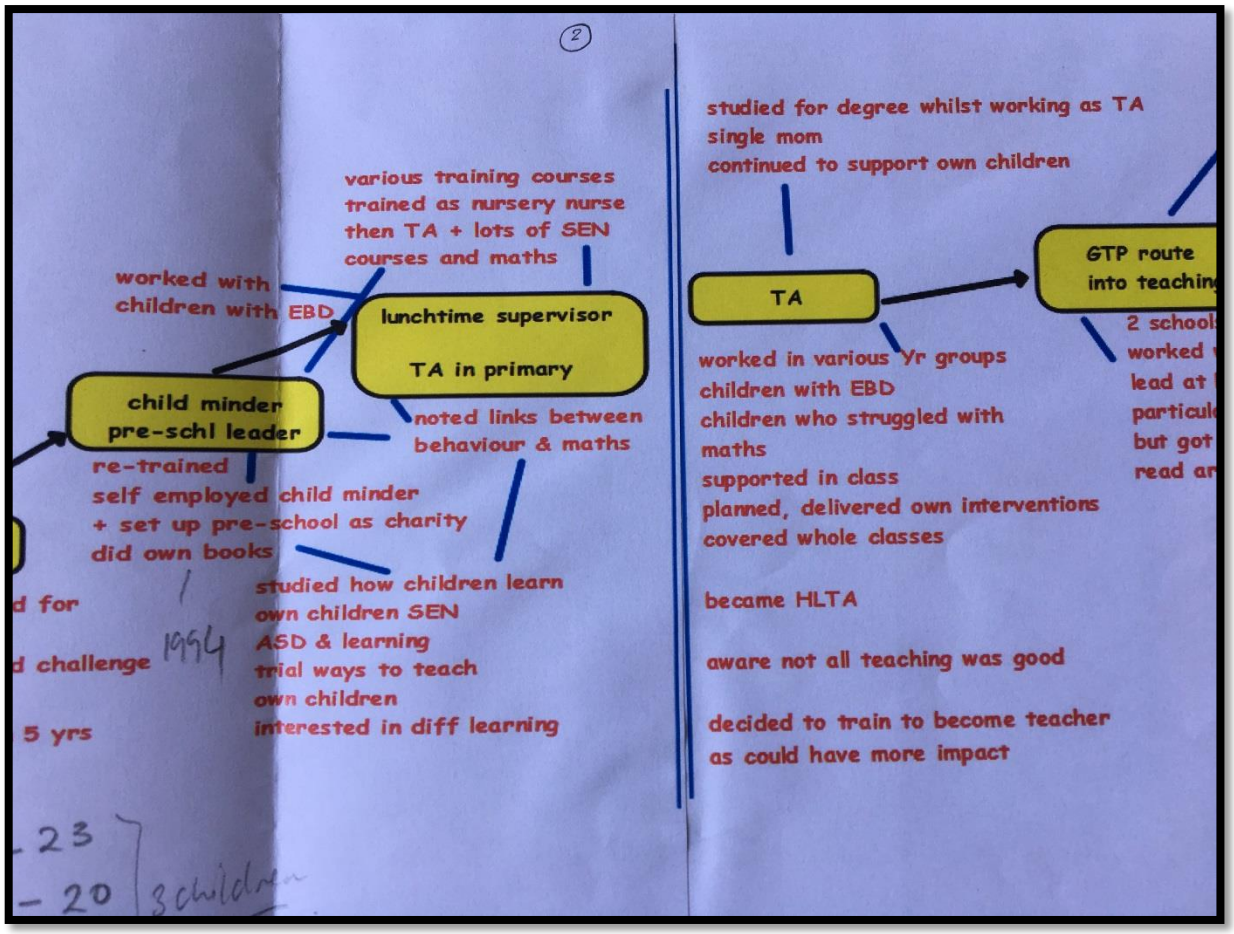


Figure 17 Roseanne's trajectory of going into teaching.

Roseanne's Life Graph in figure 17 shares an interesting aspect of noticing mathematical learning whilst working as a lunchtime supervisor in school. This awareness suggested that even when Roseanne was simply meeting pupils for an hour a day, with a pastoral role, she was still trying to understand what factors created serious behavioural issues, her Life Graph revealed that the behaviour had links to mathematical achievement. This observation suggested an understanding and interest in pupil learning support their success in school.

Roseanne further illustrated her drive to pursue a career in teaching to enable better opportunities for the pupils in her learning environment:

> *I was working in a school where I was quite passionate about what I was doing, I was covering for a lot of teachers so I was doing some teaching … I was also in a position where I*

> *was actually going into lots of different classes supporting some children and I was just aware that the teaching was not the best it could be for those children and that was impacting on their learning but any kind of conversations I might have had with certain teachers they weren't willing to have the conversations because I was a TA. I remember the one comment when one said "do you know, if you don't like the way it's done, why don't you train to be a teacher" … okay, they are not going to take me seriously till I have got a degree … I mean it took five years … a Foundation Degree and then … full BA with honours, and then to do the GTP, (Graduate Teaching Programme) teaching qualification, a year after that. So it was a long route into teaching … in a way.* (Roseanne)

This extract exemplified the determination Roseanne had to follow a route in teaching to have the power and capability to enable change. The passion and resilience shown by Roseanne resonate through many of the PMaSTs' lived experiences. Roseanne's training trajectory showed a non-traditional route to becoming a teacher and by the time she was qualified and in her first year of teaching, she had a good range of experience, as shown in the Life Graph in figure 17 and the narrative above, to draw upon to develop her expertise.

The majority of PMaSTs referred to their experiences of teacher training as being both challenging and rewarding. There were pressures and frustrations of training during their teaching practice relating to feelings of conforming to set teaching styles for mathematics, which if given the choice, they would have done differently. There were moments of reflection from the PMaSTs illustrating how they actively sought to make mathematics meaningful to pupils during their teacher training practice. Gregory reflected on this:

> *I see a struggling mathematician I can associate with the inner feelings that have probably got on the basis of having those feelings myself through much of my schooling up until my GCSE level and in terms then of wanting to support them I feel through personal experience*

> *that I can give them the elements of pedagogy that are going to make a difference to them and from previous experiences when that makes a difference has felt rewarding.* (Gregory)

This reflection underpins a sense of empathy revealed by the PMaSTs towards their pupils. Gregory's empathy for his students comes across in his use of words- 'struggling', 'inner feelings', 'wanting to support them'- therefore highlighting how as a beginner teacher he wanted to understand why a pupil felt the way they did about mathematics. He sought to use his own experiences to support pupils to develop a healthy relationship with mathematics learning. It can be suggested that if Gregory did not have the experience of struggling with mathematics, this reflection and behaviour may not have emerged.

Reece similarly discussed having empathy for pupils who do not 'get' mathematics:

> *I see them and you see the fear and … its very I can pick out each year, I can pick out children that I have taught when they have got to year 6 you know have not understood it are frightened of it are like myself is in a totally different language and I can really empathise with that and so that part of that it takes me back to how I felt and I know that I got through it so I use those skills to help them achieve and maybe they don't like maths at the end of it but they are not quite as frightened of it as they used to be.* (Reece)

These extracts from the data sets illustrated how the PMaSTs have transitioned from being learners of mathematics to a teacher of mathematics. The theme that comes through significantly is a sense of awareness of mathematics anxiety, how the PMaSTs felt about this themselves as learners and therefore sharing empathy with their pupils by adapting their teaching of mathematics. Additionally, understanding the value of mathematics and how it is a powerful tool for building successful lives, allowed these teachers to fell they could build their pupil's mathematical capital.

Future opportunities and access to mathematics can be drawn from the level of empathy and understanding the PMaSTs have towards their pupils' access to mathematics. They champion the subject for all, especially the ones who found mathematics challenging.

Generally, the PMaSTs discussed experiences of learning mathematics at University. They recalled having clear instruction as trainee teachers and having the freedom to explore mathematical ideas and understand the theories behind mathematical concepts. These reflections further strengthened their knowledge and understanding of mathematics and their growing pedagogical knowledge and understanding of mathematics at primary school.

Out of the twelve participants, only two (Daisy and Sally) elected for a mathematics specialism as part of their training. Belinda is unique within the participants, as she undertook an undergraduate degree in mathematics with psychology, initially to go into the field of educational psychology, describing her decision as:

> *I wanted to be an educational psychologist … so there was a bit of a fork with the maths and psychology degree. I managed to keep the two things that I liked which was kind of the peopleness and the mathsness.* (Belinda)

Belinda explained her experiences of mathematics taught sessions whilst training as feeling tense and not wanting to 'let on' that she had a mastery of mathematics:

> *So … I kind of got used to being a bit more public about the fact that I liked maths because I had been walking in a circle of people who were mathematicians and the love of maths and the beauty of maths and so forth and then I remember sitting in a seminar for primary maths teaching … lots of people saying oh god, I have always hated maths … and just all those old feelings came back and I don't think I even told my colleagues that I was a maths graduate … I remember talking to my maths lecturer who was my visiting tutor for my final placement and talking to him about it … and him saying "yeah no we really often see that" … He was*

> *fantastic, he was all about the beauty of maths even at primary level and the resources and the exploration and the discovery and the enjoyment of it and so you started to see primary maths.* (Belinda)

Belinda's narrative reveals a realisation of mathematics not seen in a positive light, which was challenging for her to come to terms with and she struggled with this identity of a confident mathematician while at the same time not wanting to share this with her peers. The important aspect of this reflection from Belinda was that the dialogues she had with her mathematics tutor whilst on school placement, and reassurances from him about her abilities and the positive role model he was, helped her with the approaches she used to teach mathematics whilst training.

The data analysis illustrated the PMaSTs' viewed the teaching of mathematics in schools was challenging. Furthermore, they had a sense of empathy for their pupils to enable meaningful access to mathematics. A great sense of responsibility comes through in the narrative highlighted by participants when they talk about the learning opportunities in their classrooms and what success in mathematics looks like.

4.5 Early career development and critical moments, building a mathematics identity

All PMaSTs discussed their first years in teaching with an emphasis on the learning environments they were immersed in, as well as on the individuals who enabled the development of their mathematical thinking and teaching. Furthermore, they elaborated on the professional learning that empowered them to build further understanding of being a primary teacher of mathematics and therefore facilitating appropriate learning opportunities for their pupils. The PMaSTs elaborated on significant moments that they regarded as pivotal in their development from a primary teacher into a PMasT.

Out of the twelve PMaSTs, nine (Gregory, Reece, Thomas, Sharon, Sally, Emma, Roseanne, Belinda and Michelle) were appointed as mathematics leads in their schools within the first two years of teaching.

Gregory's trajectory as an NQT is worth noting, as he encountered a great number of opportunities to develop his mathematical skills through an intensive level of support being provided to the school by the Local Authority (LA):

> *Yes, I took on an NQT post in a very small school that was the subject of intense support from the local authority and also very vulnerable from inspection as the school didn't have a maths subject leader in post … I was encouraged to get involved with the leadership of the subject at a very early time.* (Gregory)

Through this experience, Gregory highlighted a range of key opportunities that helped to shape his career in becoming a PMaST. Firstly, the leadership team having confidence in Gregory's abilities to take on a key role in managing mathematics. Secondly, Gregory's confidence in his abilities to take the risk of developing a leadership role in mathematics during his NQT year and finally, Gregory being supported by the work of the LA lead with mathematics:

> *That was made possible through the Local Authority maths advisor coming in, being able to offer me support both in the teaching and learning of maths to my class but also starting to think strategically about leadership from across the school.* (Gregory)

This narrative illustrated the influence the LA lead had in supporting and encouraging Gregory, at an early stage of his career in mathematics teaching and learning. The data revealed this supported Gregory, not only with his expertise in the subject but also taking the step into the leadership of the subject. The data further shows how Gregory's leadership team played a supportive role in the shaping of his professional learning opportunities. The extract below illustrates this well:

> *The four headteachers varied throughout my first four big terms … Of the four, the one who would have made the biggest different of my maths experiences would have been the first because she asked me to take on the role of the maths subject leader. For the rest of the year, I would say that I was more driven by the local authority advisor than any of the other headteachers, however, whilst none of them were perhaps so strategic in helping me to develop my role equally they didn't prevent me from taking on the further learning with the local authority advisor*. (Gregory)

This example can be interpreted as revealing the role school leaders play in 'talent-spotting' and nurturing mathematical skill development in school teachers.

Similarly, Reece, Belinda and Michelle expand on their experiences of teaching mathematics early on in their career, enjoying it, being recognised for being good at teaching it and then building a leadership role within it.

Belinda recalled being recognised as an outstanding teacher of mathematics in her NQT +1 year and this leading to her being seconded to develop mathematics within the Local Authority. This, as shown in figure 18, was a high point on Belinda's Life Graph, and proved to be a powerful and critical moment of recognition that helped Belinda to develop confidence and advance her career trajectory as a PMaST.

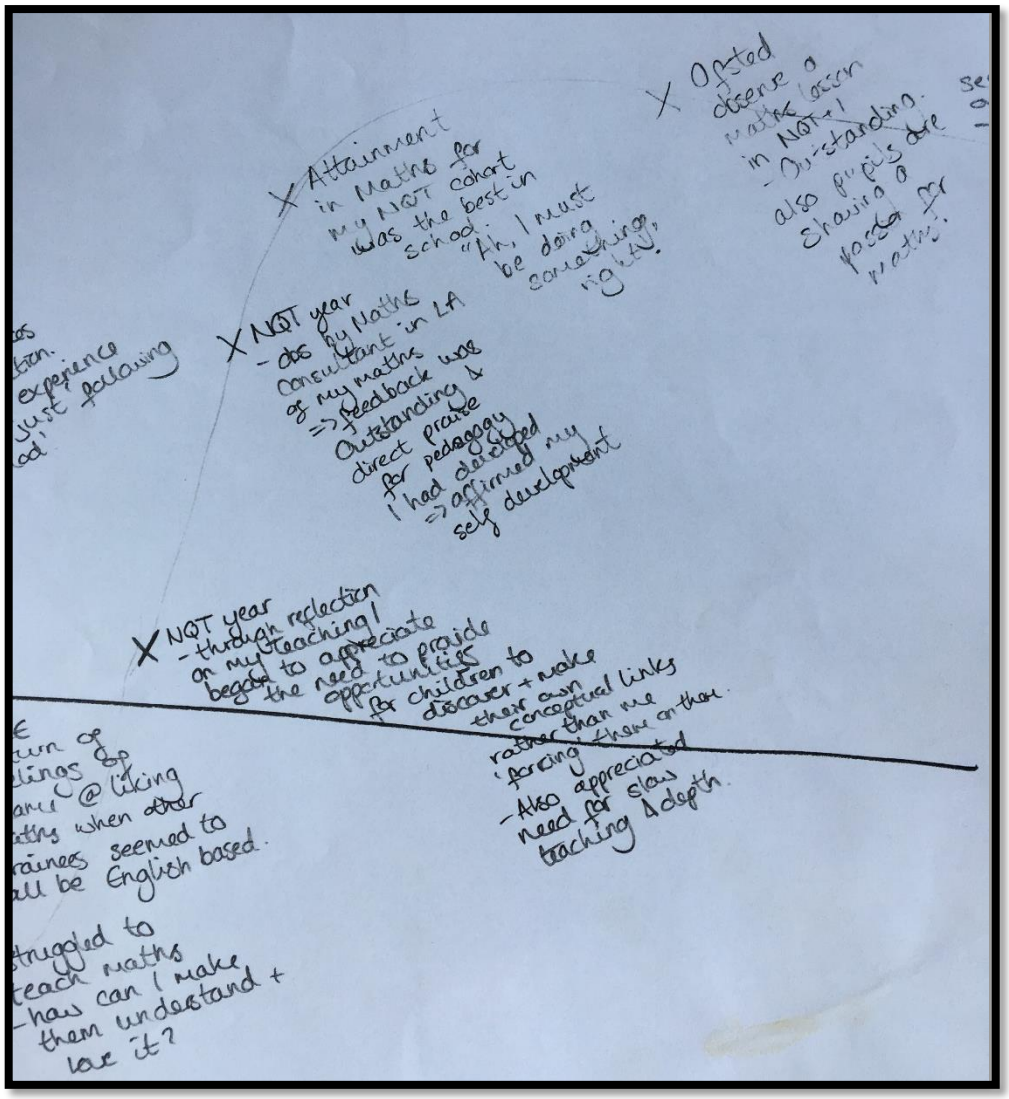


Figure 18 Extract from Belinda's Life Graph illustrating success during her NQT year.

Belinda's recognition of being a good, strong teacher of mathematics by her leadership team and then by Ofsted, encouraged her on a path to champion mathematics. Belinda exemplified this confidence on her Life Graph (Figure 18) describing the results of pupils she taught in her NQT year having the best attainment in mathematics across the whole school.

Belinda described this as: 'Ah, I must be doing something right!' indicating a growth in confidence in her ability of not just teaching mathematics to pupils but being able to lead mathematics in her school. The data showed a further development in Belinda's NQT+2 year when she was given the role of mathematics co-ordinator, and her headteacher encouraged her to gain further recognition

of the mathematics work through secondment opportunities with the Local Authority. Belinda described these as:

> *… my headteacher suggesting is it worth looking for local authority, consultant type secondments … unfortunately … there is no longer funding for it, however, we can second you for one day a week … so I did that instead which my headteacher was very supportive of.* (Belinda)

As the above narrative suggests, the secondment provided Belinda with an opportunity to widen and share her practice of the teaching and learning of mathematics, thus widening the scope of her impact in this area. Furthermore, this process enabled Belinda to further develop her confidence and belief in herself, describing this as 'love inspiring other co-ordinators to love maths'.

Aspects of the data showed that an early career 'push' into becoming mathematics leaders brought about anxiety for some PMaSTs (Thomas, Sharon, Emma and Michelle). They indicated the decision of going into mathematics co-ordinator roles as low points on their Life Graphs. There were anxieties linked to this for the PMaSTs, bringing back memories of learning mathematics whilst in school. Additionally, the PMaSTs highlighted being given roles because no one else, in the school, was available to take the responsibility on. This finding can be interpreted as the PMaSTs having the resilience of 'giving anything a go', a key identity attribute that the data showed existed in all the PMaSTs for this study. Furthermore, this finding from the study provides a window into the status of the subject and how it is perceived by colleagues in school, including the leadership team; the finding can be interpreted as there is an assumption that the role can be taken on by anyone without any prior bespoke professional learning and development. Thomas reflected on his critical moment of being asked to lead mathematics:

> *Halfway through the second year … the lower junior co-ordinator left and there was basically little option for the headteacher, who do I employ to this position? So I was given it on a temporary basis for a couple of terms and the lower junior co-ordinator was also maths co-*

ordinator, so I inherited both roles. Probably not as the first choice but as maybe the only choice … (Thomas)

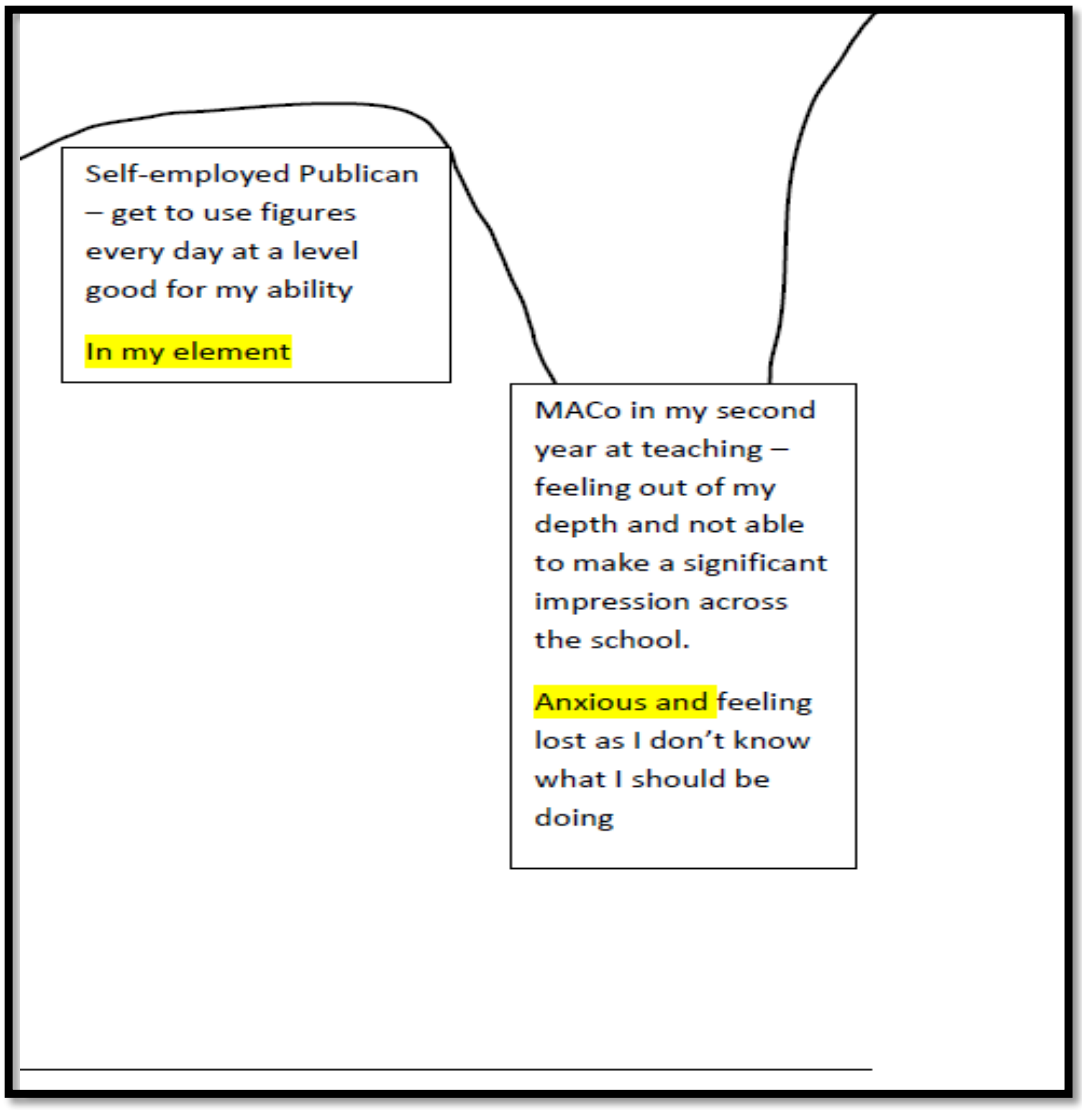


Figure 19 Extract from Thomas's Life Graph illustrating a low point, when he became a mathematics coordinator.

Thomas added the role of Mathematics Co-ordinator at a lower point in his Life Graph, providing context to how he felt when he was told to undertake the role. Furthermore, he discussed his views in the interview about being given the role:

… it's true I did actually feel I had three jobs, one of which I could barely do well anyway (classroom teaching) … there seemed no, no mentoring it was like I was progressing on my own through self-learning but that was ongoing to be finite I was never going to move on

> *without some extra help. So I felt that my maths and my teaching reached a point and that was it. So after five years, I thought I need to move.* (Thomas)

Thomas' reflection resonates with early experiences of leadership in mathematics for the majority of the PMaSTs: firstly, the way the role was given to Thomas suggested the actual role offered was that of a phase leader and the mathematics co-ordinator role as an add-on. Secondly, this suggests that, in his school's case, the school leadership team may not have had appropriate succession planning systems in place. Finally, the wording and phrasing used in both the Life Graph and narrative interview from Thomas communicated anxieties that can emerge when teachers feel they lack support to fulfil this important role- 'out of my depth', 'anxious', 'lost', 'no mentoring', 'progressing on my own', self-learning' etc.

Similarly, Sharon discussed the moment when she was given the mathematics co-ordinator role:

> *The headteacher came to see me and said I now know who is leaving so … your choice is you can be KS1 leader or you can be maths leader and that was that it was a two line whip … I didn't feel that I'd been selected on my merit or my interest particularly … I was quite excited about and honoured to be given the responsibility with it came the expectation of upping my game and performing which came with a little bit of anxiety as well.* (Sharon)

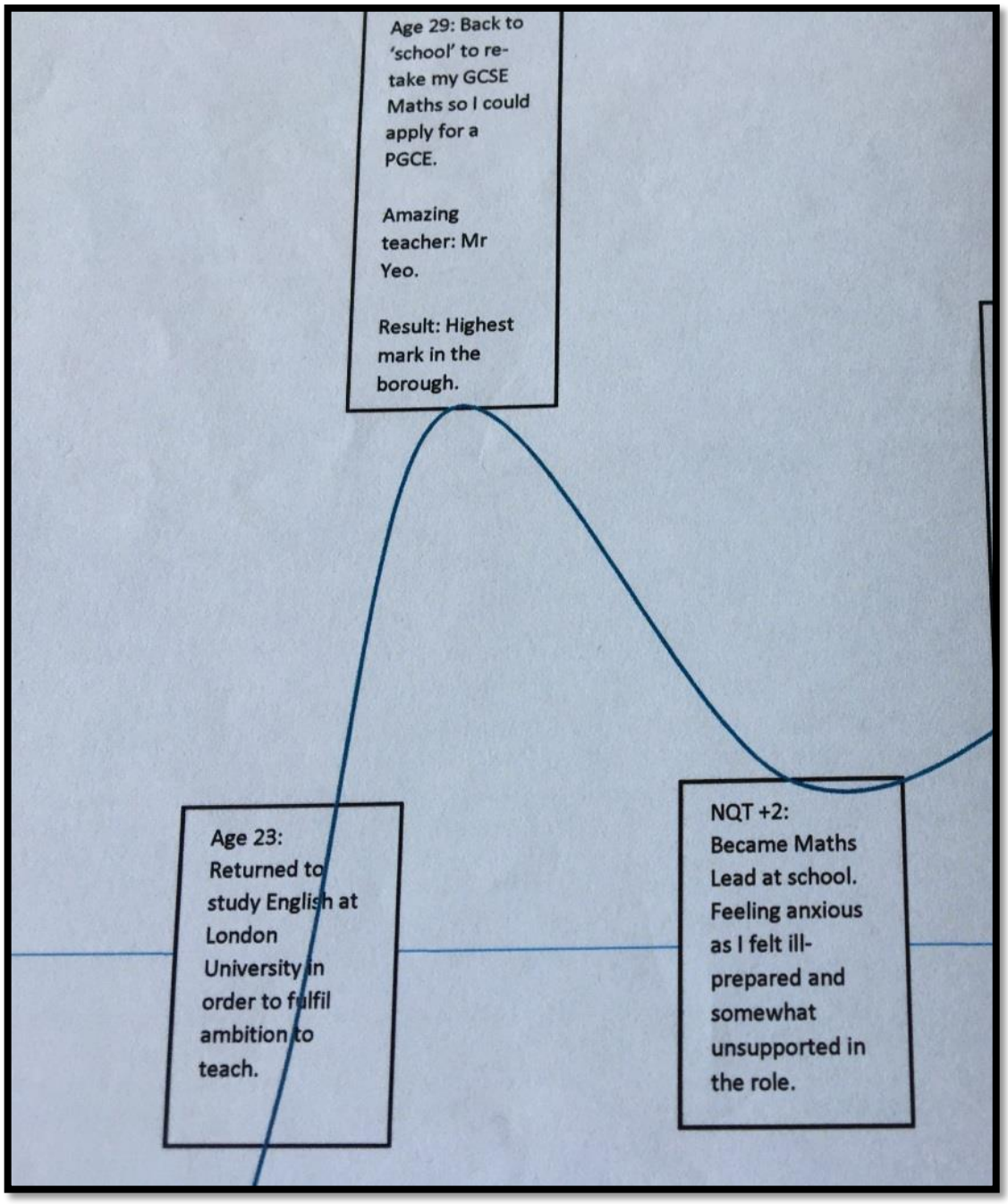


Figure 20 Extract from Sharon's Life Graph showing a low point when she took on a mathematics lead role.

Although Sharon's data suggested becoming a mathematics co-ordinator was not from choice, she does reveal a sense of pride in being selected by senior leadership to undertake the role and the challenge that came with it. This sense of pride perhaps shows an understanding of the importance of leading mathematics in school and the challenge it offers. Another interpretation of this situation could be that if Sharon had not been pushed to take on the role, would she have elected to apply for

such a role herself? How would her career have been shaped without this key opportunity coming her way in her second year of teaching? The data describing PMaSTs' being given the role of a mathematics lead can be concluded as, at times, leaders see potential that perhaps might not be apparent to the individual. This key point will be fully developed in chapter 7.

Continuing with the theme of leadership talent-spotting, Sally's data exposed her deputy head encouraged her to develop the mathematics co-ordinator role: 'When the maths lead position came up my deputy head basically said "You have to have this, this is you",' (figure 21). This highlighted the confidence in building Sally's skills as a teacher of mathematics and then into the role of a leader in mathematics.

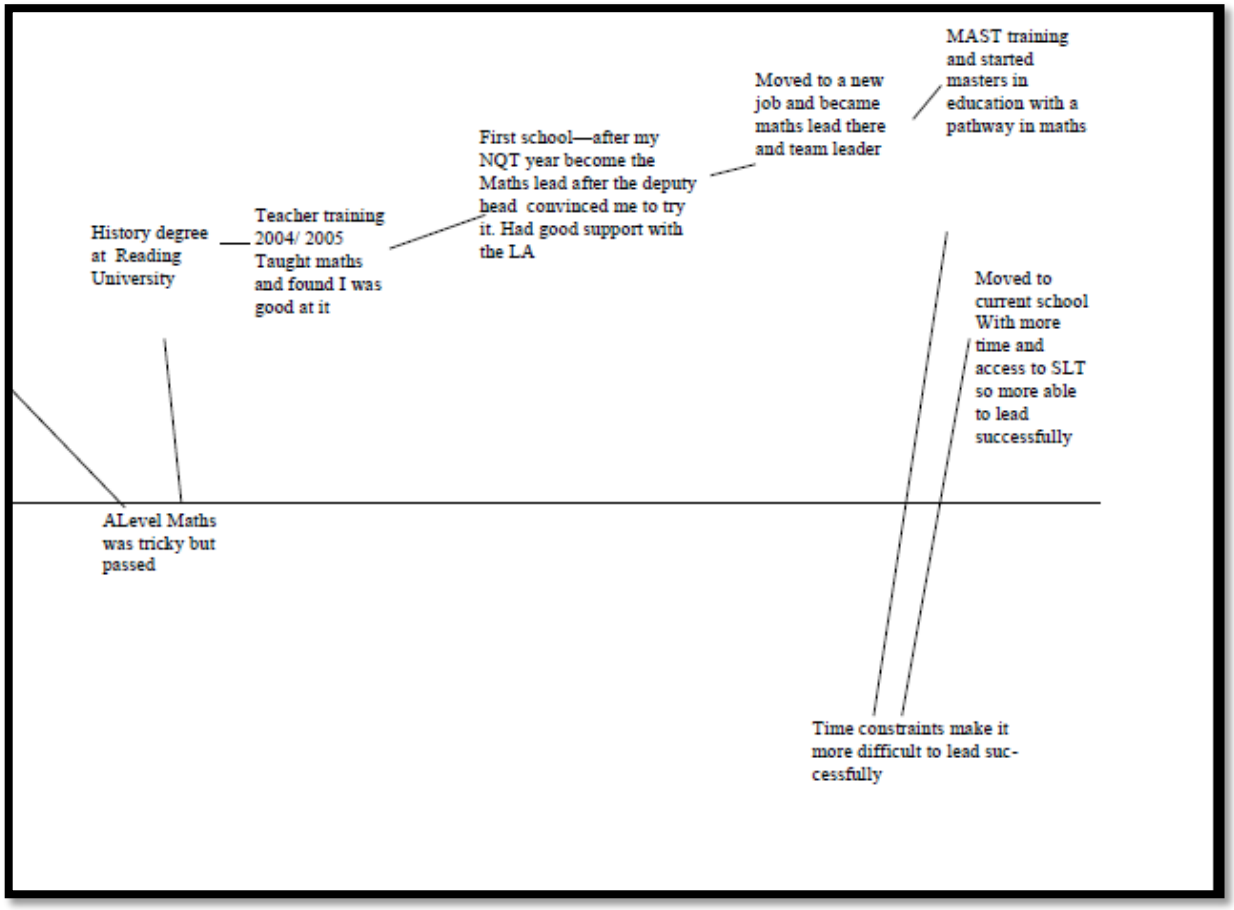


Figure 21 Extract from Sally's Life Graph showing an upward trajectory after she took on the mathematics lead role.

Roseanne's non-traditional route into teaching meant that she was securely established in her school environment when she qualified and became an NQT:

> *When I was in my NQT year, nobody thought I was an NQT because actually I'd got ten years as a TA and then I had got this sort of five years of study, they were like, oh no, you could not possibly be and I found that I had a lot more skills and understanding when I came to be an NQT than some of the NQTs we see coming in now from a short course when they are quite young ...* (Roseanne)

These reflections illustrated the transition and shaping of a teacher identity for Roseanne. They could be interpreted as the way Roseanne's school saw her during her NQT year was very different to a traditional NQT, as the extract suggests, Roseanne had been established at her school for 15 years when she came in as a qualified teacher, thus helping shape her new identity as a teacher. Roseanne's data confirmed that her motivation to pursue her teaching qualification was a direct consequence of how she was perceived as a TA by the teachers in the school. The change in identity from a TA to a qualified teacher and her colleagues' comments on her expertise being beyond what is normally seen with NQTs is arguably a persuasive indicator of Roseanne's emerging identity within her learning space.

Roseanne revealed the feelings of frustration in not being recognised and valued as a fellow professional and the impact of this on pupil outcomes:

> *Frustrated, to be honest very frustrated … I think looking back at it now, from the work I am doing now I know that's because their subject knowledge was a bit dodgy and they felt probably a little bit threatened … it made me frustrated because I had the empathy for the children and I knew that their life chances would have been different and I just thought well you can't make it about the teacher when children come to school … it is about actually making sure those children get their potential because it's their lives and you can't mess about with that.* (Roseanne)

Roseanne's data illustrated a great deal of passion and determination for developing high-levels of learning opportunities for the pupils are not compromised. A real sense of responsibility and

aspiration for her pupils comes through, showing the benefits the opportunities granted the pupils through Roseanne's adjusted approaches for the teaching and learning of mathematics.

To conclude, the major theme of early career development demonstrated that all participants had a varied start to their teaching careers and their leadership roles in mathematics. However, one aspect is clear from the data - they were all recognised as individuals who could take on the core responsibility of championing mathematics in their schools. It is important to note that some PMaSTs were in school environments where they were forced to take on the PMaST role, and upon reflection, if the role had not been 'imposed' on them, they may not have pursued it, showing the influence of 'falling' into a role that they went on to champion. Another aspect of the data worthy of note was the role of significant mentors/coaches within the workspace who encouraged the PMaSTs to pursue a mathematics leadership role. Individuals such as the LA mathematics leads as well as key senior leaders in schools helped the PMaSTs to see their potential in leading the learning and teaching of mathematics.

4.6 Chapter summary

This chapter has highlighted the data collected to answer sub-question 1:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMASTs?

Out of the twelve PMaSTs, eleven had a negative start to mathematics learning in school. The data provided insight into how this was amplified by the nature of the learning spaces and most importantly how the teachers interacted with them to build their mathematics learner identity. To note, even when a PMaST showed a level of confidence in school with their mathematics, due to peer pressure (Belinda) they stopped participating and answers due to the anxiety of being bullied. This finding illustrated how schools build their learning environments and learning communities within a mathematics classroom is key to successfully developing confident mathematicians. Furthermore, there is a need to provide professional development for teachers to self-reflect on

how their teaching style and approaches may negatively affect learners. The main theme within the experience in school data demonstrated the tensions of grouping pupils for mathematics and the participants' own experiences of grouping being negative.

An additional theme that emerged from the data showed how learning mathematics as an adult at night school inspired the PMaSTs to be part of a positive learning community and build their mathematics whilst being taught by inspirational teachers. The lessons learnt here are notable and could be communicated with schools to encourage more careful consideration of how to effectively build mathematical communities of learners. However, this finding should be taken, with caution as it is clear that the learning context of a school and that of a night school are very different and not comparable.

Another major theme of home influences showed that the PMaSTs reflect on memories of being immersed in mathematics without explicitly being signposted to it. Only a handful of PMaSTs indicated direct help with homework or a mathematically immersive environment at home. The ones that did so, provided a clear context of their parents acting as positive mathematics learning role models and therefore this immersion stuck with them as they pursued their own identity as mathematical learners.

A clear major theme across the data set was the notion of empathy that the PMaSTs shared with their pupils whilst training to become teachers and into their early careers as PMaSTs. Furthermore, they explained that as they found mathematics challenging, they were sensitised to empowering and enabling their pupils to become confident learners of mathematics. The data demonstrated that this was an important characteristic of a successful teacher of mathematics. One final mechanism to note, one of the PMaSTs who took mathematics up to University level (Belinda), found the initial teaching of mathematics challenging as breaking down the mathematical concepts to the primary level was difficult. Therefore, the learning experience of her undoing her mathematical knowledge and understanding and rethink mathematics from the perspective of her pupils to have successful

outcomes for both herself and her pupils, further illustrated, empathy and sensitivity towards pupil learning.

The data has revealed major and minor themes linked to schooling and personal learning of mathematics, as well as home influences that enable primary teachers to build an identity as PMaSTs. The early career opportunities, although in the majority of the participants' cases were somewhat accidental, as demonstrated by the data, sowed the seeds of an identity as a PMaSTs. Many of these opportunities show the merit of being in the right place at the right time for opportunities such as support from colleagues, LA mathematics leads and being recognised by leadership as someone with the potential to take on a key leadership role as a PMaST.

Chapter 5 Findings 2: Being a PMaST- Professional learning opportunities and challenges within the role of a PMaST.

This chapter summarises the data collected from twelve PMaSTs to provide an answer to sub-question 2:

Sub-question 2: How do primary teachers describe and understand their experience in the role of a PMaST?

The data was collected and analysed in two phases, as illustrated in figure 6. The data was themed and the results of this analysis are summarised below:

- Professional learning opportunities experienced by the PMaSTs throughout their careers
- Opportunities available whilst in the role of a PMaST
- Challenges experienced whilst in the role

5.1 Professional learning opportunities experienced by the PMaSTs throughout their careers.

The data suggested that the array of professional learning opportunities for all the participants supported their understanding of the role Continued Professional Development (CPD) played in becoming and being a PMaST. The PMaSTs communicated insight into how CPD was used to champion mathematics within their learning and teaching spaces thus transformed their experiences of being a PMaST. The chapter sets out the key professional learning opportunities described by the PMaSTs, highlighting the opportunities available to the PMaSTs throughout their careers and the challenges faced whilst developing and establishing themselves as a PMaSTs.

5.1.1 The National Numeracy Strategy (NNS) courses- building confidence in the teaching of mathematics

The NNS was a national education initiative to develop teacher expertise in the teaching and learning of mathematics. It was part of the election pledge from Labour and when they came into power in May 1997, the comprehensive programme was delivered across the country. The training was aimed at all teachers as a national drive to develop mathematics learning and teaching. The PMaSTs in this study benefited from the professional learning granted through the NNS.

Out of the twelve PMaSTs, eight (Gregory, Reece, Thomas, Sally, Sandra, Emma, Daisy and Michelle) elaborated on the professional learning opportunities granted to them through the suite of courses available via the NNS. It is worth noting that all 8 participants either began teaching or started to establish themselves into the role of a PMaST when training and funding via the NNS were widely available. The data suggested that the eight PMaSTs valued the professional growth in the learning and teaching of mathematics as a result of undertaking the NNS courses:

> *Yeah, the support came on two levels, both external National Numeracy courses that were run by that particular person (LA Advisor) that I went off school site to take part in and the support she offered back in school to me alongside my children (pupils).* (Gregory)

Gregory's reflections suggested that the NNS had an impact on his skill development, through attending courses and through the support provided in class from the Local Authority mathematics lead.

Similarly, Reece's data described how she developed mathematics skills through training from the National Numeracy Strategy courses:

> *I'd done lots and lots of different things with maths … we had the primary strategy team[NNS] people coming in to teach … it was for the LSA (Learning Support Assistants) … we got LSAs trained but we also had the primary strategies team coming in … over the year*

> *to train up others so we paid for that we made sure that maths was a really important thing and it wasn't acceptable if children didn't make progress and that was a really big thing.* (Reece)

Reece not only reflected on developing her expertise whilst undertaking the NNS courses but also explained how she supported the development of staff, such as her Learning Support Assistants (LSAs). Reece's reflections appear to show her strategic leadership approach in developing the teaching and learning of mathematics across her school.

The actual approach used to teach mathematics through the NNS was commented upon by Thomas and Sally:

> *I remember the primary National Strategy big document … I relied on that a lot, how to teach. So those were and I think from memory, that's how I taught a lesson, following that pretty much through the Primary National Numeracy Strategy.* (Thomas)

> *…at the time it was when you had the numeracy hour and the literacy hour so you had the kind of 15 minutes, 20 minutes structure with your lessons. I found that I really enjoyed teaching the maths.* (Sally)

Together, these extracts demonstrated how both Thomas and Sally found the teaching of mathematics, using the structures of the NNS, enjoyable, both from the perspective of the written instruction and the recommended timings for lessons. However, Thomas further debated on the limitations he experienced whilst undertaking professional learning opportunities through the NNS courses:

> *… So I do remember going on various maths courses maths coordinator courses … I think these things are brought up from time to time. I left with a whole idea of maths games we could play … laughs … but nothing concrete that could say, here is what we do, here are*

> *some ideas for you to go and implement back in school, so I felt I didn't achieve much really, I was maths co-ordinator in title…* (Thomas)

Thomas' reflection illustrated the nature of CPD courses, from his perspective and how many were one-off ideas and therefore did not support Thomas in developing as a 'maths co-ordinator'. For Thomas to suggest he 'was a maths co-ordinator in title' suggested the tensions he faced with a role that he felt not fully able to deliver.

Sally and Sandra illustrated how they experienced professional growth by doing the course available through the NSS:

> *… I was really lucky because we had some authority maths advisors who came in someone particularly called xxx who was just amazing, she really kind of inspired me, showed me exactly what to do as a maths lead, … training me and then training staff together we did some team teaching with people she did some observations with me so really kind of made me understand that I may not be a very good… mathematician but actually I am quite good at knowing how to teach children and how to teach staff …* (Sally)

Sally's thoughts on the learning opportunities granted by the NNS courses, as well as working alongside a LA mathematics lead, share her perceptions of the importance of a scaffolded approach to CPD, and how this played a role in developing her confidence in leading the learning and teaching of mathematics. Sally's use of language such as 'amazing', 'inspired me', 'training me' suggested gaining confidence in enabling her to think like a leader of mathematics. Similarly, Sandra state:

> *… I was given the maths co-ordinator role … when the new national strategy was developed so I think all out of that there was a lot of provision for maths co-ordinator to be trained up in the whole new strategy … we had five day training we had training ourselves as co-ordinator and then we delivered training in the school […] so*

> *I just loved going on those courses. …because we had maths advisors at that time as well which also helped they did some great training … they were trying to get maths to be much more practical.* (Sandra)

Sandra, similar to Sally, mirrored her enjoyment in the learning process through the NNS courses in assisting her capacity in the leadership of mathematics. Furthermore, Sandra also discussed the role the LA lead had in supporting her learning and leadership in mathematics.

Emma's data revealed her interpretations in the way mathematics was taught and therefore learnt. She provided a personal context of approaches into learning mathematics that she did not enjoy as a child, but the professional learning opportunities granted through the NNS helped her to realign her thinking and therefore understand the purpose of using practical tools to enable deeper mathematical thinking. This realisation suggested changes in the way Emma perceived the different approaches to developing mathematical concepts with her pupils:

> *… numeracy strategy had come in … I remember doing … what I didn't enjoy as a child, the practical lessons, and really enjoying doing it and actually the children being quite engaged with it so I did a bit of a turnaround that what I found uncomfortable when I was a child … that the children seemed so much more excited and enjoying it* (Emma)

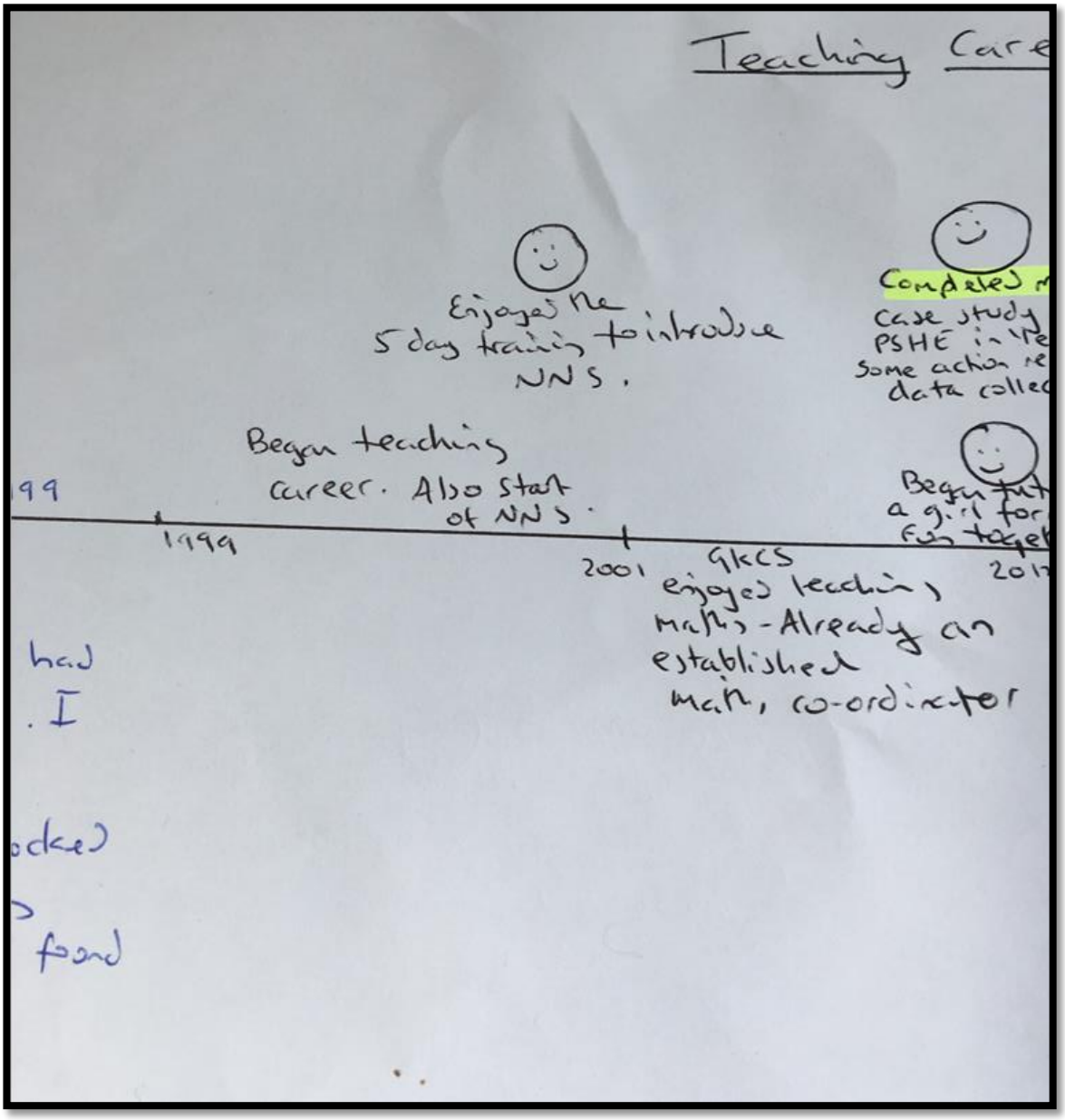


Figure 22 Demonstrating where Emma placed the NNS courses on her Life Graph.

The language used by Michelle to describe her headteacher explained her perception of her headteachers' role in sending her on courses and the impact they had on her practice. Furthermore, Michelle described being mentored by a colleague during her NQT year and when they left, she was given the responsibility of leading mathematics, this resulted in her being anxious to undertake the role. However, she communicated how the professional courses, via the NNS, and support from her colleagues, provided confidence and skills, helping her emerging identity as a PMaST:

> *That was one of the strengths in my school, my headteacher. He was very willing to send people on training courses and they did have a massive impact. They were the biggest thing to boost my confidence because after [NQT mentor colleague, also mathematics lead] left the school, then the headteacher was sort of like, well, 'nobody else showed an interest in maths, so…guess what lucky you, you are in charge', and which was really frightening internally, the maths consultants were very experienced, … I can remember being given a CD specifically for Maths co-ordinators with fairly simple advice but actually exactly what I needed … but the more really inspiring courses were effective practice in assessment … Then I also did, they had a year 4, 5, 6 course which I attended and I really enjoyed that… it was delivered again in a very interesting, practical way* (Michelle)

Michelle also revealed the negative impact her perceived lack of support from leadership had on developing capabilities in the learning and teaching of mathematics when she returned from maternity leave; this is illustrated by Michelle's Life Graph in figure 23:

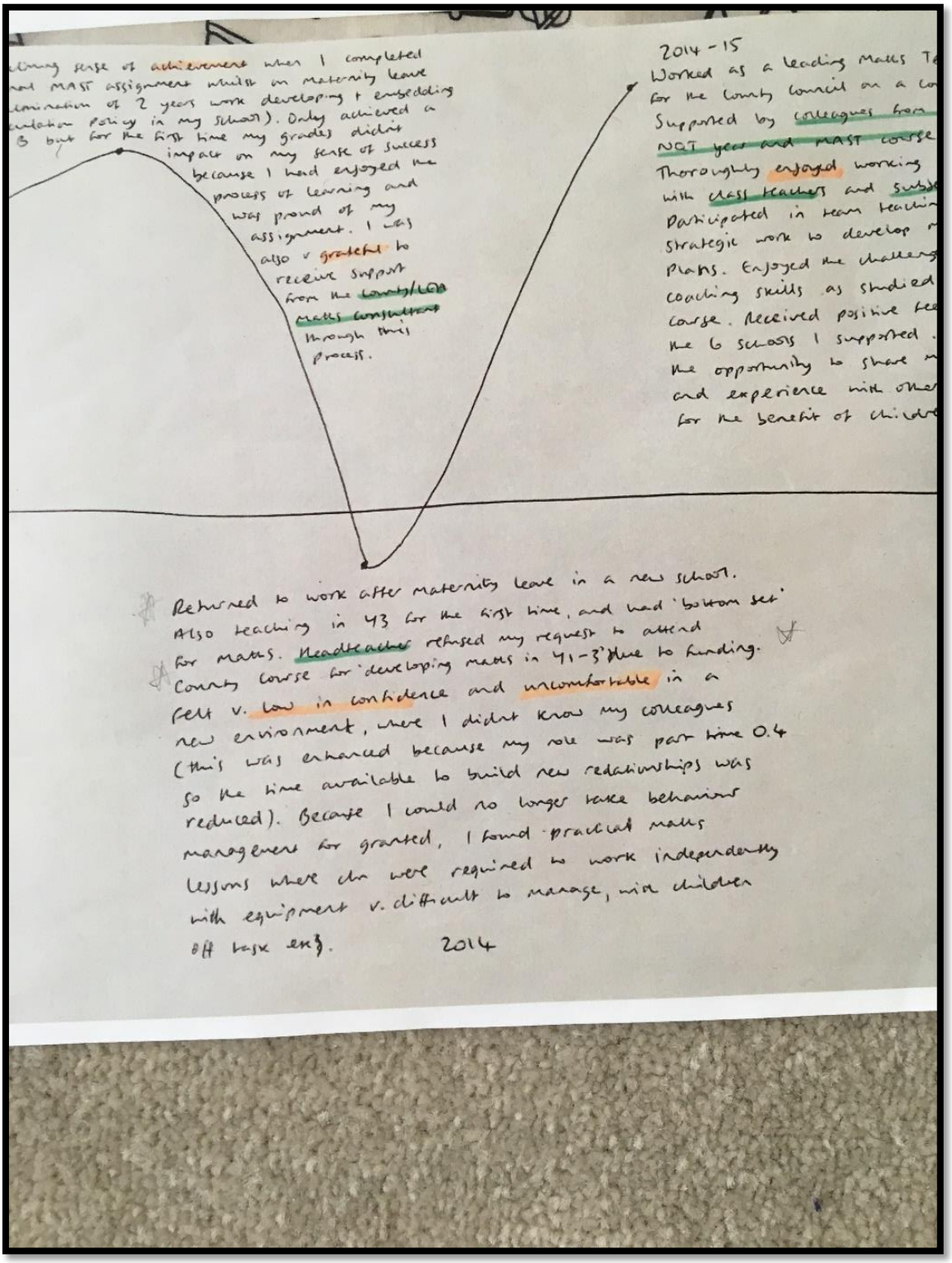


Figure 23 Michelle's Life Graph illustrating the negative effect of not being sent on professional learning courses by the leadership team.

Michelle's use of language such as: 'refused my request', 'low in confidence', 'uncomfortable' suggested an unease of being in an environment where she felt a perceived lack of support in developing her professional skills.

To conclude, these results indicate that the professional learning provided by the NNS was perceived by the PMaSTs as having a lasting impact on how they developed their roles. The structures of the NNS were discussed as positives in framing effective learning and teaching of mathematics and the support received by, not just going on the courses, but also the opportunities gained through networking and being part of a learning community were all perceived as positive ways in developing their learning of mathematics and furthering their leadership of the subject. The data further demonstrated how the support received by the PMaSTs' school leaders was highlighted as a positive. When leaders did not allow PMaSTs to attend courses, the data showed this to be seen as a disadvantage in developing their professional expertise.

The findings also suggested the value placed by the PMaSTs on LA structures and the role LA mathematics leads played in supporting course delivery and work in schools. This finding came out consistently across the experiences of learning and teaching of mathematics by the PMaSTs.

5.1.2 The Mathematics Specialist Course (MaST); transforming into leaders of mathematics

The Mathematics Specialist Teacher course (MaST) was undertaken by ten out of the 12 PMaSTs (Nicola, Gregory, Reece, Thomas, Sharon, Sally, Roseanne, Daisy, Belinda and Michelle). The course was a nationally-funded professional learning course for leaders of mathematics in primary schools. One of the main aims was to further develop capacity in building local expertise in mathematics, with an emphasis on subject knowledge, pedagogical knowledge and, to use the expertise to support others through coaching and mentoring skills developed through the programme.

The data suggested all of the PMaSTs who undertook the course viewed it with enthusiasm and had it very high on their Life Graph. The strength of this professional learning can be exemplified through how the PMaSTs described their learning on the course and how the course enabled their career development. Michelle described this as:

> *I remember the first assignment being based around division and the teaching and learning of division. So I found that very interesting but it was almost a bit similar for me in terms of an approach to learning something to how I had done things in the past whereas I think I found, from a content point of view the second year a lot more interesting and I was able to personalise my second assignment a lot more, which I enjoyed … a lot more focus on the coaching side of things in the second year, that for me was quite interesting because I had never really learnt anything about that before.* (Michelle)

Michelle's evaluation of the course content was not dissimilar to other PMaSTs, sharing her views of how being in a supportive learning space (figure 24) enabled her learning journey. She discussed having time to network with other mathematics co-ordinators and furthering her skills by developing subject knowledge and coaching skills. Furthermore, figure 24 also illustrates how Michelle felt about the growth in her learning from undertaking the second assignment for the MaST course. This could be interpreted in two ways: the significance of how the assignment enabled Michelle to move her learning and teaching of mathematics forward, in addition to acknowledging the importance of developing lifelong skills rather than just achieving the 'highest score'. Furthermore, Michelle, through her interview, elaborated on her life-changing dramatically at this point, with the arrival of her first child.

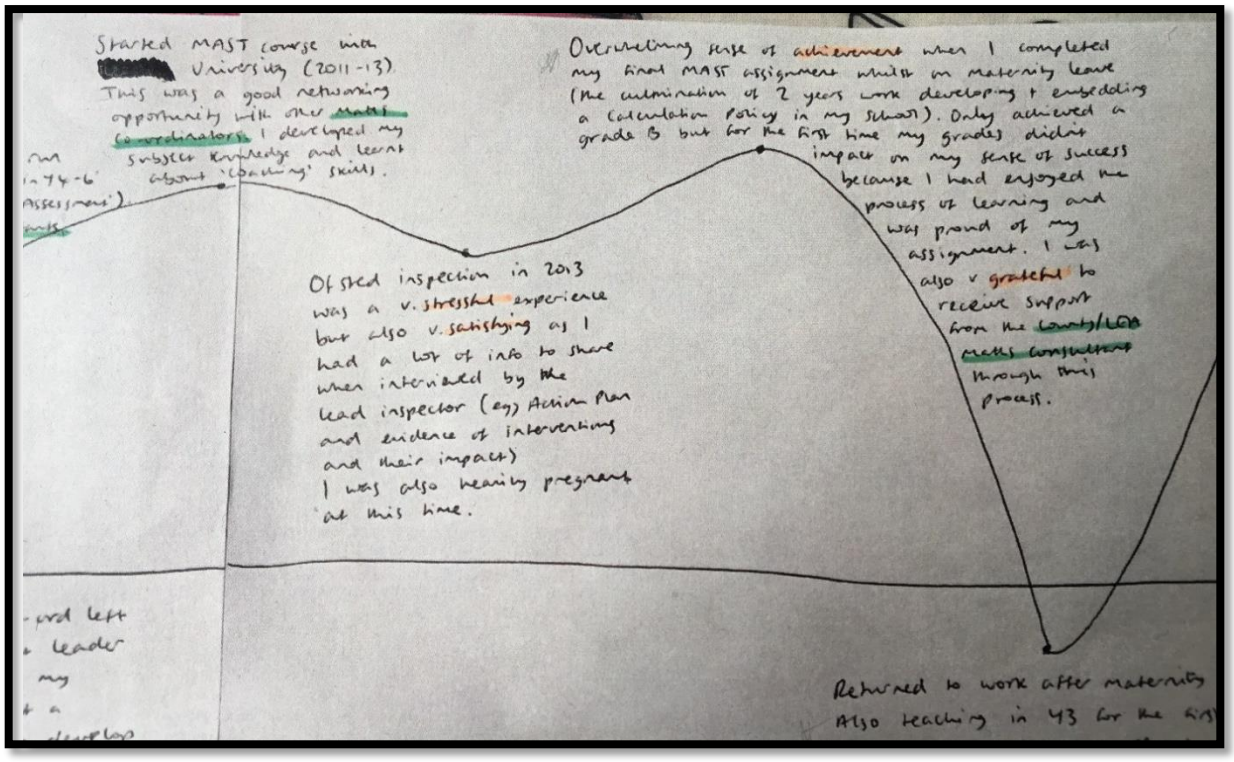


Figure 24 Michelle's Life Graph demonstrating the second MaST assignment as a high point on the Life Graph.

Similarly, Belinda described working with fellow course participants as 'chewing the fat' (figure 25). Belinda's insights into her journey through the MaST course characterised the changes in identity as a PMaST during and after the course:

> *… so instead of all of us kind of naively blinkered saying, well the best way to do statistics is like this, brilliant, we go out into the world, we tell everyone that this is how you do statistics, there was enough voice around the table, however what about this … it also gave me a bit of insight into why it is not as simple as having good maths knowledge, because there is so much more to it and particularly around maths, particularly around attitudes and beliefs and all of that kind of stuff. Even if you have got the subject knowledge and you have got the pedagogy there is a whole other thing going on with maths and that gave me a kind of an insight into that … and I remember thinking back on the secondment I had done and thinking, yeah actually I can see other people's perspectives a little bit better now just from listening to other people's experience, you know.* (Belinda)

The deeper understanding emerging from Belinda's data of how learning happened in mathematics and, therefore, the ways pupils could be taught mathematics successfully, illustrated the complex dynamics of how mathematics is perceived and Belinda's transference from the point of being a primary teacher to becoming a PMaST.

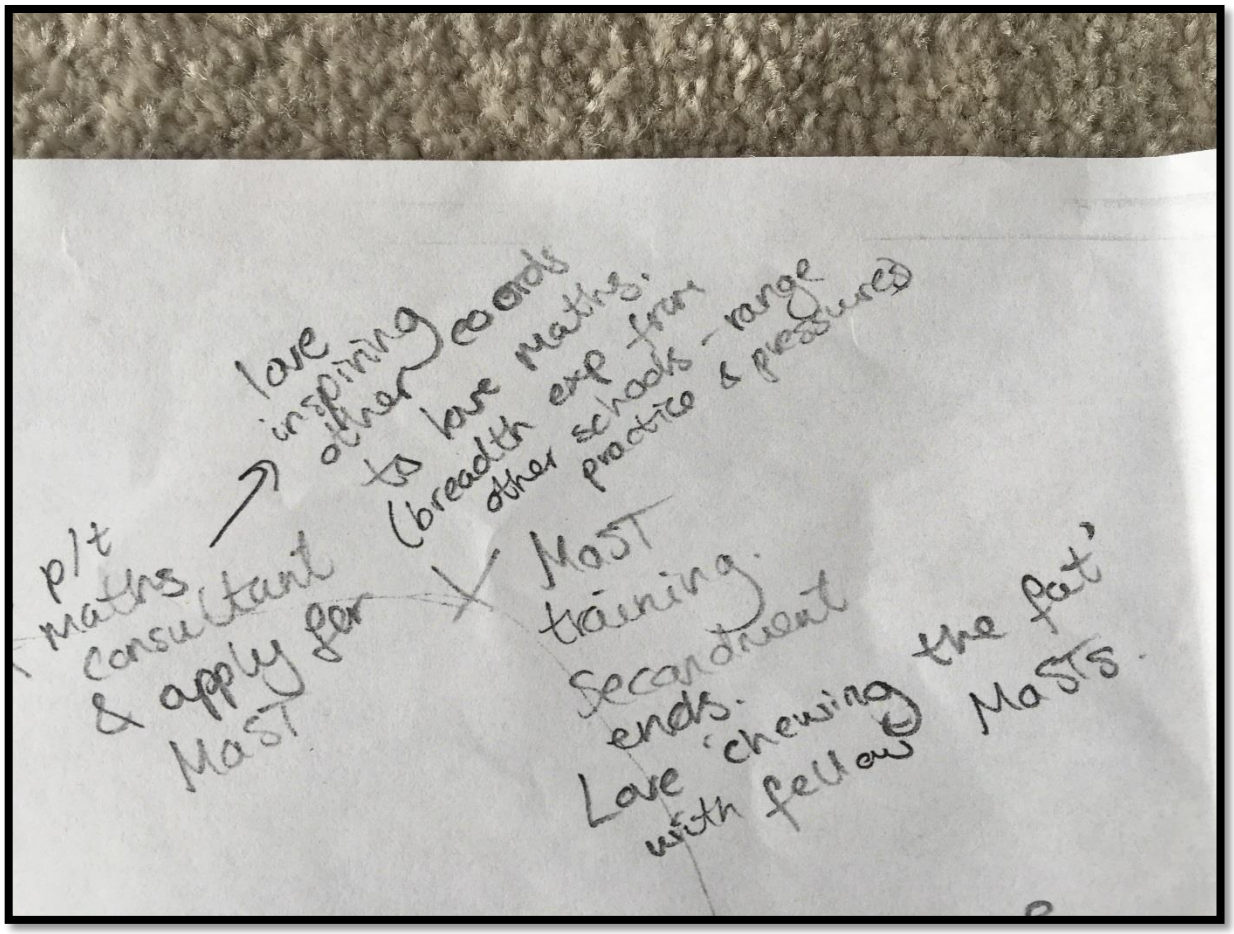


Figure 25 showing extract from Belinda's Life Graph.

Furthermore, Roseanne's declaration of the anxiety she initially felt at the beginning of the course but reflecting upon this and thinking of pupils and colleagues who may feel this way whilst learning mathematics, illustrated how this helped Roseanne further understand her constantly changing role from being a primary teacher to becoming a teacher and leader of mathematics. Her reflections on the delivery style of her CPD courses illustrated how her own experiences of undertaking the MaST course reflected positively on how she now plans and delivers her CPD courses:

> *I think there were things … I vividly remember starting on the MaST and sitting in this huge lecture theatre with all these others and there were a lot of men in there … we were first asked to do some maths, I remember thinking, gosh where is the toilet, I need to get out of here and all the men were like, oh yeah, yeah, yeah, yeah, I can do this … I still think about that to this day and I think, gosh, you know that is how a lot of teachers feel when they go on maths training so I don't ever want to make someone feel like that in a classroom or on training.* (Roseanne)

The PMaSTs especially commented upon the structure of the course and their interpretation of the impact the content had on their practice, helping their professional learning, through group collaboration and assisting their evolution from a primary teacher into a PMaST:

> *… It was nice that you went to the lectures and you got the theory and you were reading the books … and then two or three weeks later you'd be going to your local workshop days where you [were] actually doing the practical maths and I think getting the theory and then getting the practical side of it alongside and looking at the subject knowledge and looking at doing the maths and then looking at teaching maths I think that was really, really beneficial and that was what was good about that course and the fact that it was two years, I think it possibly could have …it was a real huge learning curve that was pushing me and challenging me but I really enjoyed it.* (Roseanne)

All ten PMaSTs mentioned the sense of community they experienced whilst undertaking the programme and the subsequent networking groups that developed for continuing support available to them from colleagues within the LA and fellow PMaSTs.

> *Also, it got me connected with a lot of other people who were interested in maths, so then the network started to form and then we started to go to each other's schools and talking to each other electronically and sharing things and planning things together and doing things.* (Roseanne)

There was a range of changes that Roseanne's narrative interview extract and her Life Graph extract in figure 26 suggest, firstly, in her experiences of learning and teaching of mathematics, secondly, the way she described the learning community, set out how she valued the building of networks in supporting her continued development her mathematics teaching and learning. Furthermore, the MaST course was described as a way of fostering change within Roseanne's and other PMaSTs' schools. Her Life Graph sets out how she developed a 'keen interest' in getting involved in research projects.

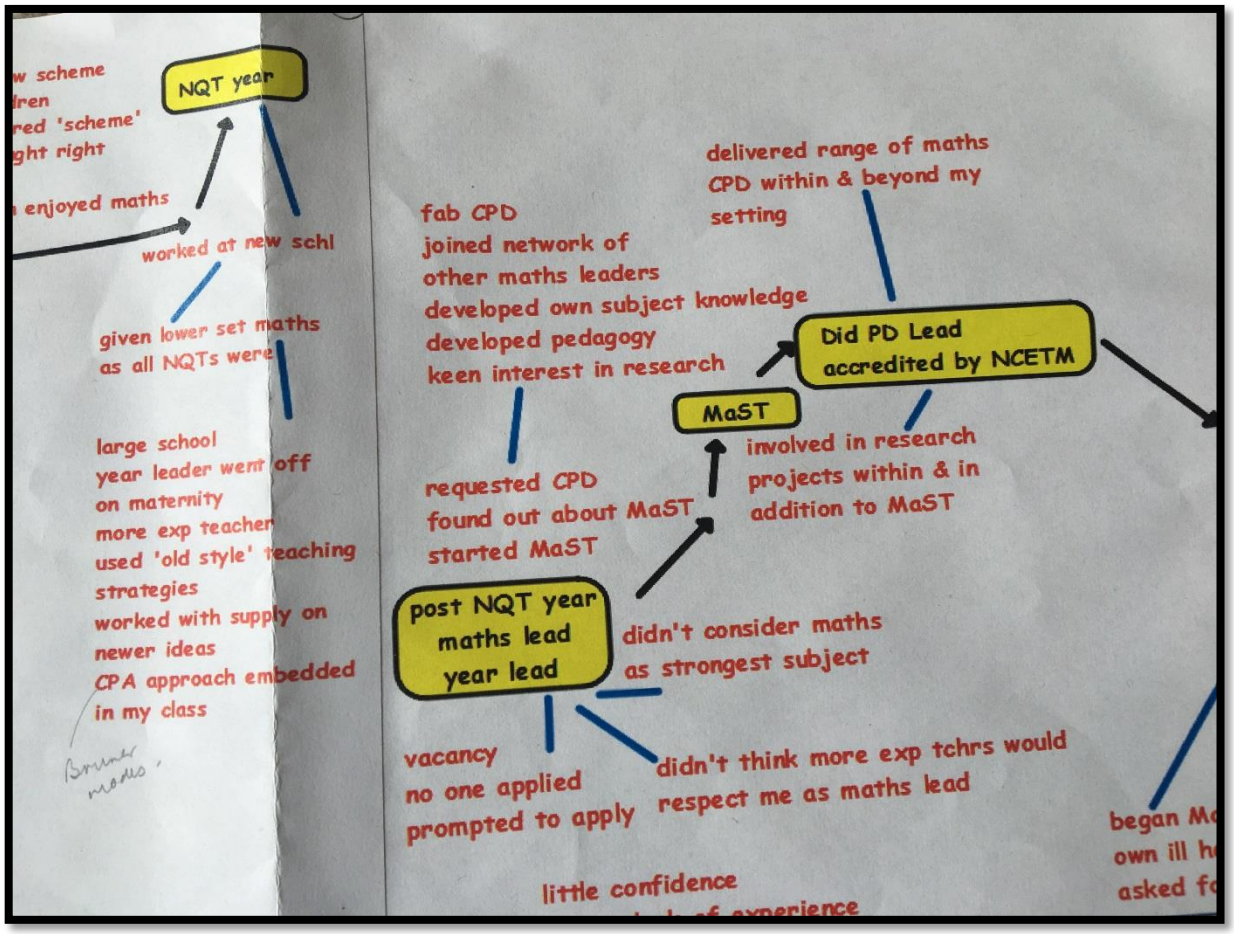


Figure 26 Extract from Roseanne's Life Graph showing the impact of MaST course.

Finally, the PMaSTs reflected upon the 'Coaching and Mentoring' strand of the programme. Their reflections suggested this being a new element of learning that was perceived as empowering in

supporting their work more effectively with colleagues to build confidence. The data showed how the coaching and mentoring skills enabled the PMaSTs to widen the scope of the support provided to their schools and local communities. Gregory stated:

> *I would say that throughout the training it was the first time that I really understood the very strategic leadership role of maths subject leader and was able to engage with … encouraging others to get involved I think particularly in terms of the mentoring and coaching element.* (Gregory)

Similarly, Nicola emphasised the scope of Coaching and Mentoring: 'I also did coaching with other teachers at the school to help them bring in resources and how to use them'. The collective voice of the PMaSTs suggested a collective a sense of belief in their emerging identity as PMaSTs, through the MaST course.

In conclusion, the MaST programme provided an organised and systematic investment for building capacity of the learning and teaching of mathematics. Things that stood out from the PMaSTs as the highlights for this programme were: building a sense of community; feeling empowered to develop a better approach to the teaching and learning of mathematics; and, most importantly, building the confidence to impart the knowledge and skills gained to their colleagues. The PMaSTs were asked to sum up the course in three words. The word cloud (figure 27) shows the words used to describe the course, with the most popular ones included: positive, empowering, fun, interesting, inspiring etc.

Figure 27 Word cloud showing words used by PMaSTs to describe the Mathematics Specialist course.

The findings demonstrated how professional learning played a substantial and integral role in building PMaSTs' understanding of their roles and that of 'being' a PMaST. Furthermore, professional learning empowered them to see themselves as mathematicians and champions of mathematics within their learning spaces. Therefore it can be concluded that professional learning during all stages of a professional career was vital for primary teachers to emerge as champions of mathematics and assume a PMaST identity.

5.2 Opportunities available whilst in the role of a PMaST.

All twelve PMaSTs provided examples of opportunities they encountered as a result of being a PMaST.

5.2.1 Developing research projects

The PMaSTs discussed undertaking research projects either as part of the MaST course or having being allowed to do so through other channels. From the perspective of the PMaSTs, the research projects provided them scope for development in many ways: firstly, they saw this as an opportunity

to develop their skills by looking at an area of mathematics in-depth and, by doing so, they developed their pedagogical, subject knowledge skills. Secondly, the data illustrated that the PMaSTs saw this as a further opportunity to work alongside colleagues in their schools and across the local area and, in the process, viewed this as a chance to enhancing their leadership skills in the effective teaching and learning of mathematics. The PMaSTs elaborated on this skill development by discussing their coaching and mentoring skills. Finally, the PMaSTs reemphasised how this endeavour permitted them to network with colleagues with whom they collaborated on the research projects, thus expanding their peer circle to discuss mathematics learning and teaching. Reece's Life Graph (figure 28) demonstrates this well.

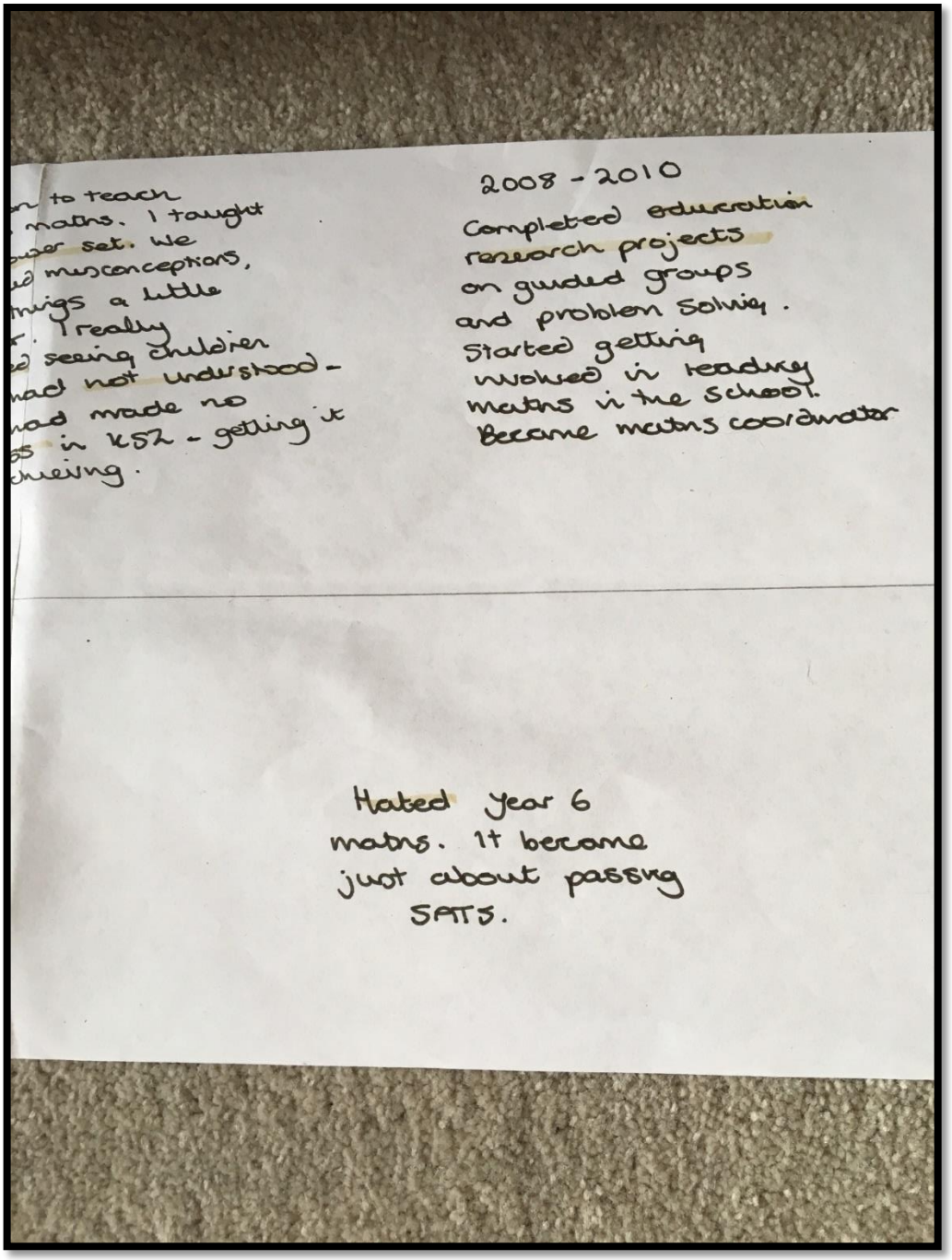


Figure 28 providing detail of where Reece added the research project on her Life Graph.

5.2.2 Moving into senior leadership roles and diversifying the role of a PMaST.

Out of the twelve PMaSTs, eight continued to maintain a role within Primary Mathematics. Nicola, Reece and Daisy have now moved into other senior roles, Special Education Needs co-ordinator

(SENCO), Deputy Headteacher and Headteacher respectively. All three showed how moving into their current roles was a direct consequence of the leadership skills they developed as PMaSTs. The remaining nine PMaSTs used the opportunities as a PMaST to diversify their roles within mathematics. Therefore, two (Sally and Roseanne) are now working as Mastery leads with the NCETM, a National Mathematics organisation (this will be expanded upon in Chapter Six). Three (Thomas, Sharon and Belinda) gained teaching positions within Higher Education, working with primary trainee teachers. Sandra, as well as continuing her role as an Every Child Counts teacher, has expanded her role into training primary teachers through a SCITT programme. Gregory's role evolved to the independent consultancy of mathematics in schools, a position facilitated by Gregory's previous job as Local Authority consultant of mathematics. Due to the changes in the support structures within Local Authorities, Gregory filled a training gap to pursue this role, hence staying within the role of supporting mathematics but now in a private, consultancy capacity. Emma's reflections suggest how she utilised the expertise gained as a mathematics lead in school by facilitating training and development through the local Mathematics Hubs. These roles will be further explored in Chapter 6. The perceptions of PMaSTs, captured through the data sets suggested how the core skills developed through being a PMaST allowed them to innovate beyond the role of a PMaST in primary schools.

The innovations in the career trajectories illustrated here appear to indicate how all PMaSTs in this study demonstrated that professional learning, through the development of their skills in mathematics enabled them to pursue further leadership roles and helped them advance in their careers.

5.2.3 Support provided by the Leadership team

The PMaSTs interpreted support from leadership in a range of ways - the data showed how leaders in schools (Head, Deputy) played a part in developing the role as a PMaSTs. Additionally, PMaSTs discussed the role of mentors, such as fellow class teachers, who supported them to build

confidence in the teaching and learning of mathematics. The data revealed that these relations were not formal, but more casual, day-to-day practices of asking and taking on board advice. Furthermore, a range of PMaSTs (Gregory, Belinda, Reece and Michelle) demonstrated the important role the leadership of LA mathematics consultants played in supporting their route to becoming PMaSTs. This particular finding can be argued to have wider implications, in the current policy landscape of the removal of the LA role in building teaching and learning opportunities in schools.

Gregory mentioned the role of headteachers but considered the most significant role of developing his mathematics was that of the LA lead:

> *That was made possible through the Local Authority maths advisor coming in being able to offer me support both in the teaching and learning of maths to my class but also starting to think strategically about leadership from across the school…* (Gregory)

Reece's reflection of her deputy head:

> *…the main one was my key stage leader who then went onto be my deputy head and I would say that she was the one that just said go for it … was a really dynamic person you know shaped my teaching career … But then my headteachers again allowing me to do other things outside. You know I started chairing our maths co-ordinators meetings and he would give me time to lead that he would release me for going to do the primary strategy team. He saw the benefit of that in the wider community of me being a maths specialist was a good thing for his school. … I think because you work hard, you actually put a lot into the school so he gave me the time and the time to do whatever I wanted to do. So if I'd go to him and say can I do this he'd go yes … what I was going to do was of benefit to the school.* (Reece)

These reflections note how the head was seen by Reece as not the enabler for her transformation into a PMaST, however, supporting Reece by giving her time to do 'other' things such as chair

meetings and allowing her to attend meetings during school time is interpreted by Reece as supportive and therefore helping develop the role of a PMaST. Therefore, the data suggest a symbiotic relationship that emerged for Reece developing as a PMaST and the school benefiting from her expertise through the reputation she was building around her leadership role as a PMaST within the LA. A further aspect to note from Reece's reflection is that she saw her Deputy Head as someone 'shaping her teaching career', a significant claim explaining how leaders have the power to transform opportunities for primary teachers.

5.3 Challenges whilst in the role of a PMaST.

The PMaSTs showed a range of frustrations, including difficulties of getting appropriate resourcing to facilitate the learning and teaching of mathematics, challenges with school leaders who did not support the approaches they were trying to embed to develop mathematics across the school, and working with colleagues who openly acknowledged that they did not have confidence in teaching mathematics, are just a few examples that have been drawn and expanded from the data sets.

5.3.1 Working with colleagues

As PMaSTs started to develop their role, they felt anxious about a range of things, such as not knowing whether they would be able to fully support colleagues across the primary age range. This is illustrated in Figure 29, where Emma discussed her anxiety, as a low point in her Life Graph, of supporting a colleague in KS2.

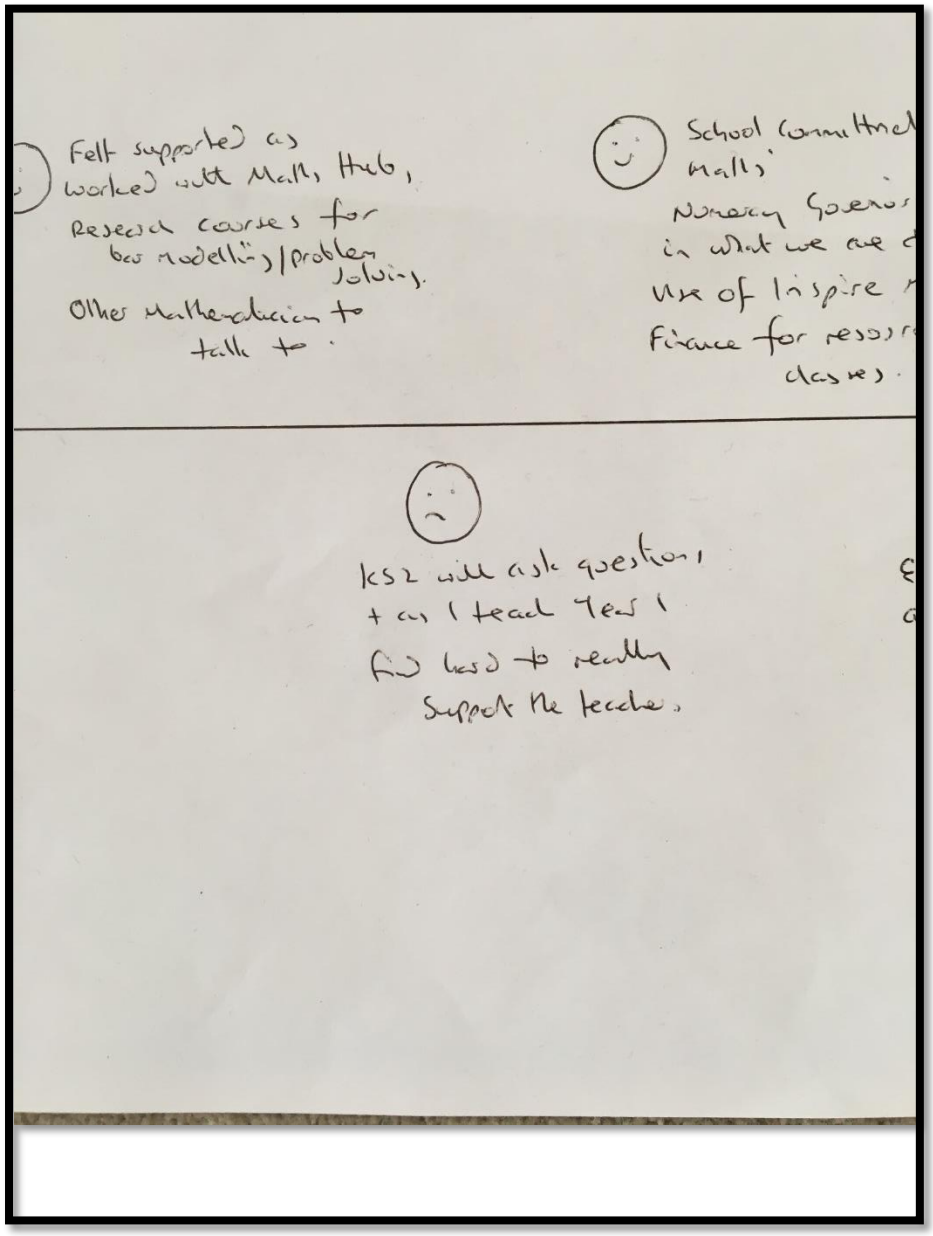


Figure 29 Emma sharing her anxiety.

Further analysis of the data showed how some PMaSTs felt intimidated by more experienced colleagues. Gregory exemplified the anxieties he felt whilst sharing expertise with older colleagues as:

> *Whilst on the whole everybody was willing to engage on one level or another there were a very tiny minority of people who found that age difference a big barrier to being able to really engage with the support that I was offering as a bigger big thing that stands out now*

> *looking back in terms of the engagement of others really due to my personal context and notably age.* (Gregory)

Similarly, Sharon states:

> *… when I was doing the teaching and learning role though because it was difficult working with some of the colleagues who were more senior and more experienced than me when there in one instance one of the teachers had been my NQT mentor and I suddenly felt myself in a role where I was expected to advise her on practice and that felt rather awkward.* (Sharon)

The challenge, as illustrated by Sharon here was not just working with a colleague who had been in teaching for a while but this is further exacerbated by this colleague being her NQT mentor in the previous year and therefore the role change was seen as 'awkward', by Sharon.

Roseanne's Life Graph in figure 30 illustrates similar challenges to Reece and Gregory,

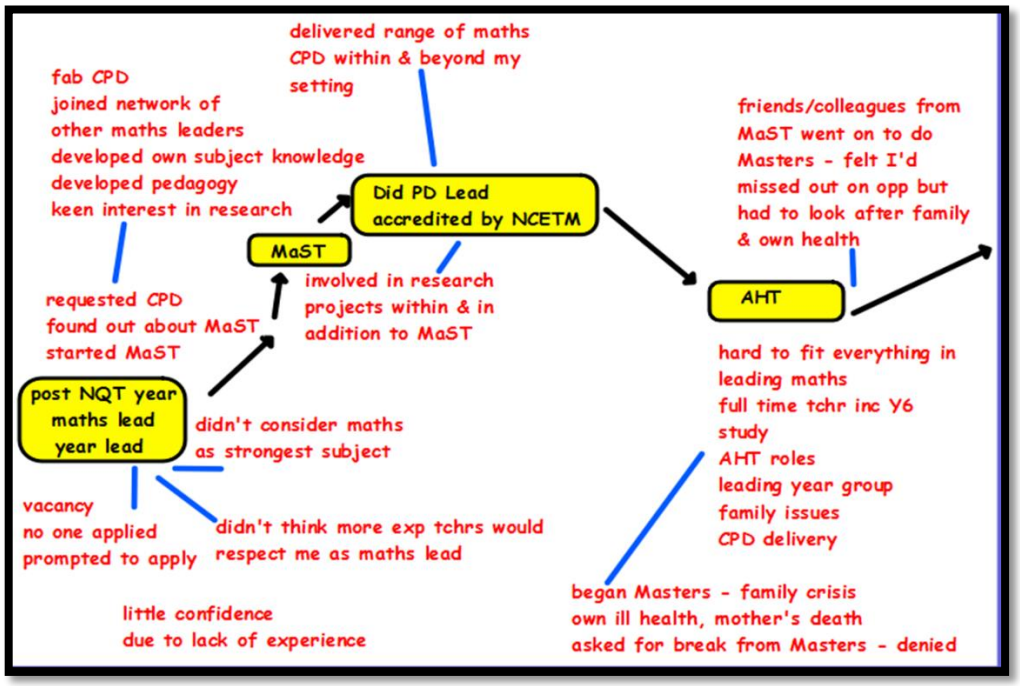


Figure 30 Roseanne's Life Graph sharing frustrations with developing mathematics.

Here, Roseanne mentioned the notion of experience and feeling that, only having been qualified as a teacher for one year, more experienced teachers would not respect her as a mathematics lead, leading to 'little' confidence in taking up the role.

5.3.2 Pedagogical frustrations

The data exemplified how mathematics was being taught and how the PMaSTs perceived this as colleagues not wanting to adjust their approaches to make the learning process more accessible for pupils to develop a deeper understanding of the mathematical processes. Reece highlighted her frustrations:

> *…we still have people who aren't confident in maths coming through and that really worries … I find it very hard to switch off from the experiences that I have had to what I was like as an NQT or as a student but I still feel I had a lot more passion about maths being a student and an NQT you know we have students who you know we add a zero … no we don't add a zero … ahhhhhhghhhh. This is not something that has been around for the past fifteen years we don't add a zero, we don't move the decimal point we do not do that we've got to teach them the correct method.* (Reece)

Here, Reece sets out the lack of pedagogical understanding of colleagues in the teaching of core skills. The example shown illustrated how to teach multiplying numbers by 10, 100, 1000 by using the principles of place value as opposed to 'quick fixes' of adding zeros. This aspect of the data can be interpreted as Reece's vision of developing mathematics across her school in a conceptual way.

5.3.3 Time constraints

Many of the research participants were given the role of being a PMaST very early in their teaching career (chapter 4, section 4.4). Whilst in the role, the data suggested that they felt challenged to do the job well without having extra time out of class to develop the role effectively. Sally's data below expands on this point:

> *I was put in to be a KS1 team leader and assessment lead and maths lead but I didn't have time out of class I only had my PPA (Planning, Preparation and Assessment) afternoon so I would say that the last year was when I wasn't able to do what I wanted to do with the subject which was a big driver for me to actually move on.* (Sally)

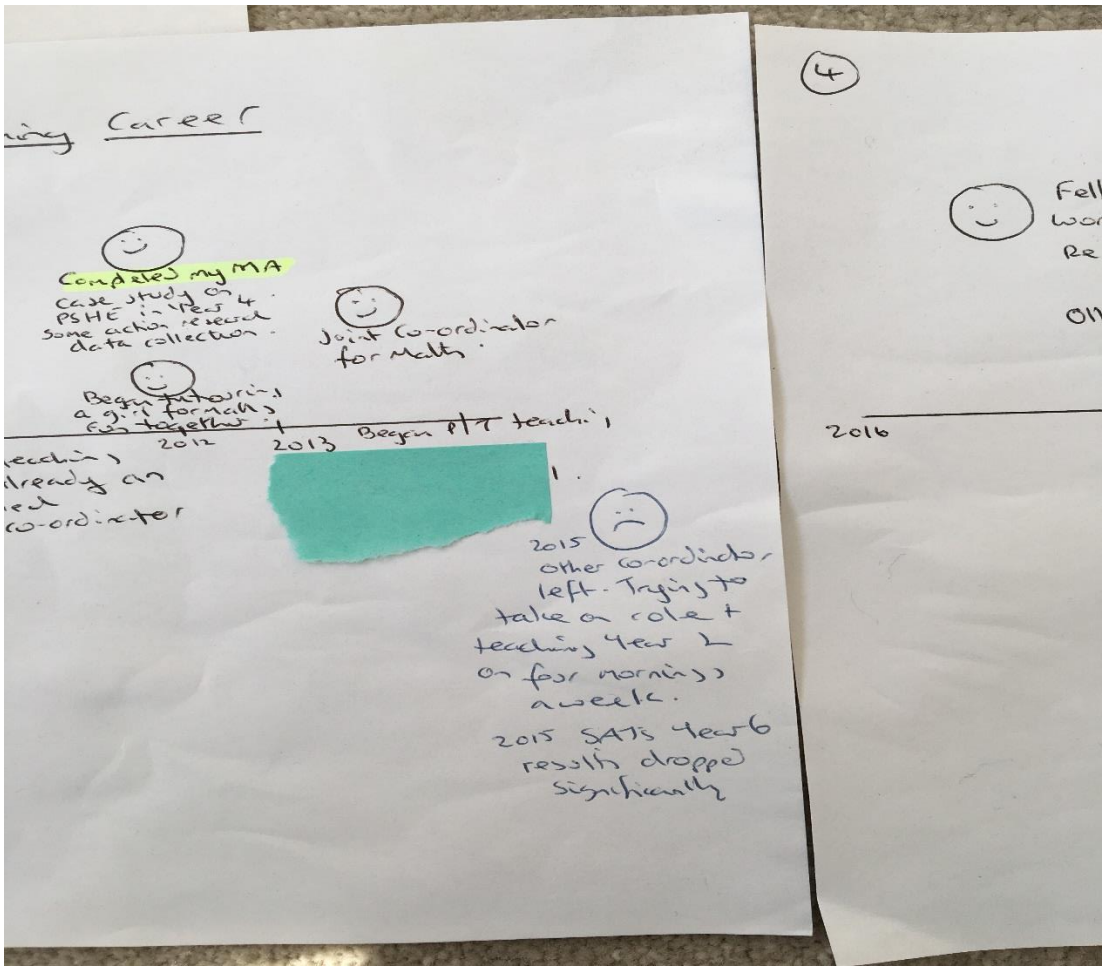


Figure 31 Life Graph of Emma illustrating time pressures of being a PMaST.

Emma, similarly to Sally, elaborated on the tension she faced when her colleague, who was a joint of co-ordinating of mathematics, left, and Emma was given responsibility for leading mathematics across the school whilst teaching a year 2 class and working part-time. Emma's perceptions suggest this led to time constraints of effectively doing the role of both class teacher and PMaST.

Thomas' data also showed him being given a variety of responsibilities early on in his teaching career and not being able to execute them effectively.

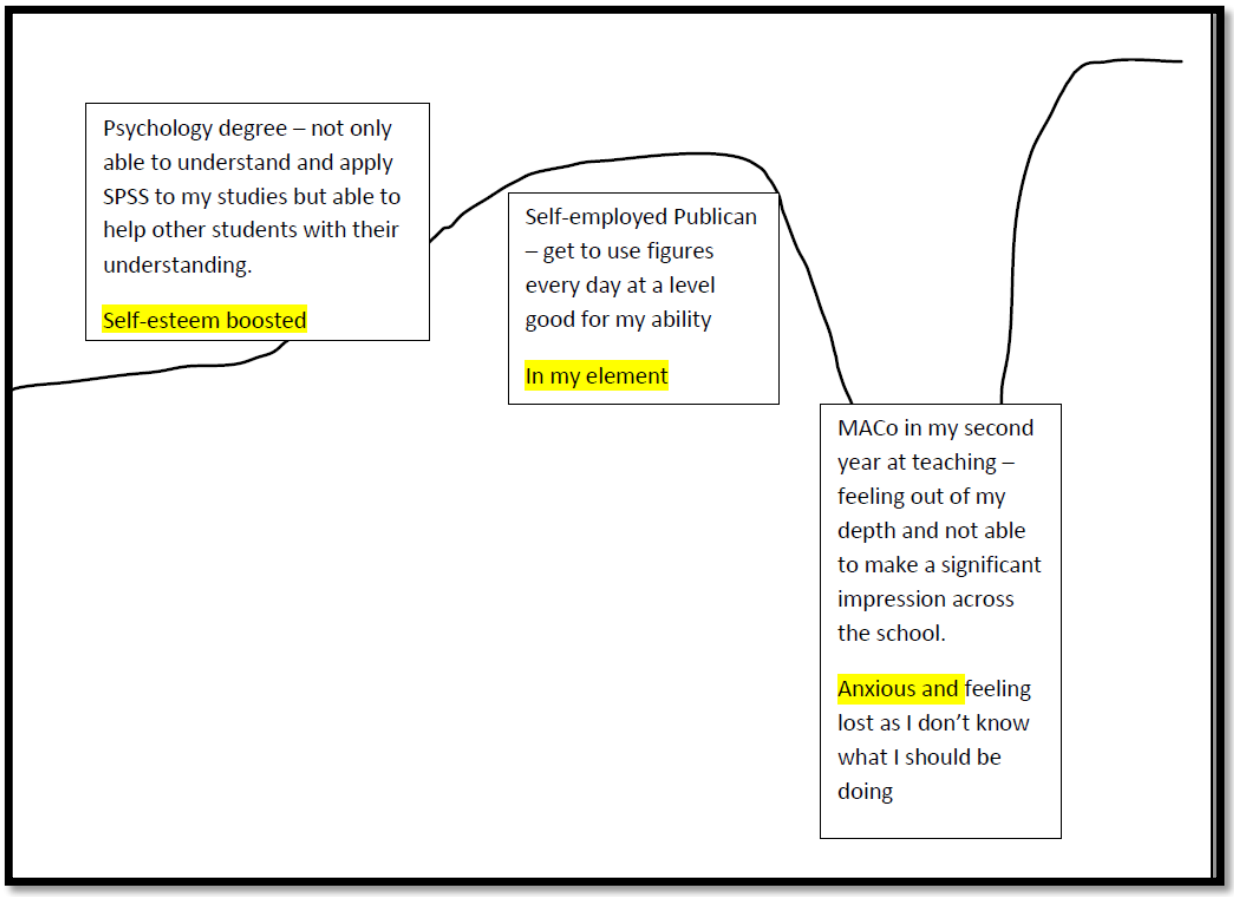


Figure 32 shows Thomas' Life Graph.

The language used by Thomas to describe his experience 'anxious and feeling lost' could be interpreted as showing a lack of confidence in doing the job of a mathematics co-ordinator as well as consolidating the role of a class teacher.

5.3.4 Parental challenges – societal frustrations

The data suggested the perceived tensions felt by the PMaSTs when discussing mathematics with parents of pupils either on a one to one basis or during whole school events. The PMaSTs reflected that this frustration stemmed from the realisation that the parents would speak about their lack of confidence with mathematics in front of their child, and this was viewed by the PMaSTs as creating a barrier to the learning opportunities of the pupils. This is exemplified in the extracts below:

within everyday life maths still appears to have a stigma compared with other subjects based on many people's experiences through their own schooling and based on interactions they are likely to have with their parents. (Gregory)

parents who say I can't do maths … you know society as a whole it is still acceptable to say I can't do maths. (Reece)

I would say still got too many parents who because they are scared of it indirectly transfer that onto other, their children not all obviously. I would say the value of maths while parents know about its value might shy away from it because they do not feel so… (Thomas)

I was helping parents to feel more confident about maths, changing attitudes to the subject and giving parents and carers the confidence to feel that they could engage in partnership with the school to support their children's learning and that was really satisfying and I really enjoyed the sessions. (Sharon)

… but then the parents I always end up talking to parents they always say to me, the first thing is well I wasn't good at maths in school so I'm not surprised they are not, and its infuriating because you could be having a meeting with them and their child is there well I wasn't good at maths so I am surprised, so it is just like perpetuating this myth that maths is a terrible thing and actually it is not… (Sally)

I think because maths is seen as important so even though you will still get the parents I could never do the maths, it's my husband that can do it … but of course you know that the parents want them to do well in maths it is, they obviously realise it is an important subject and the school setting here is that you got very supportive parents, […] (Emma)

I would say there are two sides to it because there is on the one hand certain people who would be happy to say that they hated maths at school and could not do it but on the other hand other had there are some parents who are very supportive and enthusiastic and really

> *value maths and kind of acknowledge that you know career wise a lot of very successful financial, you know accountants or bankers or medics, a lot of, you know very successful professionals need maths and are good at maths, so there are two sides to it.* (Michelle)

Gregory, Reece, Thomas, Sally, Emma and Michelle all discussed their interpretations of the societal norm of parents openly acknowledging that they were no good at mathematics. This, as the extracts from the data, suggest, proved frustrating for the PMaSTs who know that such societal perceptions of mathematics, especially coming from parents, are not helpful and can be suggested, continue to feed the anxieties and attitudes towards the subject.

However, the PMaSTs also provide a narrative of parents acknowledging the importance of the subject and therefore enabling their children to develop confidence with it through supporting the teaching within the school. This is exemplified by both Emma and Michelle's life history interview extracts.

5.3.5 The dissolving of LAs across England

Many PMaSTs spoke of the dissolving of the LAs and the impact and void they felt in their professional learning space:

> *so our local advisor we lost her two years ago, and they never replaced her.* (Sandra)

> *was a lack at the time of support from the LA because of funding and support that had been there and the support that had been there had been withdrawn* (Sharon)

> *… she (Headteacher) was very supportive of people's career development and things like that. That was back when the LA was prosperous … I went in during like an afternoon or a morning and all the fees went straight back into the school so it was just a case of releasing me basically … by this point the Local Authority was less able to support, … so it was kind of muddling through when the LA was falling to bits, was kind of what was going on…* (Belinda)

The data emphasised the perceptions of the PMaSTs how the LAs were seen as essential support networking spaces and therefore the impact of their fragmentation was deeply felt by the PMaSTs. Belinda's data explained how the structure of the LA served her well, as she developed a consultancy role, supported by her Headteacher (figure 33). The wider implications of this policy change can be interpreted as schools having to get creative in developing their mathematics professional learning and leadership opportunities with little support externally, Belinda describes this as 'muddling through as the LA was falling to bits'. It is worth mentioning that there are still local Mathematics Hubs, and the involvement of PMaSTs in this initiative will be further discussed in chapter 6.

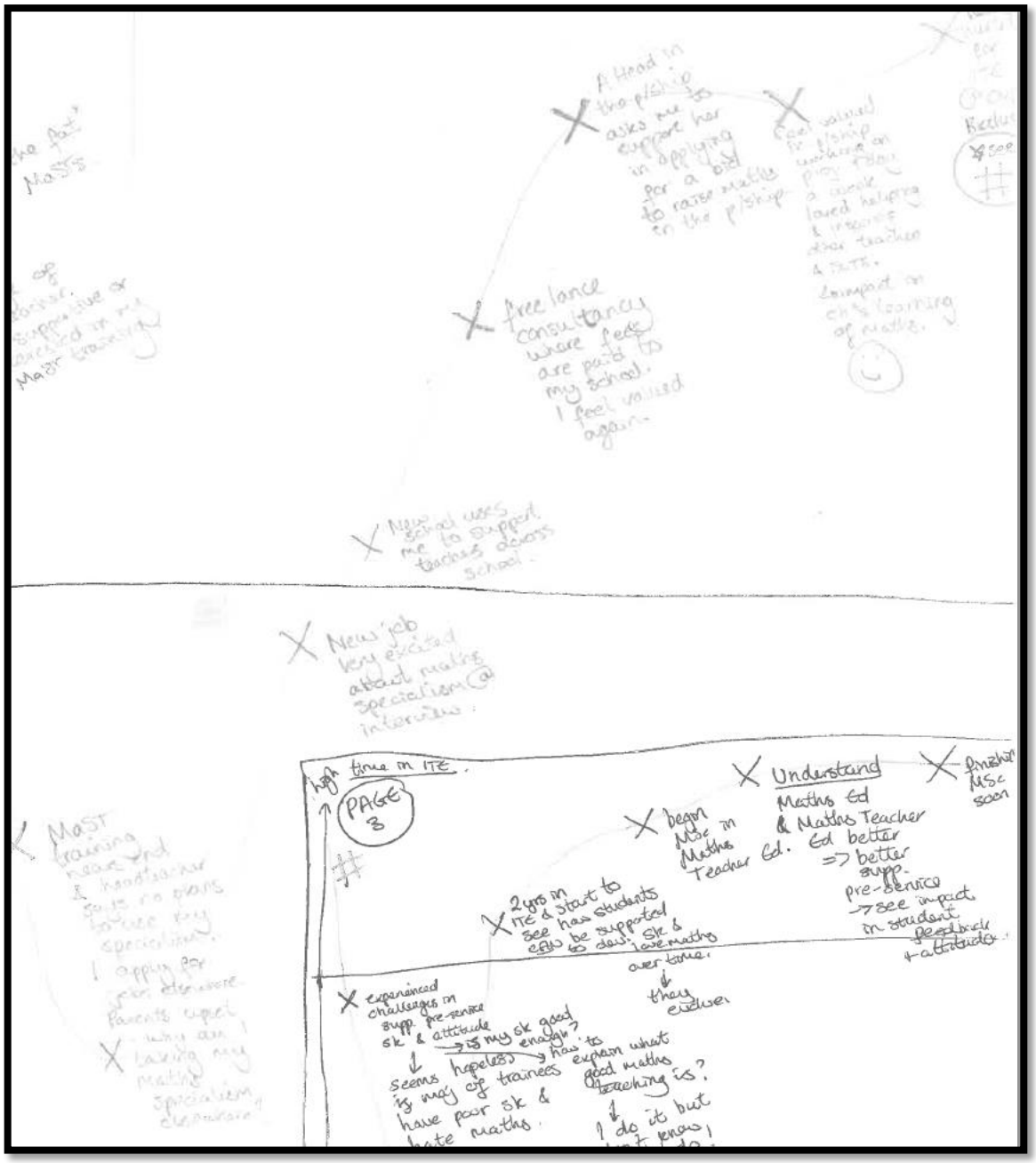


Figure 33 showing an extract of Belinda's Life Graph.

5.3.6 Curriculum content and teaching to the tests

The data showed how national curriculum changes and the demands this placed on the PMaSTs' teaching philosophies, as well as imparting that knowledge to colleagues, was seen as a challenge by participants. Furthermore, the data showed how the PMaSTs felt discouraged by the role of National Testing at both KS1 and KS2 played in narrowing the curriculum and diluting rich mathematical

learning opportunities. This is exemplified well by the discourse illustrated in Reece's Life Graph, figure 34, and the subsequent narrative through her interview:

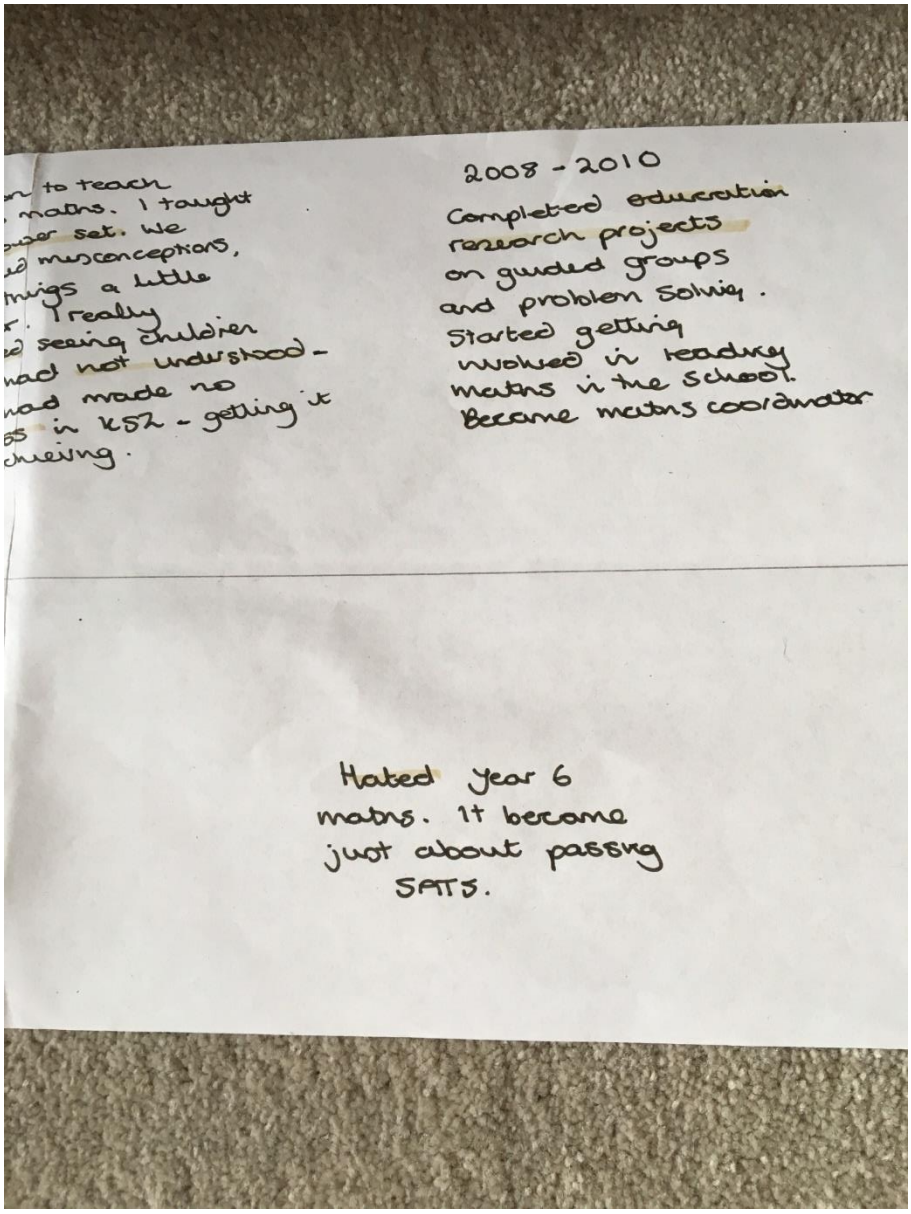


Figure 34 Showing Reece's Life Graph.

Reece elaborated on the Life Graph entry as:

> *It was … the last year in year 6, I got to the end and I remember starting the year and I have got to go through this again and it wasn't so much that … it was because I'd got the lower set, it was having children that had … never done maths before that you know had made no progress over the four years … three years of being in key stage 2 and all of a sudden I had to*

> *get them yet again back up to a level 4, … So I said I want to move into year 3-4 I don't want to keep having this problem that we are just in year 6 I've got to make all this progress in year 6 … was lucky I kinda went out of it and then went into year 3-4 and it was fantastic … my class made really good progress and I loved teaching year 3-4.* (Reece)

Reece's data can be interpreted as her perceived frustrations about being a teacher in year 6 and 'became just about passing SATs'. The data revealed how she reflected on the teaching in year 6 and subsequently moved down to years 3-4 to improve the teaching experiences of pupils in mathematics.

The data also illustrated how lesson planning proved time-consuming and problematic for PMaSTs. Daisy's Life Graph demonstrated this well in figure 35.

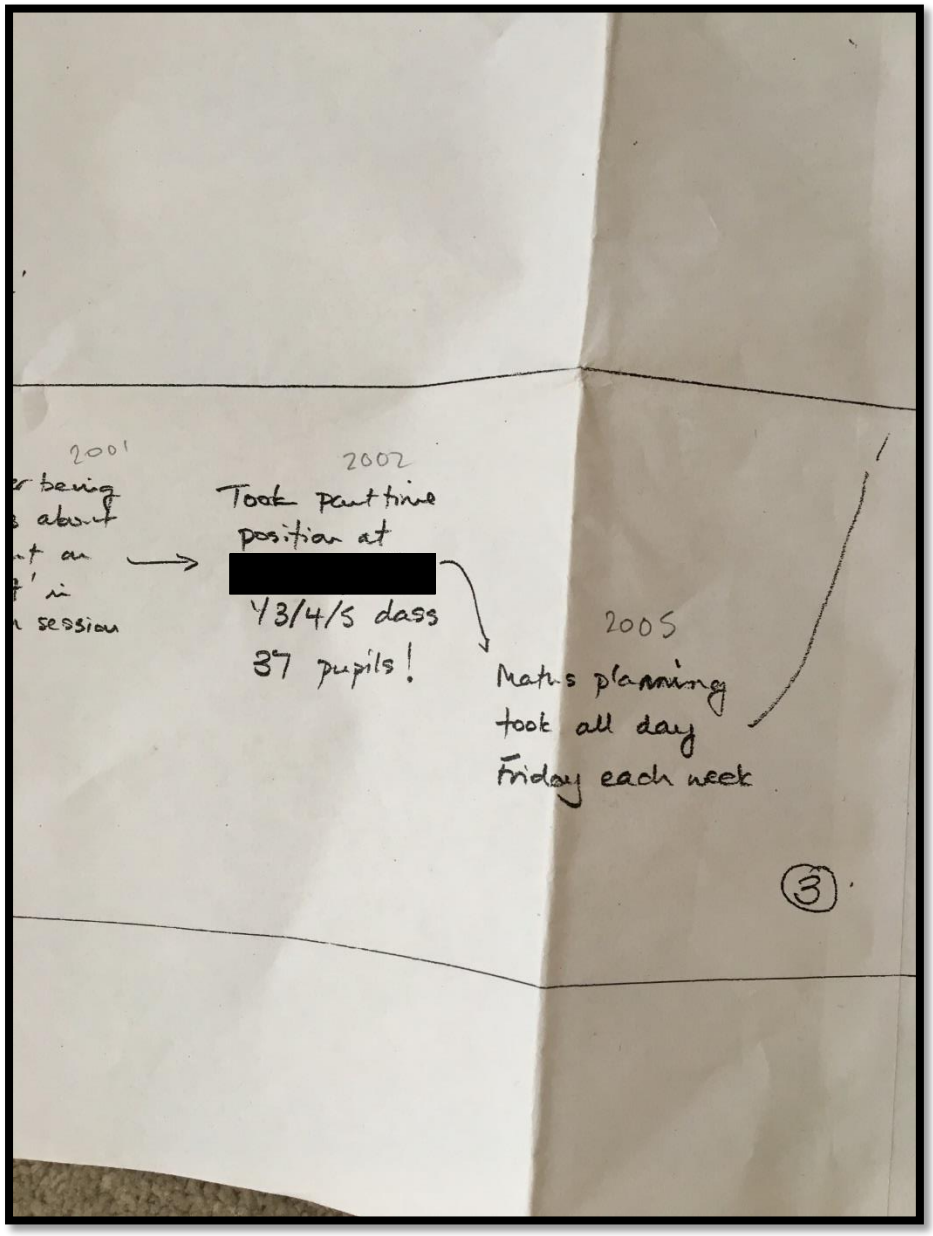


Figure 35 illustrating Daisy's Life Graph.

Daisy illustrated the tensions of time spent in planning and knowing that this model is not sustainable, this is further elaborated upon in her narrative interview:

> *Well I think I really felt very at sea, I had children in my 3/4/5 class that I know I remember … were only working at a year 1, some P scales(previous pre NC levels) … I really felt very unhappy that those children were not getting good quality maths from me. I didn't feel that*

> *the National Curriculum was even lending itself to really giving them a good quality maths experience.* (Daisy)

The data collected illustrated the negative perceptions the PMaSTs felt with leaders when they got promoted and departed from their role of a PMaST. When PMaST progressed to a new middle leader role, they were, by some leaders, no longer viewed as mathematics experts. This can be exemplified by Nicola's case:

> *… in my new school when I went for my interview, I was very proud to say" I'm a maths specialist teacher" and at the time I don't think the headteacher understood what I was saying and he said …"oh we've got … nearly every member of staff here is a maths specialist, they are two a penny".* (Nicola)

The perceived damaging comment made by the head during a job interview illustrated how a negative attitude towards the skills developed by Nicola as a PMaST made her feel undervalued. Further conflict occurred when mathematics expertise was needed in the school:

> *…but I told you I'm a maths specialist teacher, let me show you. The headteacher said, "no, the teachers … won't listen to somebody in house and we are going to call upon [named her LA] to say have you got a maths specialist?" And I said, and you know who they are going to tell you to ask, they are going to tell you to ask me!* (Nicola)

The above example can be used to suggest how Nicola's headteacher was not able to use her expertise as a PMaST. This led Nicola to feel undervalued for a role she worked to develop and forms part of her identity as an educator.

Further tensions of moving on from the role of a PMaST can be illustrated where PMaSTs had to let mathematics leaders in their new schools do the role and of leading mathematics, and pursuing a more strategic leadership role. Reece describes this as:

> *I think it's just you know it is really hard to sometimes take a step back when I know and I can see and I would do the staff meeting like this … I'm having to take a little step back and go its not my responsibility…I can advise and I can hopefully steer in the right direction but actually it has to be somebody eases responsibility and I can't take that away from them but I do miss that you know feeling of you know I'd be doing this you know I'd be jumping and I used to every time we had staff meetings I'd be like yeah yeah no I want two staff meetings for maths this week, this year share…*(Reece)

This extract communicated Reece's reflections show how as a senior leader she has had to take a step back from being a PMaST but her reflections show that she still misses being a PMaST.

5.4 Chapter Summary

This chapter aimed to provide context from the collected data on sub research question 2

Sub-question 2: How do primary teachers describe and understand their experience in the role of a PMaST?

All the participants provided a rich context of their experiences enabling them to develop their role as PMaSTs. They revealed detailed narratives on professional learning opportunities at a micro and macro level to develop their expertise. Further data on the role of leaders in schools and the LA provided a context of the enabling or disabling opportunities facilitated by leadership.

This chapter has concluded that PMaSTs developed their roles with hesitation and anxiety but were empowered and encouraged by reflecting on their past journeys of the learning and teaching of mathematics. The professional learning granted to them through the range of nationally-funded courses supported them to assimilate being in and having the confidence to pursue the role of a PMaST.

An important aspect of developing as PMaSTs was that of creating learning communities and how these communities were continued. Many PMaSTs utilised these learning communities to further

understand the role of a PMaST and have Communities of Practice for mathematicians, be it face to face or on a virtual platform, to bounce ideas and build further opportunities for the learning and teaching of mathematics.

The PMaSTs reflected on mathematics anxiety and the way they were taught mathematics whilst discussing the professional learning courses. They emphasised the importance of building appropriate enabling learning spaces to facilitate the learning and teaching of mathematics for their colleagues and this having a ripple effect on pupils in schools.

Furthermore, all PMaSTs experienced profound changes on a professional level whilst they transformed their identities from a primary teacher into a PMaSTs; they all discussed the building of capacity and skills, thus illustrated developing confidence. When PMaSTs were asked to describe professional learning opportunities such as the Mathematics Specialist Teacher course, two popular words were ‘empowering’ and ‘positive’, confirming the changes that they had experienced.

Finally, a large number of PMaSTs mentioned the role of the LA mathematics consultants and particularly the support provided in building them into PMaSTs. This poses many questions regarding the current policy changes in the dismantling of provision through the LA. How will future capacity be built if such structures have now dissolved because of lack of funding available through LA and many schools converting to Multi-Academy Trusts? These are key policy questions that have been highlighted through the findings of this chapter.

Chapter 6 Findings 3 Future career trajectories of PMaSTs:

Championing the subject.

This chapter reports on the findings from the analysis of data to provide an answer to sub-question three:

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

To answer sub-question three, PMaSTs expanded on their current roles and their hopes and aspirations for the future. Within this context, the PMaSTs provided further perspective on how they see themselves now and how this professional identity developed throughout their career, with an emphasis on mathematics learning and teaching. Finally, PMaSTs interpretations were gathered on how they saw mathematics at their current career stage and their opinions of societal perceptions of the subject.

The chapter will be divided into three main sections as follows:

- PMaST's current role
- Factors shaping and constraining identities through career trajectories and professional learning opportunities
- Perceptions of mathematics

6.1 Current roles held by the PMaSTs

Out of the twelve PMaSTs in this study, nine (Gregory, Thomas, Sharon, Sally, Sandra, Emma, Roseanne, Belinda and Michelle) continued to have careers intrinsically liked to mathematics education. Out of these nine, three (Sally, Roseanne and Emma) continued to be based in primary schools. Both Sally and Emma had leadership responsibilities as well as being class teachers and

school mathematics leads. Roseanne was an Assistant Headteacher as well as mathematics lead. Additionally, she had a Primary Mastery lead role with the NCETM as well a leadership role with the local Mathematics Hub. The Primary Mastery lead role supported Roseanne to have a local and national impact on the learning and teaching of mathematics. She also facilitates national-level training. Sally similarly diversified her PMaST role and is now a Mastery lead for the NCETM. This had enabled her to continue to gain high-level training for the current trends in the learning and teaching of mathematics. Thomas, Sharon, Sandra and Belinda have left schools and are now teaching within Higher Education. All have roles in ITT with a focus of developing the learning and teaching of mathematics with primary trainee teachers. Michelle, at the time of data collection, was on maternity leave and aspired to go back into schools as a Leading Mathematics Teacher to continue her role as a PMaST. Gregory was unique, as, after developing his role as an LA mathematics lead, he has set up a private mathematics consultancy and is continuing to deliver mathematics training on a local and national level. The remaining three participants, Nicola, Reece and Daisy had transitioned their careers into senior leadership roles in schools with Nicola being a SENCO, Reece a Deputy Headteacher and Daisy a Headteacher.

6.1.1 PMaSTs' current experiences developing mathematics teaching and learning.

A common theme in the data demonstrated all PMaSTs continuing to develop mathematics learning and teaching, even if they were no longer leading mathematics within their schools. The nine PMaSTs still working within mathematics provided a detailed narrative of current government policy changes and how they continued to deliver mathematics education.

A major theme concerned the current developments within the learning and teaching of mathematics and the role they continued to play in implementing and sustaining the changes to ensure the best outcomes for pupils.

Emma was now part of a senior leadership team and contextualised her current work as:

> *[…] I was part of the senior team … that had a big impact because there were things I could do … the new curriculum that had come in and to make sure we are really stretching the children enough which I don't think at the time we thought … we were. So, … luckily with the maths hubs, [I] got involved quite early with them because, you get a lot of funding there and a lot of support also, they realised that actually this is a very big job, … so I also got the year 3 teachers and NQTs also supporting … I have taken a lead, for the maths development … things like problem solving, bar modelling, so that we understand ourselves a lot more about the different methods and then being able to cascade that to staff.* (Emma)

Emma's reflections suggested how she adapted her practice and leadership in light of the changing expectations nationally for the teaching and learning of mathematics. Furthermore, the data explained how she transformed her practice and leadership of the subject to establish best outcomes for pupils within the school. Emma's data illustrated the value and benefits of the training opportunities available through her local Mathematics Hub. An additional feature extracted from the data was that of Emma's successful implementation of new strategies through training colleagues within a year group and all new teachers joining the school. Furthermore, Emma reflected on the types of subject knowledge training provided to colleagues in light of the changing landscape of mathematics education. A final aspect of Emma's perceived successful transitioning into the leadership of mathematics learning and teaching came through Emma investing in a scheme for the teaching of mathematics. She discussed this as:

> *The school has decided to take on a scheme to help us with the maths, to get consistency across the school. … Everybody is quite committed to it and they like the scheme. Children seem very enthusiastic. We have had a maths consultant come in a couple of times and he has sort of worked with me as well and that has been really really helpful, so that has been a high.* (Emma)

This evaluation revealed the commitment from the senior leadership team for the development of mathematics. Emma noted that the support given by leadership through investment in the scheme and subsequent support for her to establish the scheme with the assistance of a consultant was viewed, by Emma, as an investment not only in the mathematics provision but also her leadership and commitment to the learning and teaching of mathematics. Finally, Emma reflected that being part of the leadership team as a PMaST had a positive impact on decision-making in developing mathematics across the school.

Similarly, Sally was also part of the senior leadership team and described the context of her school's journey in the learning and teaching of mathematics and the role her leadership played in developing provision to bring mathematics teaching in line with the demands of the National Curriculum.

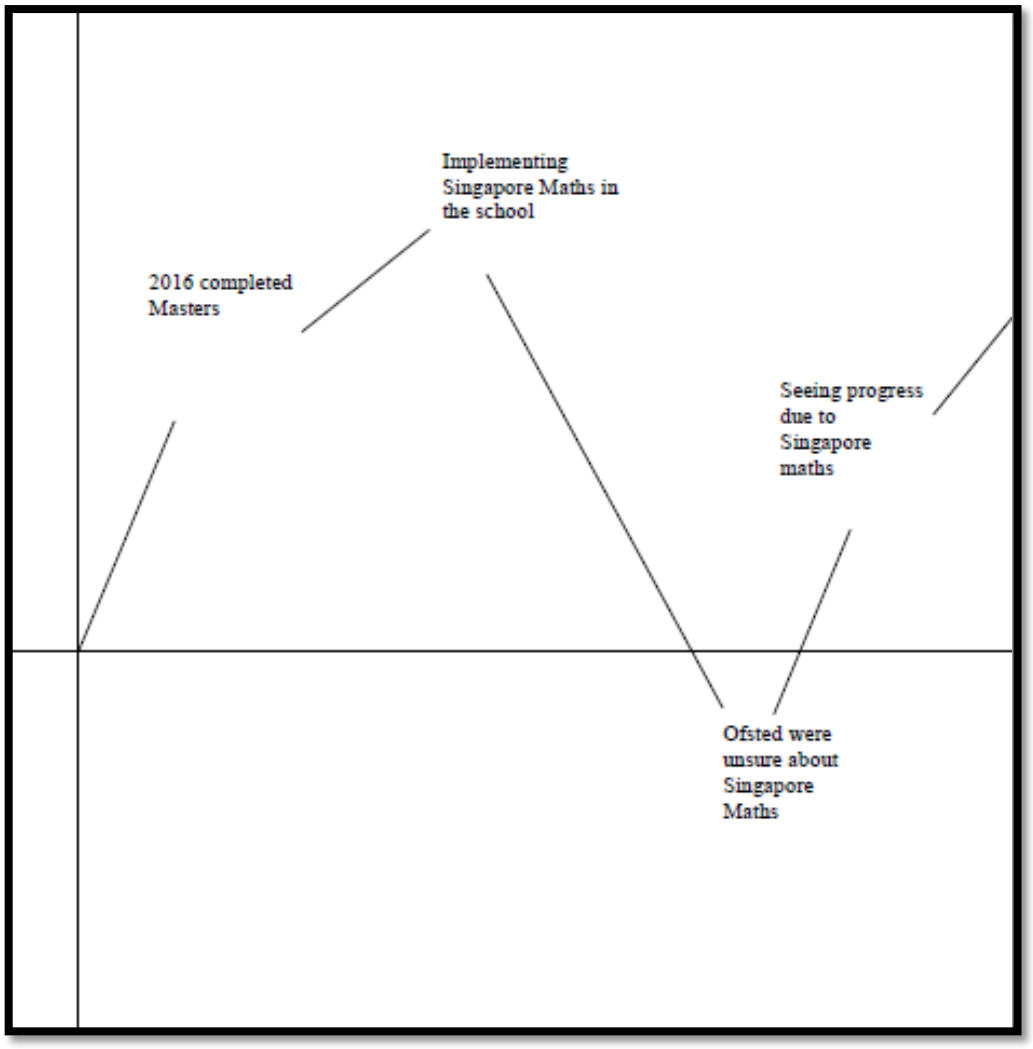


Figure 36 Sally's Life Graph extracts illustrating the implementation of 'Singapore Mathematics' in school.

Sally placed the implementation of Singapore Mathematics as a high point on her Life Graph, suggesting confidence in the CPD she received and then imparted to her colleagues for a successful transition to this method of learning and teaching mathematics. However, she also highlighted her frustration at the lack of insight demonstrated by Ofsted towards the approach. She described this as:

> *I think one thing we had Ofsted and they were not sure about Singapore Maths which I thought was really interesting. They did not really understand the whole concept of mastery and this whole class approach they were still very much still looking for old school, here is my*

> *activity here's my middles here's my bottoms (groupings in class) they totally missed the point.* (Sally)

The extract from the interview suggested the frustrations that Sally felt after the feedback from Ofsted. The data further indicated the level of expertise Sally acquired whilst being a PMaST and understanding how to develop mastery of mathematics. These reflections suggest Sally building her confidence in leading mathematics and having the courage to have a professional dialogue with Ofsted, where she disagreed about their opinion. Additionally, she discussed her pupils and contextualised the learning opportunities as:

> *I think the thing is that Ofsted they wanted hard proof data and I could not give it to them at the time because… with Singapore, you extend everything so much longer you actually do the subject only once a year so the results aren't looking great so they were like the results aren't moving up … I was saying well our EAL children are discussing things have you looked in their journals with what they are doing the way they are talking about maths the vocabulary they are using … they just wanted data and I was like I can't give you that.* (Sally)

Sally highlighted how she understood her pupils, their needs and the need to develop depth in mathematical understanding, as well as ensuring that the mastery approach was embedded. Additionally, there is a realisation that for results to improve, the model and methods of the mastery/Singapore approach need to be embedded. The Life Graph in figure 36 revealed a dip when Ofsted commented on the mathematics but a sharp increase in pupil progress because of the Singapore Mathematics approach, proving the points Sally made about pupils making progress despite the data showing otherwise.

Similarly to Sally and Emma; Roseanne became part of the senior leadership team. The difference in her role was that she was a strategic partner of the regional Mathematics Hub and continued to gain training from the NCETM to develop the mathematics provision across the area. This is illustrated with the detail provided in Roseanne's Life Graph in figure 37.

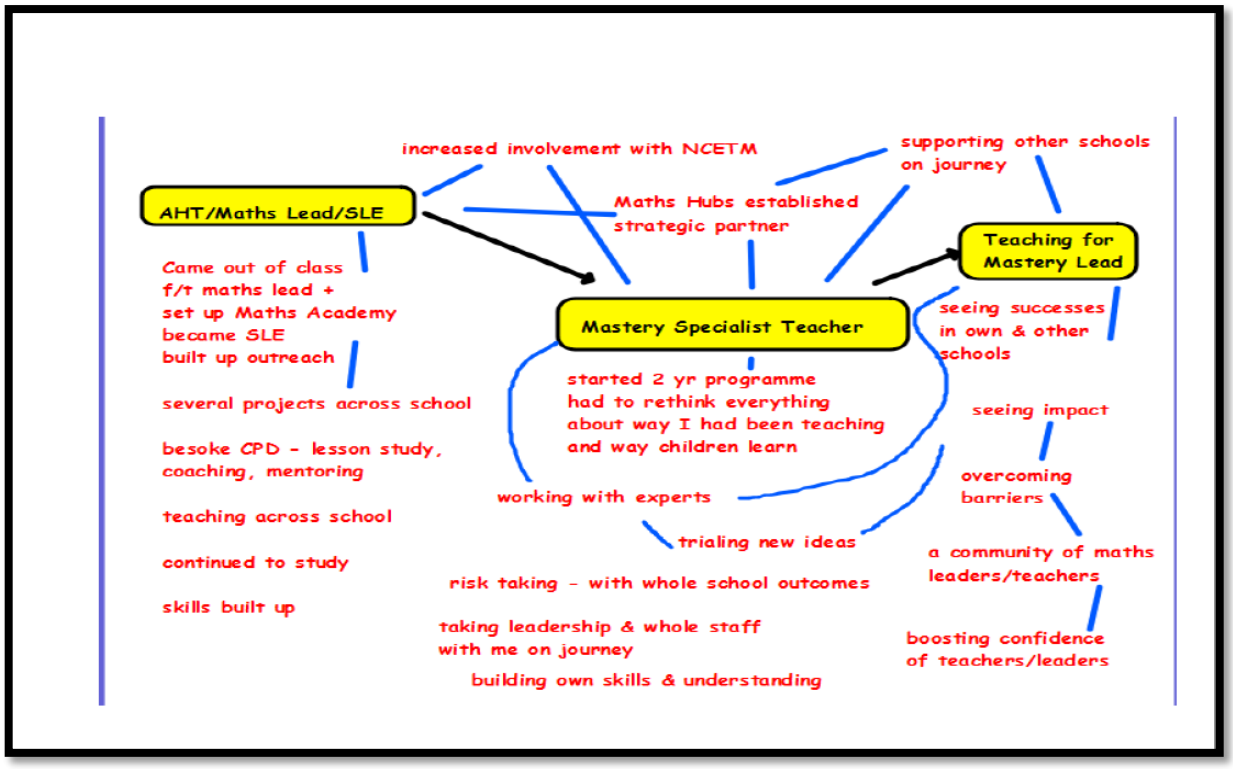


Figure 37 Roseanne's Life Graph illustrating her current role as a Mastery Specialist Teacher.

The detail shown revealed Roseanne's interpretation of her role. Firstly she had the luxury to come out of class and solely focus on mathematics to build mathematics capacity, enabling the deployment of high quality 'bespoke CPD' with the example of using lesson study and coaching and mentoring strategies to support colleagues. Secondly, the data illustrated how Roseanne's training and becoming a Mastery Specialist Teacher allowed her to refresh her approach and insight into the learning and teaching of mathematics, she described working with 'experts'. Roseanne acknowledged the growth in mathematics within her school as 'seeing success in own school and other schools', 'seeing impact', 'a community of mathematics teachers/ learners' and 'boosting the confidence of teachers/ leaders' illustrating a strong narrative of the confidence Roseanne showed in the impact her CPD and approach, through the Mathematics Hub, was having on the community of mathematics teachers and learners.

At the time of data collection, both Sharon and Belinda had established roles as teacher educators within the Higher Education Institution (HEI) sector. The data showed how their own experiences of

learning mathematics significantly influenced how they approached the teaching and learning of mathematics with their students. Additionally, they reflected on how professional learning as a PMaST also gave them the confidence to apply for these roles. Sharon reflected on the job and her perceptions of herself within the role:

> *Definitely, without being on the MaST course I would never have had the confidence or probably wouldn't even have come on to my radar … I read the job description and with increasing sort of excitement thinking oh my goodness I think I could evidence that and yes I think I could do that … because I never, up to that point had even appeared on the periphery of my radar the thought that I could go into teacher training. Perhaps I didn't really have a clear idea of where teacher trainers came from but I didn't think that they would come from humble beginnings like mine, put it that way.* (Sharon)

The language used by Sharon to describe her thinking when she applied for a HE post suggests a sense of belief in her abilities as a mathematics champion. Her reflections confirm her confidence to apply for this post was boosted by knowing she has the MaST qualification.

Further data from Sharon illustrated and enabled reflection on her changing role as she recalled some reticence towards moving out of the classroom. The language used such as 'the way I reconcile it with myself' suggested transitioning into a new role was challenging but Sharon saw the wider benefits in her new role as a teacher trainer, supporting the next generation of teachers to widen the scope of her impact in champion mathematics:

> *I love my job it is challenging but it's not exhausting in the way that teaching was … the way I reconcile it with myself is that even though it took me 13/14 years deciding I wanted to teach and being a teacher none of that is wasted because I really do truly believe that I impact on far more children and their good attitudes around maths because of those new teachers … so we recognise that not every student who trains here to be a teacher will necessarily have good attitudes or even really tip top skills in maths … We try to show our teachers, ask them*

> *to think about maths as a responsibility not just for the year but developing attitudes to maths that will last a lifetime.* (Sharon)

Belinda reflected on the poor subject knowledge of trainee teachers and initially being 'at a loss' as to how to develop this – she illustrated this as a low point on her Life Graph (figure 38). However, through professional learning and research in the area as part of an MA dissertation, Belinda developed a way forward in fine-tuning appropriate subject knowledge to support the changing of attitudes of her trainee teachers.

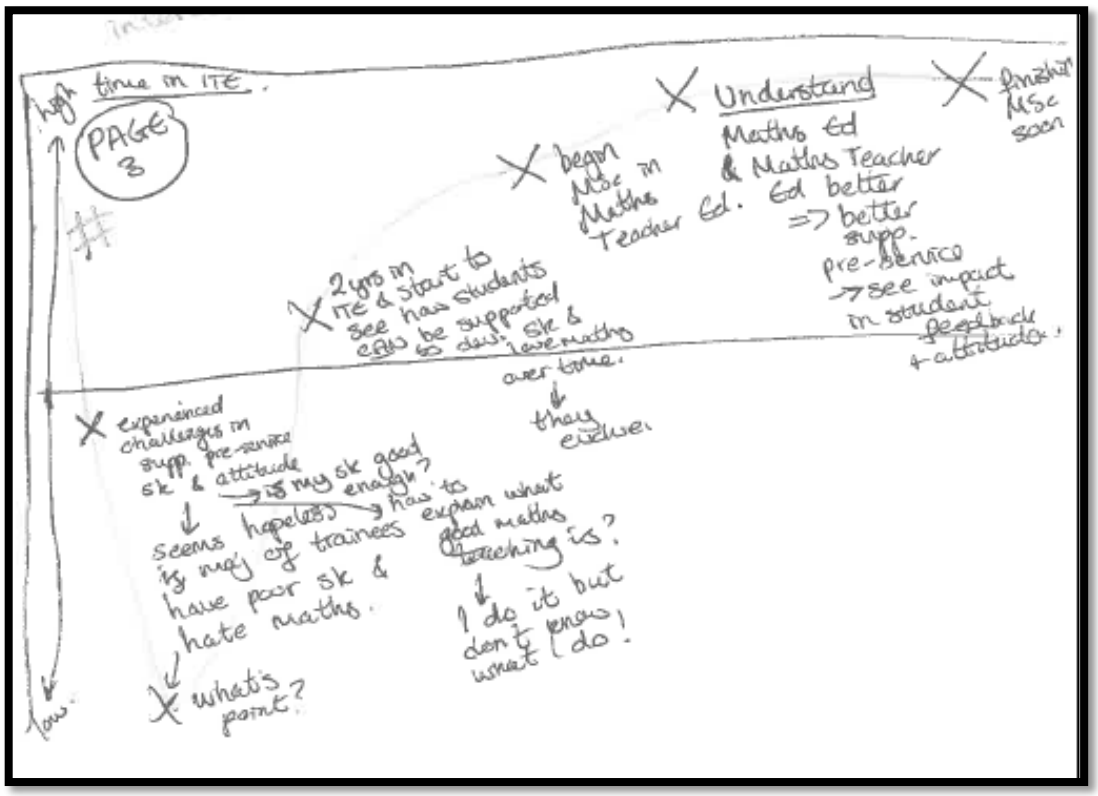


Figure 38 Belinda's Life Graph illustrating her changing understanding of trainee teachers and the development of subject knowledge in mathematics.

Daisy's data suggested that her role as a headteacher and as a former PMaST meant she had a deeper insight into developing mathematics in school than perhaps a headteacher without a specialist understanding of mathematics teaching and learning. Daisy elaborated on the role she

continued to play with training key members of staff (figure 39), not just within her school but within the LA., thus validating the level of knowledge and skills as an alumni PMaST.

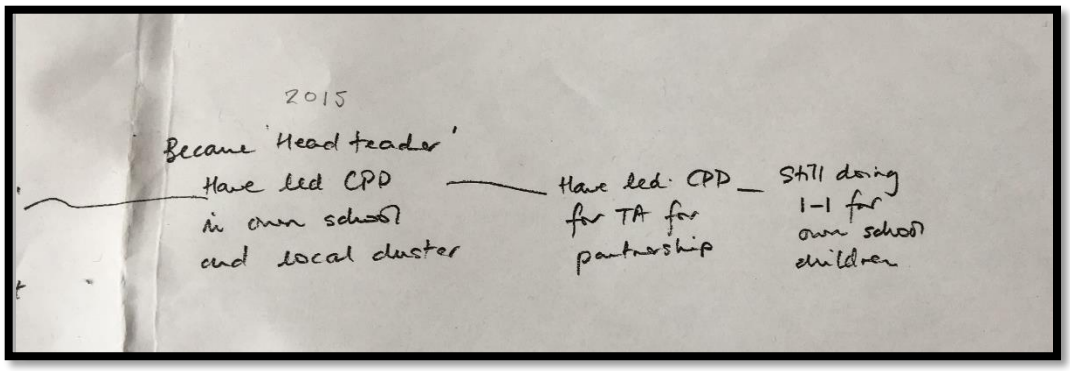


Figure 39 Extract from Daisy's Life Graph showing her leading professional learning for the LA.

To conclude, the data communicated that most of the PMaSTs continued to develop their learning and teaching of mathematics within their current roles. Their actual roles had evolved and transitioned as their career paths had progressed but this strong identity as a PMaST remained at the heart of their practice and therefore the desire to continue to champion mathematics within primary schools and primary education.

6.2 Factors shaping and constraining identities through career trajectories and professional learning opportunities

This section shares a summary of the data representing the PMaSTs' reflections on the current stage of their professional career and where being a PMaST sits within that context. Furthermore, it explored their views on perceived professional identities - do they see themselves as primary teachers or have they transitioned into PMaSTs, or moved into school leadership roles that have taken the emphasis away from pure leadership within mathematics?

Out of the twelve PMaSTs, only two (Thomas and Sally) firmly identified themselves as primary teachers with further expertise within mathematics. The remaining 10 participants set out mixed

views of how they saw themselves now, reflecting both to being a primary teacher and a PMaST. Out of these 10 participants, three (Gregory, Reece and Daisy) stressed that they now saw themselves more as leaders, as well as having expertise within mathematics. Gregory, especially, saw himself as a PMaST and a leader within primary mathematics:

> *More as a maths specialist and yet at the same time because of further training I've done since MaST developing leadership skills, I would argue maths specialist alongside … a leader.* (Gregory)

Furthermore, Reece revealed tension in how she identified herself:

> *I think it's a new identity, next year it's going to be much more going into the deputy headship … if I could I would just love to teach maths … here we've got a lovely opportunity because we are part of a through academy so … there might be opportunities that I could go and teach year 7 maths … but at the moment its taking a path into deputy headship and taking a step outside the classroom and seeing how that goes.* (Reece)

Reece's data illustrated a tension in her view of her emerging leader self and the transition from being a primary class teacher and a PMaST. It can be suggested that although Reece is happy to continue to develop her role as a leader, there is a part of her that would like to continue to be at the 'chalk face' teaching mathematics, suggesting that transitioning to a new role can be very challenging for a PMaST.

Similarly, Sally defined herself as being a 'teacher +':

> *The other day, funnily enough, we had to describe what our roles were and I decided I was a teacher+ so that is how I want it to be… I do find that being a teacher is really important … in the future I want to be an assistant head but I know that I don't want to leave the classroom so I have really got this kind of conflict. I need to find myself a really great part-time job, assistant and teaching. Maths is my identity especially my professional development. And I*

> *find that if I am not feeling secure of what I am able to do in my maths it actually has a knock on effect on everything else so like if I am not feeling confident … I can be grumpy at home and all that sort of stuff so yeah, it does play a big part in who I am now.* (Sally)

Sally's narrative extract suggested a strong grounding as a teacher first and as a PMaST. Although she acknowledged gaining a leadership position, she followed this by stating firmly that all aspects of her career continued to be driven by her work and her professional learning within mathematics, to the point that Sally identified the professional development that she continued to receive around mathematics as a key aspect of learning that supported her development as a PMaST and moved her career forward. Finally, she reflected on the consequences of not being able to do tasks effectively within mathematics having a lasting impact on her personal and professional life.

Michelle, in transition and between jobs due to being on maternity leave, defined herself as:

> *I think both at the moment yeah. Because I think to be a successful maths specialist, to a certain extent still need to have a toe in the water with primary teaching.* (Michelle)

Michelle's data highlighted understanding that to excel and become a professional PMaST, there needs to be a close connection with and understanding of primary teaching and all that is involved within it. Therefore, her response could be interpreted as; to be a successful PMaST, part of the success is dependent on a continuation of a role in primary classrooms.

Daisy firmly defined herself as a leader in her role as Headteacher of a primary school:

> *…it is interesting because I think I wrote both, but I also feel that I have moved on because now I am a leader, a manager and teaching I am afraid is part of what I do, it is not a great deal of what I do.* (Daisy)

Daisy's comments illustrated a clear transition and a firm rooting within her established role as a headteacher. Daisy reflected on continuing to influence local thinking and professional learning

through her CPD provision for mathematics, thus perceiving herself to continuing her strategic role as a leader in education and disseminating her expertise in mathematics. She described this as:

> *I have also taken over the lead of the xxx Partnership of School maths group … As part of this, however, I will be doing some more training of teachers and TAs (I am looking forward to it but I'm also quite nervous about it).* (Daisy)

This extract set out a clear progression, revealing strategic leadership, not just from a school leader perspective, but also from a regional perspective. Furthermore, it highlighted the continued strategic role that Daisy is playing in developing mathematics regionally and at her school. However, the data does reveal some trepidation about working with colleagues, suggesting a sense of unease from Daisy in moving between roles.

Two of the PMaSTs, Emma and Thomas, firmly identified themselves as primary teachers first, with an expertise in mathematics:

> *Oh, I see myself as a teacher, oh very much so! I enjoy teaching other subjects … I really enjoy, to answer your question, there are too many other things I like, to just say I am a maths specialist.* (Thomas)

Thomas' remark revealed that he was firmly a teacher and mathematics teaching was part of his identity as a teacher. A final note about Thomas: through an update received via email after the completion of data collection, Thomas noted his change in role from a school PMaST to a lecturer at HEI.

Three participants, Nicola, Roseanne and Sandra, defined themselves as PMaSTs at this stage of their career, describing their thinking as:

> *I would say I am a frustrated maths specialist who is teaching in primary.* (Nicola)

> *I think I see myself as a maths specialist really only because I don't class teach now. … I just see myself with the maths expertise … This is partly to do with my career progression. I have gone this way now slightly and I like it.* (Sandra)

> *I would not see myself necessarily as a maths expert … but I do see myself as a specialist when it comes to teaching maths and when it comes to working with other teachers and I do know that is something that I can do and that I have learnt a lot about.* (Roseanne)

Both Belinda and Sharon changed roles from primary schools into HEIs, teaching mathematics to primary trainee teachers. They acknowledged the challenges in redefining their role whilst moving out of primary schools:

> *I don't know, to be honest, there are times when I feel very much like a primary school teacher, I certainly do feel like a maths specialist still and at other times I feel like an academic, a lecturer and I wonder how credible I am as a primary school teacher when actually I haven't taught in a primary school now for four years, … I fear sometimes that I ask student teachers to do something that I could not have done myself so I sit with two selves on my shoulders often and as a lecturer and as a trainer of maths teachers I think about what my expectations of their teaching are what do I want to see them providing for their learners but then I have to put it through the filter of what is realistic and what might be potentially creating barriers to them being able to do that.* (Sharon)

> *…oh I don't know, It depends who I am talking to I think. So, e.g. I was talking to somebody the other day about rehabilitating my dad and she mentioned Twinkle (Primary online resource) and I immediately said, oh I am a teacher so … but there are other, so when I was at a maths research conference then I feel like I am a maths researcher I don't know, I think it depends which group I am in. I would say I am definitely a specialist Primary Maths Teacher who is interested in stuff so is doing a bit of research on the side.* (Belinda)

Both Belinda and Sharon reflections suggested juxtapositions of how they saw themselves, rooted within how others saw them, the reflections suggested how both Belinda and Sharon realigned how they see themselves as a result of these perceptions. Furthermore, Sharon recognised a struggle for her reduction of direct contact in the classrooms and expecting trainee teachers to do tasks that may be unrealistic and excessive. Both however, saw themselves as emerging academics, working within the field of mathematics education in teacher training.

To conclude, all PMaSTs discussed and identified themselves as being in transition between the role they were in at the time of the data collection and the role of a PMaST. Many continued to juggle being a primary teacher with an expertise in mathematics and others transitioned to new roles at a local and national level, whilst remaining firmly rooted in championing mathematics. Furthermore, a handful of PMaSTs had completely changed roles and now played strategic school leadership roles as Headteachers and Deputy Headteachers. One aspect that came out clearly in all the PMaSTs' reflections was that having a strong relationship with their professional learning and development as a PMaST within their career trajectory to date, the data suggested this enabled them to emerge and evolve into the teachers, lecturers and leaders they are today.

6.3 Perceptions of mathematics

This section will expand on the data, showcasing how the PMaSTs continue to develop their understanding of the learning and teaching of mathematics within primary schools and how they see mathematics being perceived within society. The PMaSTs determination and professionalism are explored as to how they continued to develop a positive attitude towards the subject to champion mathematics locally and nationally.

All participants continued to utilise the range of CPD granted to them. The data showed how most PMaSTs discussed how mathematics still maintained a negative image in society and the work they continued to do to foster the positive attitudes the subject deserved. Reece suggested that:

> *I think, I still feel it's the second subject, … Literacy is everywhere … I still have … people who aren't confident in maths coming through and that really worries me … I find it very hard to switch off from the experiences that I have had to what I was like as an NQT or as a student but I still feel I had a lot more passion about maths … so it still feels like there is a slog to go and I wish there was more people who had that good understanding.* (Reece)

Sandra revealed her perceptions of mathematics and society:

> *I think mathematics runs through a lot of things I think obviously typically its always been one of these things that it doesn't matter and actually a lot of people did not have positive experiences so probably out of all the areas its an area oh I am really rubbish at maths and its sort of accepted that that is okay.* (Sandra)

The data illustrated how Reece still perceived mathematics being seen as secondary to literacy and wanting the emphasis that is placed on literacy to be replicated with mathematics. Her self-reflection as a student and an NQT was worth noting as her experiences with teachers now, their attitudes and how she worked towards changing those attitudes and perceptions towards the subject would not have actualised without her own experiences with mathematics.

Furthermore, Sandra's reflections echo Reece's on mathematics and society:

> *I think mathematics runs through a lot of things… typically its always been one of these things that it doesn't matter and actually a lot of people did not have positive experiences so probably out of all the areas it's an area oh I am really rubbish at maths and its sort of accepted that that is okay.* (Sandra)

Emma highlighted a slightly different insight into mathematics gaining momentum due to government policy and therefore, more funding being provided to develop the subject in schools, which Emma perceived as an empowering experience:

> *… that maths is gaining more importance … I think we are in challenging times but I think it is exciting and I think that will cascade and come across to hopefully it is important you know it's not the case of, oh no I can't do maths, no let's find ways … there is a big influence from the government okay, might be because the results are poor but …, it's brilliant because we are getting funding and I think that is the big plus, a big plus.* (Emma)

Sally reflected on working with adults and the 'hang-ups', she perceived them to have with the subject:

> *I think working with educators, I see a lot of hang ups much more from staff than from kids and I think I want to make staff realise that actually they can, they are able to teach maths … I tend to be really enthusiastic and way over the top when it comes to maths. … I think it is this whole kind of idea that everyone can achieve which I think is a thing that really has the difference from when I started as an NQT when it was like oh you've got your lowers, and they can't achieve, well actually everyone can achieve you just have to give them scaffolding to do it. And I think that is where the difference in my attitude is now.* (Sally)

Sally's extract illustrated her reflecting on personal experience, that adults had more 'hang-ups' with the subject than pupils. Her reflections suggested her enthusiasm for the subject now supported her to engage colleagues in enriching learning opportunities and therefore making a lasting impact on the school provision for mathematics. Sally noted her trajectory of when she was an NQT, the attitudes she noted towards the subject. Now, through her experiences of becoming a leader in mathematics, she had a greater understanding of making mathematics accessible for all.

Sandra and Daisy, similarly to Sally, discussed adult anxieties and the need to develop positive reinforcement for adults as well as pupils to develop better attitudes towards mathematics:

> *…the whole maths anxiety thing is huge. I think it is huge for teachers trying to teach it if they don't understand it. Fear stops people and I think anywhere that you can really encourage and you can say you can do.* (Sandra)

> *I still see that a lot of people struggle, teachers struggle often teachers come in and they will say, oh my specialism is English … we have recently recruited most of the teachers, in fact all of the teachers that we had for this particular post specialisms, not maths and that I find is quite upsetting …* (Daisy)

Sharon provided context to her learning journey and reflected on how she could continue to develop her expertise within mathematics to strengthen her subject knowledge. This could be interpreted as Sharon continuing to reflect on her ways to develop her learning and teaching of mathematics and it being a lifelong process:

> *I think the more you learn the more you realise is still to learn so I feel a huge obligation to keep building my skill set and my knowledge, … my daughter who is 16 and just about to sit her GCSEs came flouncing down the stairs the other day and showed me some mathematical hieroglyphics on the page and said can you show me how to do those and I looked with shame at the piece of paper and said no darling, I don't know how to help you with that … I was acutely aware of the limit of my subject knowledge … it's made me think that perhaps I do need to go a bit deeper and I have an obligation to the students that I teach to continue to develop my subject knowledge.* (Sharon)

Roseanne mentioned the notion of developing strong learning communities and enabling a resilient attitude for the learning and teaching of mathematics. Furthermore, she emphasised, the need to remove labels when it came to mathematics education and this being the only way to open up opportunities to further understanding and developing the mathematics capital needed.

> *… very passionate that actually all children can learn maths. Very passionate that children should not be labelled, … yes there are some children with special needs, yeah, but there are a lot of children that have had some poor maths teaching and that is not the maths teacher's fault that is the system's fault that a lot of us coming through school with poor maths teaching … I am not very confident, can someone help me without judging me. They say, well you are not a good teacher, you are not an outstanding teacher, oh yeah, we will help you, lets change our attitudes, let's just make maths good for everyone, … let's get parents, when we are doing a maths workshop, parents saying, I really wanna go to that, that will be good fun and I can go to that even if I don't feel very confident in my own maths … changing those whole attitudes, very much about when I put Coronation Street on like I did this week I don't want to hear that the little boy does not want to go to school because it is maths … So when people come in here [pointing to her Mathematics Hub], I am not an expert, I am not going to take you into my lesson … I will work together with you and … we will both learn.*
>
> (Roseanne)

Roseanne's reflections detailed her vision of enabling learning space for the whole school community to elevate the learning of pupils in her care. It is worth noting that Roseanne's school was situated in a challenging socio-economic area and therefore, her data illustrated her heightened sense of responsibility to make a measurable difference through improving the learning and teaching of mathematics.

Michelle had similar arguments to Roseanne, in not making assumptions about her expertise and explicitly stating that although she had a set of knowledge and skills in mathematics there was still a lot to develop and learn, re-emphasising this notion of learning being on a continuum and lifelong.

> *I think generally I feel quite enthusiastic about the subject, so I think when I am working with other people hope that my enthusiasm rubs off. I also would not say that I have confidence, even having done the MaST course that my own subject knowledge, I still feel that is very*

> *much a work in progress, so I don't feel because I have done LMT work I know everything about maths …* (Michelle)

Whereas Belinda's data contextualised how she felt about mathematics by shaping the narrative from the perspective of her current role and enabling trainee teaching to develop a set of skills that empowered them to have a love for the subject and critically examined the curriculum appropriately. Belinda's data revealed this to be a key attribute she developed whilst transitioning from being a primary teacher into becoming a PMaST and now a leader in mathematics teacher education:

> *I feel as though thinking mathematically is so much more important than attaining mathematically if that makes sense. … I talk about with my students is kind of a parallel purpose to maths teaching, you have got the one thing which is at the end of the day your children need to achieve their year 6 SATs and they need to be able to go on and do their GCSEs and we may not agree with the hoops they are jumping through but there is that but what you are trying to create is somebody who is able to go into the world and solve problems confidently and happily rather than go into the world and see something and need one method, and they can't necessarily remember sums they can't do, you see what I mean, so that is kind of how I see maths.* (Belinda)

To conclude, the data revealed that all the PMaSTs had mixed views about how they saw mathematics now and their role within it. However, they had mathematics at the heart of their identity as an educator, throughout their career trajectory. The data illustrated a passion for making the subject accessible for adults they were working alongside, be that in schools, Hubs or HEI for this to have an impact on pupil outcomes. The notion of mathematics and opportunity will be expanded upon in the next section. The notion of learning being a lifelong process, supported by CPD came across strongly in the data, suggesting their mathematics learning trajectory would continue in whatever phase of learning and career they may be in.

6.3.1 Mathematics, attitudes and opportunity

All PMaSTs agreed that mathematics learning and teaching was intrinsically linked to building opportunities later on in life and as a means of social mobility. They highlighted building and fostering positive attitudes towards the subject as well as developing expertise in schools through mathematics leadership opportunities and high-quality CPD, accessible to all, to foster a love for mathematics and instil pupil confidence, so that the pupils can pursue mathematics confidently at a higher level. Indeed, this could be suggested to help bridge the growing gap in the number of young people pursuing mathematics at a higher level.

Over fifty per cent of the PMaSTs elaborated on their role and how they continued to work with colleagues, parents and pupils to foster positive attitudes in mathematics. They saw this as a vital aspect of building capacity and mathematics capital both at a school, local and national level. Reece's extract below summarises the collective voice of the PMaSTs well:

> *I think just that I still feel quite sad when people you know, teachers especially will turn around and go I don't think I can teach year 6 maths and that worries me … I can't teach the maths whatttt … you know and parents who say I can't do maths you know society as a whole it is still acceptable to say I can't do maths … I was that person so I have changed and I keep trying to change it and we have a real growth mindset I can't do maths, we can't do maths yet, … we are trying to change the mindset of children … so children know there is a journey.* (Reece)

An additional observation from the data, linked to these attitudes, is that of pupils building a negative attitude and the triggers for this. Many PMaSTs saw this emerging early in secondary education, where the learning was amplified and had added layers of challenge. The PMaSTs concluded that the ways and approaches to teaching mathematics in secondary school could be restructured to create better and meaningful access to the subject:

> *I don't think we are shown at secondary how it [maths] can move into our adult life.* (Nicola)

> *I worry that it's still acceptable that maths is less important or its okay not to be able to do maths than and we would not say I can't really read or write properly but it's okay to say I can't do … I think that something happens, often at secondary school that turns children off maths … there is still scope to look at maths in a creative way that perhaps secondary school maths teachers don't have the scope to do.* (Sharon)

The PMaSTs added ways mathematics could be taught and should be taught to foster positive attitudes and build a love for the subject. The data suggested they felt this could go towards fostering positive attitudes within the subject for future generations. Belinda illustrated the views of how mathematics is taught and how this could be seen as hindering opportunity for pupils. She elaborates on this:

> *I think there is value in achieving exam results and you need to have achieved certain exam results to be able to progress. I don't think there is value in thinking mathematically and reasoning and thinking and problem solving I don't think that gets valued at all. I feel as though that gets worse as you go into secondary school …* (Belinda)

Belinda further emphasised the point of how secondary school learning and teaching of mathematics needed a shakeup so that when pupils leave school they have a good understanding of mathematics to potentially pursue further mathematics related courses.

The PMaSTs emphasised and provided examples of how their confidence and achievement in mathematics was linked to future advancement and job opportunities. They saw this as an essential factor to rationalise the work they continued to do with colleagues and pupils. The PMaSTs also suggested that the way CPD was currently distributed, may create inequality of access for teachers and therefore had a direct impact on pupil outcomes:

> *Within the education world I would suggest that there is a level of inequality at the moment so in terms of some practitioners getting access to a lot and others access to very little*

> *whether that be in terms of CPD … or whether it be in terms of what schools have available to them to support maths teaching and learning I would say there is a strong inequality with some that have and some that don't have.* (Gregory)

Emma's data below exemplified the notion of opportunity created by developing successful mathematics learners and how, if this opportunity was not available, could hinder future job prospects:

> *I do think now with going into University education … and he [Son] did maths and … realising how it opens doors … so I think maths has become so important because they realise it is opening doors … I think it does give opportunity not quite sure I am a bit worried about the social justice bit because I am worried about whether there is that equality now because of cost of education is suddenly become a barrier I think you know, there will be a lot of children who won't have those opportunities which is a shame.* (Emma)

Emma's personal experiences highlighted how, as a PMaST, she saw mathematics providing access to greater opportunities in adult life, exemplifying this with her son's education. She further suggested that a lack of opportunity was developed by negative attitudes towards mathematics, further exacerbated with the costs involved in building educational capital, leading to inequality of access to resources within the learning and teaching of mathematics. Additionally, PMaSTs expressed concerns that the school environments did not necessarily reflect the importance of mathematics as much as, e.g., English, therefore this unintentionally created a bias towards the subject:

> *If you look around the school English is everywhere … maths isn't unless you look for it. … I do think its profile could do with being raised. Certainly in school, certainly in primary school.* (Thomas)

> *I was listening to a speaker,… they were talking about the idea that a maths education is a basic thing …you go through and at some point the maths gets too hard and you drop out. The person who was presenting their research had a different slant on that idea and was saying actually because of the way we teach maths you drop … it is not so much that you can't do it but you have not been supported to do it, so it still works as a selection process but it is not because of your capabilities in maths it's to do with the way we teach it … basically whether it's because they can't do it or can do it is another matter but they get fed up.* (Belinda)

This observation from a research presentation that Belinda attended suggested, through Belinda's reflections how she perceived approaches to the teaching mathematics creating barriers rather than pupils not engaging in the learning process. Belinda further suggested that disengagement in mathematics was less to do with pupil 'capabilities' and more to do with the way 'we teach' mathematics.

Another aspect mentioned by one PMaST suggested the impact of negative attitudes was the role of media. Roseanne described this as:

> *I think you know the media have got a huge responsibility with this, they keep on portraying maths either negatively, no its hard it's too hard, its geeky, it's boring, which is affecting the whole nation and that is shameful and that does need to stop …* (Roseanne)

Throughout the interviews, the PMaSTs emphasised how they develop and fostered positive attitudes and 'can do' attitudes with pupils and colleagues to build the mathematics capital in their schools and further afield.

> *…so one of my firm beliefs is where there is a will there is a way, so if you are wanting to do that learning then you can … you know we are giving them the groundings to do that.* (Daisy)

> *I can't do maths and … I was that person so I have changed and I keep trying to change it and we have a real growth mindset … I can't do maths, we can't do maths yet, we can't do it yet, of course, we can't we are learning you know we will learn and we will try and we will get better at it … so we are trying to change the mindset of children.* (Reece)

Finally, some PMaSTs reflected on the repositioning of mathematics they are witnessing in society giving them hope that attitudes were being realigned and, given more time, there could be a positive change in how mathematics was perceived and taught. Michelle reflects on this as:

> *I would say there are two sides to it because there is, on the one hand, certain people who would be happy to say that they hated maths at school and could not do it but on the other hand, there are some parents who are very supportive and enthusiastic and really value maths and kind of acknowledge that you know career-wise a lot of very successful financial, you know accountants or bankers or medics, a lot of, you know very successful professionals need maths and are good at maths, so there are two sides to it.* (Michelle)

It can be concluded that the PMaSTs, at the stage they were in their career, still felt that there are entrenched ideas around mathematics learning and teaching which were personified by the role of parents, carers, teachers and media. This was further complicated by how mathematics was valued in learning spaces in schools. The PMaSTs further highlighted mathematics bringing societal change and opportunity for individuals, so it was not an option to continue on a negative trajectory of attitudes in the subject. Their self-reflection of being in similar situations to those that they witnessed with some pupils' and adults' attitudes showed a sense of frustration that attitudes had not shifted and continued to develop negatively. All the PMaSTs provided instances of how they passionately continued to advocate for the subject through example, either in their current role as a PMaST or through their new leadership roles.

6.4 Chapter Summary

This chapter aimed to provide context from the collected data on sub research question 3:

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

All the PMaSTs continued to champion mathematics in schools. Some had diversified their roles in school leadership and had strategic school improvement responsibility. The data suggested these individuals had a particular drive to provide equality of opportunity for mathematics in their schools so that it was seen as an equally important subject and given the same weighting as subjects like English. Furthermore, there were some PMaSTs who had expanded their roles and now worked for Mathematics Hubs, delivering mathematics training to teachers. The nature of their roles enabled them to work on a local level to train teachers, with one PMaST working at a national level at a local Mathematics Hubs. Some PMaSTs had moved onto training teachers and saw their new roles as increasing their scope and impact of building mathematics capacity.

Additionally, the PMaSTs had mixed views about how they saw themselves now and how the transitions in their careers had enabled them to develop this notion of self. The majority felt that their career trajectories had enabled them to move on from being a primary teacher and they saw themselves firmly as leaders in mathematics. Only two PMaSTs still identified themselves as primary teachers whereas a further two felt that they had transitioned into strategic school leadership roles and had not entirely left the PMaSTness behind but had certainly felt they were transitioning from this role or had already done so.

Furthermore, many PMaSTs felt a sense of frustration on how mathematics continued to be perceived by society and how this hindered opportunity for pupils in schools. The way, they perceived, mathematics being taught in secondary schools was revealed by over fifty per cent of the PMaSTs as being the main factor for pupils developing negative attitudes towards the subject.

Therefore, it is important to rethink how mathematics could be taught at secondary schools to further enhance positive attitudes and a love for the subject for pupils to pursue it at a tertiary level.

Finally, all the PMaSTs demonstrated a drive for mathematics, how they saw mathematics now had changed from the start of their learning journey and been redefined in line with their learning of mathematics and emerging identities as champions of mathematics. All this aligned with their learning trajectories in mathematics as well as developing their careers as PMaSTs, linking with their CPD opportunities and further opportunities encountered within their careers, to date. All the examples communicated an outstanding belief in building and fostering mathematics capital by developing and driving attitudinal changes towards mathematics.

Chapter 7 Discussion

7.1 Introduction

This chapter sets out an analysis of the findings of the narrative data explored in chapters 4, 5 and 6. The data in each chapter were themed to explore and relate the findings to research sub-questions 1, 2, and 3 respectively. Therefore this chapter will follow this structure and discuss the data, linking it to the literature from chapter 3 and relating it to the theoretical and conceptual ideas framing this study. The final section of this chapter will summarise the theoretical contributions made by this thesis on the transforming identity of primary teachers into PMaSTs.

The study set out to understand the career paths of primary teachers in England who became PMaSTs. Theories linked to identity development, career progression and professional learning (Ibarra, 1999a, 2004; Illeris, 2014; Lave & Wenger, 1991; Wenger, 1998, 2000, 2004; Wenger et al., 2011) were drawn upon to understand the complex nature of becoming a PMaST. Using a narrative approach enabled the collection of rich data to analyse and understand the experiences of the PMaSTs (Bruner, 1991; Kaasila, 2007). The socially constructed nature of the PMaSTs was developed in the crucible of their personal and professional journey with mathematics learning and teaching. This suggests that PMaSTs' identities are socially and historically shaped; they are not factually based or ridged realities but instead change as social constructions.

This framework has gone some way in enhancing our understanding of, and contribution to, knowledge in the area of mathematics identity, allied to primary teachers' professional learning and career paths as PMaSTs in England. This is important because several recommendations to the government (ACME, 2016a, 2016b; Vorderman et al., 2011; Williams, 2008) have re-emphasised the importance of professional learning and developing experts in mathematics at primary level to champion the subject. The notion of identity development is rarely defined in these recommendations and thus a neglected idea. This thesis, therefore, hopes to add to this body of knowledge.

Following on from the conceptual framework, the following research questions have been addressed:

The main research question undertaken by this thesis was:

How do biographical processes and experiences shape identity developments and career trajectories of primary teachers who become PMaSTs?

To address this main research question, the following sub-questions were posed:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMaSTs?

SQ2: How do primary teachers describe and understand their experience in the role of a PMaST?

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

7.2 The professional and personal circumstances that lead to primary teachers becoming PMaSTs (SQ 1).

The research results demonstrated that a variety of circumstances and opportunities led the participants to develop into PMaSTs. Their experiences of learning mathematics, and how mathematics was perceived within their social structures and educational setting, had a profound and lasting impact on their construction of a mathematics identity. Key aspects of the findings are explored, linking them to the literature in the field and drawing conclusions to understand the lived experiences of the PMaSTs in this thesis.

7.2.1 Early experiences of mathematics

Home life had an impact on how all of the participants built their identities as mathematicians. The majority of them discussed being immersed in mathematical environments, giving examples such as

how the household budget was managed, shopping with their parents and developing an understanding of arithmetic processes (McMullen & de Abreu, 2011; O'Sullivan et al., 2014; Schnee & Bose, 2010). These experiences were complemented with learning mathematics in schools through exposure to immersive mathematical activities, such as roleplay, that associated mathematics with real-life activities. One PMaST experienced immersion in mathematics through both parents learning mathematics to pursue careers in the subject (McMullen & de Abreu, 2011). This lived experience of mathematics at home provided a real sense of pride and confidence in the learning and teaching of mathematics, an enthusiasm that continued to grow throughout the career of the PMaST.

Participants also recalled examples of helping, either parent helping with homework themselves or providing support through tutoring (O'Sullivan et al., 2014). This illustrated an understanding from the parents of the importance of the subject and support needed for the PMaSTs to be successful at it. Additionally, getting this extra assistance also suggests confidence in their child, as well as having the finances to impact in this positive way.

These findings indicated home influences played a pivotal role in nurturing a relationship with mathematics, thus contributed to the development of the core identity and the personality layer of Illeris' (2014) model. The findings support the notion that social interactions and family aspirations support the building of a mathematics identity (McMullen & de Abreu, 2011; O'Sullivan et al., 2014)

The study confirmed that school experience was associated with mathematics identity development. The PMaSTs shared vivid memories of experiences in school and their impact on developing their mathematics identity. The majority provided specific critical moments that led to mathematics becoming abstract in school and thus becoming disengaged with the subject or how a teacher's treatment of them in school, in front of peers, created a sense of anxiety and thus barriers for future mathematical development. These results are consistent with those of other studies (Dowker et al., 2016; Grays et al., 2017; Moustafa et al., 2017; Skagerlund et al., 2019) and suggest that school

experiences have a lasting impact on the development of a positive mathematics identity (Boaler, 2009). The description of negative experiences ranged from being good at mathematics and marginalised by being given a textbook to work from, with little or no teacher instruction, to being singled out in front of the whole class for not getting a calculation right or doing a task in a way that the teacher did not teach and having the work destroyed. These instances shared some parallels with the work of Darragh (2015), confirming that the learning environment played an integral role in the development of a mathematics identity. Furthermore, life experiences can also be drawn upon to understand the anxieties a teacher might face, with a lack of confidence in mathematics leading to inflexible teaching methods. This example resonates with the work of McCulloch et al. (2013), where teachers experienced anxiety when it came to teaching mathematics because of their own lived experiences in learning mathematics. However, as in the findings of McCulloch et al. (2013), this research has also illustrated how negative learning experiences of mathematics can be used positively, with PMaSTs drawing on their negative experiences to facilitate positive learning spaces for their pupils. Therefore, an important finding of this research is how negative experiences can be drawn upon to create learning opportunities that support, nurture and develop positive attitudes towards mathematics. Thus illustrating, as Povey (1997) suggests, going from a 'position of silence, or disconnection with mathematics, to a position of authority, a belief in his/her active role in the construction of mathematical knowledge' (p.471).

It is encouraging to note the transformative nature of a mathematics identity from negative to positive. The support and encouragement of a teacher or group of teachers within a class community of learning was key to building a positive mathematics identity. The majority of participants developed individual agency in mathematics because of the way a teacher engaged them in understanding mathematics. This enabled them to make meaningful connections to transform their perceptions towards the subject. Thus, this enabled the PMaSTs to go from a point of anxiety (Wilson, 2018) to a point of believing in themselves as 'mathematicians' (Taylor, 2009).

Another key finding was the experiences of the PMaSTs transitioning to secondary schooling. The majority of PMaSTs recalled this as a daunting experience and one PMaST compared it to being spoken to in 'Japanese', demonstrating a deep disconnection with the subject (McCulloch et al., 2013). This highlights the fragility of identities and how teaching approaches shape them, over time. These findings corroborate those of previous work done with secondary pupils in mathematics finding that the subject was not making sense and having anxiety with learning mathematics and therefore developing a negative image of the subject (Picker & Berry, 2000).

One unanticipated finding related to a confident mathematicians' memory of answering questions in secondary school and, initially, feeling proud of this achievement. However, after being 'teased' for doing this, the participant consequently decided not to make further contributions. This finding has clear implications for developing a positive culture of peer interaction, as defined by the study of Darragh (2015) and learning from each other rather than being ridiculed for being good at something. This crucial finding illustrated the importance of developing authentic and meaningful approaches to shape pupil experiences and therefore their mathematics identities (Darragh, 2015). This would be particularly beneficial in mathematics due to how mathematics is perceived and the decline in mathematics confidence that is documented at secondary schools.

Studies by Jo Boaler indicate the negative effects of grouping in mathematics (Boaler, 1997, 2009, 2014; Boaler et al., 2000). The findings of this research confirm the association between grouping by ability and the development of negative attitudes towards mathematics. The majority of the PMaSTs indicated a lack of agency in secondary school and the main reason was given for this was grouping. Furthermore, PMaSTs elaborated on the perceived unfairness of grouping, such as being put into sets according to when they were born (summer born, lower groups) without understanding the needs of pupils and hence their capabilities (Anderson et al., 2018). The significance of this is strong, as pupils, no matter how young, know if they are put in a 'lower group'. Therefore, this research supports the work already in the field, carried out by Boaler (1997); Boaler et al. (2000); Francis et al.

(2017). This study confirms the detrimental effects of ability grouping on pupil belief and pupil identity development as mathematicians, and schools need to be challenged to reconstruct ideas around grouping and how learning environments are developed to facilitate the teaching of mathematics.

The findings show that even when the PMaSTs were put in high groups for mathematics, they experienced a sense of dissatisfaction with their treatment by the teacher. The clear articulation of these memories shows how much grouping affected the PMaSTs and, therefore, informed their identity as a mathematician. It is appropriate to suggest that addressing grouping in mathematics at both primary and secondary level would support positive change in how mathematics is perceived by the learners.

7.2.2 Learning mathematics as an adult

A strong relationship was found between building agency towards mathematics whilst relearning mathematics as an adult. A quarter of the PMaSTs had to gain mathematics qualifications as adult learners. The motivation for gaining the mathematics qualification stemmed from wanting to pursue a career in primary teaching.

The data demonstrated the powerful impact individual teachers had on the PMaSTs and their confidence levels when relearning mathematics as an adult. Drawing on and supporting the findings of Palmer (2009), the evidence substantiated the power of developing learning through the social interaction between the community, self and knowledge to realign one's understanding (Wenger, 1998, 2000). One reason for this could be explained as being in non-traditional learning spaces such as evening classes and, more importantly, being with fellow students who have had similar experiences with mathematics learning. This may be due to a sense of community developing (Wenger, 1998, 2000) within the learning space but also an underlying connection with peers because of their previous collective experiences with learning mathematics (Hodgen & Askew, 2007).

The success of this learning is exemplified in the high scores achieved by PMaSTs and the way they describe their teachers. Many participants used terms such as 'amazing', 'empowering' and 'transformative' when describing their teachers and reflected upon why these feelings did not emerge whilst they were in the schooling system. This supports the notion of mathematics being a subject that can be mastered, with appropriate scaffolding and support (Anderson et al., 2018). Redeveloping their knowledge in spaces that supported their learning enabled the participants to experience successful reconstruction of a mathematics identity (Berger & Luckmann, 1966). It could therefore be suggested that although it is accepted that the way adult learning is structured is very different to the structures of secondary schools, lessons could be taken from the way learning communities are nurtured and developed to enable successful mathematics learning (Lave & Wenger, 1991; Palmer, 2009; Wenger, 1998).

7.2.3 Primary teaching and early career development

Out of the twelve participants, half took a traditional route into primary teaching (either through an undergraduate or a Post Graduate course), whereas the other half either changed career or started by volunteering in their children's schools and were then talent-spotted and encouraged to pursue a career in primary education. These experiences were seen by the PMaSTs as a powerful endorsement of their potential and, therefore, had a positive impact on their self-belief. Critical moments were revealed by many participants who were offered an opportunity to build a career in teaching. For example, one participant who had a non-traditional route into teaching was spotted by an Ofsted inspector, who recommended that the senior team should support her journey into primary teaching. This transformation in identity, shares parallels with Ibarra's (1999b, 2004) working identity, where individuals reinvent themselves throughout their lives. In this case, the participant undertook an extensive programme of redevelopment, starting with a Foundation degree to become a teacher and thus realign their working identity.

The data showed that those PMaSTs who pursued a more traditional route into teaching had a career in teaching at the heart of their motivations and did not consider becoming a mathematics specialist when deciding on a career in primary education. However, the surprising aspect of the findings, for this thesis, was that all of the PMaSTs' talent for teaching mathematics was recognised very early on in their careers and were accelerated into a leadership role in mathematics, thus illustrating the point made by Illeris (2014) regarding flexibility in developing an identity and adjusting to professional and social situations. Furthermore, the findings also substantiate Chen's (1998) insight into stages of career development, where the PMaSTs had demonstrated their career development as life processes, individual agency and meaning-making. For some of the participants, this leap into being a PMaST came as a surprise to themselves, as they had never considered that being a champion of mathematics could be an integral part of their identity as a primary teacher.

Another important but unusual finding of this thesis is how all the PMaSTs initially had little or no desire to pursue a career as a specialist teacher of mathematics. They described 'stumbling' into becoming a mathematics lead and the role professional learning opportunities and support of colleagues played in building a mathematics identity and continuing to champion mathematics through their career trajectory (Ibarra, 1999b, 2004; Lave & Wenger, 1991; Palmer, 2009; Skott, 2013; Wenger, 1998). This key finding described a new construct of being seen as a mathematics expert, not driven by self-belief nor enthusiasm for the subject, but facilitated through leaders seeing the potential in individuals and nurturing that potential. Therefore, the PMaSTs' interaction with the personality layer, and more readily through the preference layer of their identity development (Illeris, 2014), played a key role in their realignment as a PMaST (Bjuland et al., 2012). Additionally, community, in the shape of colleagues and family supporting their development through formal coaching and mentoring opportunities and informal discussions and advice, enabled the participants to conceptualise themselves as PMaSTs. Although their core identity suggested they had no desire to become a PMaST, interactions within their personality and preference layers enabled them to see themselves as a PMaST (Illeris, 2014) and the whole process being supported

by community activity (Goos & Bennison, 2008; Graven & Lerman, 2003; Wenger, 1998, 2000) and structured learning opportunities to reinvent as a PMaST (Ibarra, 1999a, 2004). This finding confirm and support previous findings from the work of Bjuland et al. (2012) and Palmér (2016). Further analysis of the implications of this for primary teachers' career development will be explored in the second section of this chapter.

The results share an aspect not exemplified in defining a specialist teacher of mathematics, in that the majority of the PMaSTs (ten out of the twelve) mentioned that they struggled with their mathematics learning. This resulted in a heightened sense of sensitivity and empathy for pupils who struggled with mathematics, tapping into their own experience of anxiety when they were in school. This sense of empathy led to each of them developing a greater sense of awareness of utilising innovative approaches for teaching mathematics by creating positive learning cultures in their classrooms, as well as in their schools and local areas, through developing positive communities of mathematics teachers and learners (Goos & Bennison, 2008; Graven & Lerman, 2003; Lave & Wenger, 1991; Wenger, 1998, 2000). From all participants, there was a real sense that building their pupils' mathematical capital was key to their sense of identity as a PMaST and as a primary teacher.

7.2.4 Summary of section

This section has provided an analysis of the data, linking it to the literature, to provide an answer to sub-research question 1. Although these findings will doubtless be further scrutinised, there are some immediately dependable conclusions regarding how individual experiences, both as a learner of mathematics and an educator and champion of mathematics, enable a rich development of a mathematics identity. Within this identity formation, the role of individuals through the community, seen through the lens of home, school and work proved to be either enablers or disablers in developing a rich construct of a mathematics identity. Furthermore, formative experiences of professional learning played a pivotal role in supporting an identity as a PMaST. Therefore the theoretical ideas of Illeris (2014), where a layered identity plays a part in understanding individuals,

are shown to support the emerging identity as a PMaST. The ripple effect from the core identity into the personality and preference layer illustrated how PMaSTs use the opportunities afforded to them, through the course of the trajectory of being a student of mathematics into becoming a teacher of mathematics.

To summarise, the lived experiences of the PMaSTs' trajectories with learning mathematics have left lasting legacies of what mathematics is and what it means to them. These experiences have evolved, through constructing, deconstructing and reconstructing an identity as a mathematics learner and the journey to becoming a teacher of mathematics thus creating a new identity as a PMaST. All aspects of this identity formation have been enabled by the powerful role community played in balancing out mathematical attitudes and success in engaging with pupils and teachers to enact change in attitudes in the teaching and learning of mathematics as a PMaST.

7.3 The PMaSTs' perceptions and experiences of being in the role of a PMaST (SQ 2).

The PMaSTs' change from being a primary teacher to leading mathematics teaching is drawn upon in this section, paying particular attention to the professional learning opportunities available to them in constructing a strong sense of identity as a PMaST. This section particularly hones in on key moments in the participants' careers that led them to see themselves as PMaSTs and influenced their belief that they could play a significant role in embedding positive attitudes towards mathematics at a micro (school and class) level, and often at a macro (local and national) level. The role of key individuals, who were noted as significant role models in their career development is expanded upon to form a picture of the network of individual connections that shaped the professional identities of primary teachers into PMaSTs. Finally, the factors that proved to be limitations to advancing careers are drawn upon to firstly understand the factors that supported their emergence. This allowed barriers to be identified and minimised in the future career aspirations of primary teachers wanting to become PMaSTs.

7.3.1 Professional learning (CPD) as a PMaST, enabling the building of a mathematics identity

It is encouraging to note that all the PMaSTs provided extensive narratives on professional learning opportunities that enabled their development as a PMaST. Significantly, eight out of the twelve PMaSTs in the study recalled the substantial capital investment of the National Numeracy Strategy (NNS) and the influence this had on their teaching of mathematics very early in their careers (McCormack et al., 2006). The support discussed by the PMaSTs from the NNS was three-fold: one related to courses that they went on to develop their subject and pedagogical knowledge in key areas of mathematics; the second, the networking opportunities of the courses enabling a community approach to learning and therefore further collaboration outside of the course; and finally, the interplay between the local authority consultants, running the courses, coming into schools and supporting the PMaSTs post-course (Van Zoest & Bohl, 2008). All these aspects strengthened confidence levels (Povey, 1997) and provided a tool kit for the PMaSTs to successfully transition from a primary teacher to being a PMaST. Therefore, for a primary teacher to successfully transition into a PMaST, CPD and support from colleagues (Hodgen & Askew, 2007) and experts is a key factor in successfully constructing an identity as a PMaST.

Ten out of the twelve PMaSTs undertook a professional learning course at Masters level called the Mathematics Specialist Teacher (MaST) programme (Williams, 2008). Out of the remaining two participants, one was a qualified Every Child Counts (ECC) teacher, a qualification that required Masters Level study, and the remaining PMaST had completed a Masters, but not in mathematics. Two key observations can be made here: firstly, any individual undertaking further study whilst working full time has proven motivation to build their pedagogical and subject expertise (Copur-Gencturk & Lubienski, 2013; Copur-Gencturk et al., 2019) to further their career development, this is discussed in detail in the conceptualisation of careers and changing careers over a lifetime, through the work of Ibarra (Ibarra, 1999b, 2004). Secondly, a significant transformation in the PMaSTs undertaking and completing a MaST or ECC qualification gave them a concrete sense of achievement

and belief that they are the experts in mathematics. Thus further strengthening their position within their learning communities and backing the values of Shulman's (1987) framework of Subject Pedagogical Knowledge (SPK) to broaden and expand their professional skills and identities. Furthermore, empowerment, through professional learning, mirrors the work of Povey (1997), with the PMaSTs repositioning themselves as mathematics experts, thus realigning their identities from a novice to an expert teacher of mathematics (Dreyfus, 1982; Dreyfus & Dreyfus, 1980).

Working with other PMaSTs and networking whilst attending courses further emphasised the value of a community of learners and the value of thinking, discussing and reconstructing ideas of teaching and learning mathematics (Goos & Bennison, 2008; Wenger, 1998, 2000). One final aspect of the MaST course worth noting as singled out for good practice is the strand of coaching and mentoring as the PMaSTs who took the MaST course, saw the value of developing the coaching and mentoring skills to sustainably develop capacity in their school. This finding links with research into successful models of professional learning starting from self and working outwards, through engaging and networking within a community of PMaSTs to inform change (Goos & Bennison, 2008; Graven, 2004; Lave & Wenger, 1991; Palmer, 2009; Skott, 2013; Van Zoest & Bohl, 2008; Wenger, 1998). To summarise, the participants saw themselves moving from a novice to an expert, specialist teacher, through the variety of CPD opportunities they experienced (Dreyfus, 1982; Dreyfus & Dreyfus, 1980).

7.3.2 Developing into a PMaST. The opportunities and challenges within the PMaST communities.

The PMaSTs highlighted a range of ways that their careers emerged as a direct consequence of training as a PMaST and the professional learning opportunities that this opened up (Darragh, 2015). This led to high rates of return for the teachers they were working with and, most importantly, had an impact on the learning opportunities of the pupils, therefore enacting notions of emerging identities as mathematics specialists (Bjuland et al., 2012).

The findings conclude that being a PMaSTs supported the participants to move into more strategic leadership roles. This finding resonates with the work carried out by Skog and Andersson (2015),

who detailed the nature of positioning and the command this perceived for mathematics, played a part in developing teacher expertise and therefore their future career opportunities. This can be exemplified by the PMaSTs now working in positions that have moved them further afield from primary schools and the traditional classroom setting (Chen,1998) such as consultancy roles and national leadership roles in the embedding of mastery (Ibarra, 1999a, 2004). A small number of PMaSTs had left their role as PMaST and taken up other key leadership roles, such as deputy headship and headships. These transitioning identities (Chen,1998; Ibarra,1999a,2004) provides valuable context to how the diverse professional learning opportunities and growth experienced in the role of PMaST, not only enabled participants to champion mathematics but also supported their leadership growth thus, refining their toolkit of skills required to take up strategic leaderships posts beyond mathematics (Peavy, 1993). Furthermore, three PMaSTs successfully transitioned into ITT, directly as a result of having close links with the universities they are now based in (Sparks & Hirsh, 1997). These findings re-emphasise the value of professional learning assisting the development of knowledge and skills to successfully undertake a job and the role a strong community plays in further career development (Berger & Luckmann, 1966; Ibarra, 1999a; Luckmann & Berger, 1964). Finally, even when the PMaSTs moved into new strategic roles, they carried their mathematics skills with them, especially when moving into positions such as a Headship. This demonstrated the strong formation of a professional identity as a PMaST and the stages and interactions involved in building this complex identity (Collopy, 2003; Philipp, 2007).

7.3.3 The influence of individuals and community in developing or hindering the development of the PMaST

The results show that all the PMaSTs involved did not set out to become PMaSTs they could be classed as ‘accidental mathematicians’. This conclusion was unexpected and suggests that, with the right encouragement, guidance and professional learning opportunities, any primary teacher has the

potential to develop their expertise in mathematics (Bibby, 1999; Copur-Gencturk & Lubienski, 2013; Copur-Gencturk et al., 2019; Harris et al., 2011; McCullouch, 2016; Sztajn et al., 2007). This finding confirms the assertion that identity is a construct and, as Illeris (2014), suggests, that although one has a core identity that is relatively static and stable, the personality and preference identity can be moulded and constructed in line with external situations. The evidence further suggests that to develop the skills to become a PMaST, the backing of senior leaders is essential because they see the potential in individuals to develop the role and therefore support further career aspirations (Day et al., 2006). There is a word of caution here - at times, some PMaSTs felt that they stumbled into the role because senior leaders had no other choice and felt the role was given to them because there was no one else to take it. Nevertheless, once in the role, appropriate CPD opportunities were put in place to enable development (Rhodes, 2006).

Another aspect that encouraged growth was having a mentor and/or coach who supported the participants in shifting their identity to become a PMaST (Sztajn et al., 2007). This was illustrated through the MaST course and the link between university teaching with local authority leads (mentor/coach) who acted as mentors to bridge the theory and practice (Van Zoest & Bohl, 2008; Walker et al., 2013; Williams, 2008). This finding shows the importance of a mentor/ coach with whom the PMaST could discuss, refine and think through ideas within their learning journey, thus helping them to move from a novice to an expert (Dreyfus, 1982; Dreyfus & Dreyfus, 1980).

Whilst constructing the complex ideas of a PMaST identity, participants' experienced collective feelings of anxiety when working with colleagues. This was especially acute with colleagues who did not accept the pace of change in mathematics teaching and therefore very reticent to undertake and try out new ideas by the PMaST. Another aspect of this anxiety stemmed from being younger than the colleague and therefore being seen as less experienced. This supports the notion of self-confidence, of not being an expert and, at times, not tackling the behaviours of colleagues to inform change. The PMaSTs saw a change in confidence levels once they undertook further professional

courses and felt more confident in sharing their expertise. This finding correlates with the work of Hodgen and Askew (2007), Povey (1997), Bjuland et al. (2012) Shulman (1987), where the participants evolved from a place of anxiety to a place of confidence in developing as a PMaST. Therefore, it can be concluded that although at the time, the participants found the shifting identity as a PMaST challenging, they reasserted themselves through professional learning and sharing that learning with colleagues.

The PMaSTs mentioned some challenges whilst in the role. They experienced pedagogical frustrations when, at times, having fundamental disagreements with how mathematics was being taught. The challenge to change attitudes, including those of leaders and approaches, created professional disagreements and increased anxiety. The PMaSTs tackled this through 'leading by example', sharing approaches and developing a school approach to the learning and teaching of mathematics. There is a development worth noting here, as all PMaSTs felt empowered to tackle key issues in the way mathematics was being taught after they had opportunities to develop their professional skills - not just subject knowledge but also their role as coaches and mentors, empowering colleagues to teach mathematics in a way that enabled deeper connections (ACME, 2012, 2016a, 2016b).

Another important societal frustrations faced by the PMaSTs was the attitude of parents and how they personified negative attitudes around mathematics in front of their children (Mohr-Schroeder et al., 2017). Although they acknowledged that attitudes are slowly shifting, there is still a great deal of work to be done in this area.

The recent changes in educational policy have resulted in a reduction in funding with heightened demand for curriculum changes. Lack of appropriate support to ease into the new curricular demands has engendered a collective sense of frustration for the PMaSTs (Day et al., 2006). They all illustrated their dissatisfaction with the erosion of the LA and the implications this has had on CPD opportunities and funding as a whole. Furthermore, many voiced concerns about the new policy of

Local Mathematics Hubs, suggesting that, although the resource is available, it is not being utilised equitably, therefore creating strains between schools, limiting participation and creating further mathematics divides between regions (NCETM, 2017, 2018a).

7.3.4 Summary of section

This section has summarised the findings and linked them to the literature on what enabled the participants of this study to evolve into PMaSTs. It can be concluded that to construct the identity of an established PMaST, professional learning, through structured and sustained CPD, played an integral role in this transformation alongside the support provided through the PMaSTs' local mathematics community, as well as key individual leaders, coaches and mentors who helped the PMaSTs to bridge the gap from being a novice primary teacher to becoming a PMaST.

7.4 How PMaSTs' professional identity developments reshape values and future career goals?

The final section aims to bring together the experiences of the PMaSTs' in their current roles and how these roles have reshaped their values and future career goals. The nature of their role in championing mathematics is explored to further understand the PMaSTs' shaping of an identity and decision-making processes throughout their careers. Their reflections on how society perceives mathematics and the impact this has on future learners of mathematics and educators of the subject are drawn upon and linked to the literature available within the field. The analysis of their data has enabled conclusions to be drawn on the constructions of identities beyond that of a PMaST to understand what drives these identities to develop and flourish.

7.4.1 A transitioning identity- reshaping of professional roles

One of the most important finding from this study is that PMaSTs have a window of opportunity to transition their identity from a primary teacher into a specialists in mathematics. This finding is

encouraging because it confirms that, with the right support and professional learning opportunities, primary teachers who have previously had a negative relationship with mathematics and cannot see themselves as leaders of mathematics, can develop a successful career as PMaSTs (Bjuland et al., 2012). All the participants demonstrated this throughout their biographical reflections, from their earliest memory of learning mathematics to their current jobs (McCulloch et al., 2013). These findings enhance our understanding of primary teachers and assist us to recognise the learning ecosystems that could be nurtured for successful learning and teaching of mathematics both for the pupil and teacher.

The majority of the participants continued to champion mathematics within their current roles. Although a minority of participants had transitioned into school strategic leadership roles that removed them from being a PMaST, the findings demonstrated that once a PMaST completely transitioned into a new leadership role, their understanding of the structures of learning and teaching mathematics provided further depth to their strategic roles. An example of this can be demonstrated with one participant taking up a SENCO (Special Education Needs Co-ordinator) position and providing training for developing mathematics with SEND (Special Educational Needs and Disability) pupils. This finding supports the work on teacher identity of Kelchtermans and Vandenberghe (1994) where identity is shaped through self-awareness and thus their future self is influenced by their identity of being a PMaST. These findings further support the idea of how the PMaSTs' professional identities continue to evolve to champion mathematics throughout their careers.

It is somewhat surprising to note that the majority of the primary teachers in this study have now moved on from their PMaST role within primary schools but continue to champion mathematics in their new emerging roles. This finding is unexpected, as career trajectories of primary teachers in England usually see a move from middle (subject level, year group leadership) leadership roles to strategic senior leadership roles (Assistant, Deputy or Head) within schools, rather than continuing a

career as a subject specialist. This correlating with the works of Philipp (2007), suggesting that the PMaST identity is grounded within the context and therefore this context (mathematics) aligns their identity. It is therefore encouraging to note that the majority of participants now have roles that enable them to have an impact, not just on a school level but also on a regional and national level. This demonstrates PMaSTs having agency as champions of mathematics and evolving their careers as a champion of mathematics beyond the primary school (Chen, 1998). This informative finding illustrates Rhodes (2006) 'creative professional identity' (p.157) where individuals develop a deep sense of connection with their transformation into a role, in this case, a PMaST. This provides them with the confidence to follow this through beyond the immediate (primary school) context. A few factors can be drawn upon to explain these findings, one being the CoP (Wenger, 1998, 2000) the PMaSTs were connected with that enabled them to network and utilise the opportunities that came their way. Some PMaSTs took on positions in Higher Education (HE) to develop mathematics with trainee teachers as a direct consequence of networking with colleagues in the HE setting, through their professional learning networks. Others became local champions of mathematics after undertaking professional learning courses that allowed them to become lead trainers in the local mathematics hubs. A factor worth noting here is how the support provided by senior leadership was commended, in most cases, by the PMaSTs for allowing space and time to develop mathematics across the school and also providing funding for further CPD. This finding correlates, in part, to Harris et al. (2011) findings of the impact of CPD being felt most when participants are given time to try out and develop ideas in their learning spaces. Finally, a major factor in the success of the participants' mathematical journey was a determination and drive to change the tide on negative attitudes in the learning and teaching of mathematics. This supported the PMaSTs to make a lasting impact on a local, and national level to make and embed changes.

The study found that, generally, the PMaSTs confirm the findings of previous research into attitudes towards mathematics (Brown et al., 2008; Cotton, 2016; Ernest, 1988; Haylock & Manning, 2019). All PMaSTs provided examples from a personal, professional and societal perspective on perceptions

held around the subject. All participants confirmed that, although attitudes towards mathematics were slowly changing, there are still significant negative attitudes towards the subject within society (Dowker et al., 2016; Grays et al., 2017; Moustafa et al., 2017; Skagerlund et al., 2019). All PMaSTs saw themselves as ambassadors, who, throughout their careers to date, had worked to change these attitudes, starting with themselves and rippling out into their personal and professional lives.

Another important finding from this study was the narrative communicated by the PMaSTs on how the way mathematics is taught is inextricably linked to future opportunity. In other words, if a pupil goes through their schooling, with little or no success in mathematics, their chances of gaining appropriate qualifications in the subject are seriously hindered. This leads to pupils not being able to access further study that requires the basic GCSE qualification in mathematics. Furthermore, it hinders opportunity within the job market as all jobs require basic numeracy skills. The current findings add to the emerging body of literature on the role mathematics plays in the social mobility and future job prospects of an individual.

7.4.2 Summary of section

This section has summarised the findings and linked them to the literature on identity development and reshaping values and career goals after experiences of being a PMaST. It is therefore encouraging to note that PMaSTs take their experiences of being a PMaST to support the reshaping of their values as an educator to transition into new roles. This new identity development is supported by the structures developed whilst being in the role of a PMaST. Therefore concluding that the leadership role as a PMaST played a vital role in transitioning and reshaping into their future selves.

7.5 A theoretical contribution

7.5.1 The shaping of a PMaST Identity

This thesis has sought to understand how primary teachers in England become PMaSTs through the course of their teaching careers. An interpretive perspective, underpinned by social constructionism

was used to understand and theoretically frame how the lived experiences of primary teachers supported the construction of an identity as a PMaST (Berger & Luckmann, 1966). The social actors, work and personal environments were explored to understand the many layers guiding the *becoming* of a PMaST. The emerging data has shown how interactions across the course of one's life are interpreted, through reflective storytelling processes (Elliot, 2011), providing rich insights into identity development processes. The experiences illustrated and analysed by this thesis start with the earliest memory of learning mathematics to becoming and being a PMaST and ending with future trajectories, to understand how being a PMaST supported and enabled future career goals.

The theories used to understand this emerging identity as a PMaST were: Illeris (2014) who views identity as a layered process, Ibarra (1999a, 2004) who views identity as being constantly reshaped throughout one's career through professional learning opportunities, and the work of Lave and Wenger (1991); Wenger (1998, 2000, 2004); Wenger et al. (2011) who's work on communities of practice and situated learning practices have helped shape a deeper understanding of community learning practices and their place in shaping professional identities.

The discussion of knowledge acquisition by Burr (2006, 2015) explains how social interactions support the emergence of new knowledge and understanding of a phenomenon. This was found to be the case in the present study, which has illustrated how individuals build and sustain knowledge that supports their developing PMaST identity through social interactions, and by building knowledge and understanding of their subject within communities of practice. It can therefore be argued that this notion of sustained knowledge acquisition and the role of communities of practice is important for any novice primary teacher transitioning into a specialist role. Therefore, the findings from this study may be relevant to non-mathematics teaching disciplines.

Figure 40 illustrates an adapted version of Illeris's (2014) layered identity model. It has been adapted to summarise the main findings, linking them to the notion of a layered concept of identity, developed through the myriad of interconnections the PMaSTs developed throughout their personal

and working lives. The layers ripple out from the core self into the trajectory of a beginner PMaST, being a PMaST and future career opportunities. The model has been reshaped to represent two arcs: an empowering arc and a constricting arc. Within each arc, experiences that helped shape professional identity are illustrated as social structures that either empowered individual agency as a PMaST or constrained it. Each layer will be discussed next.

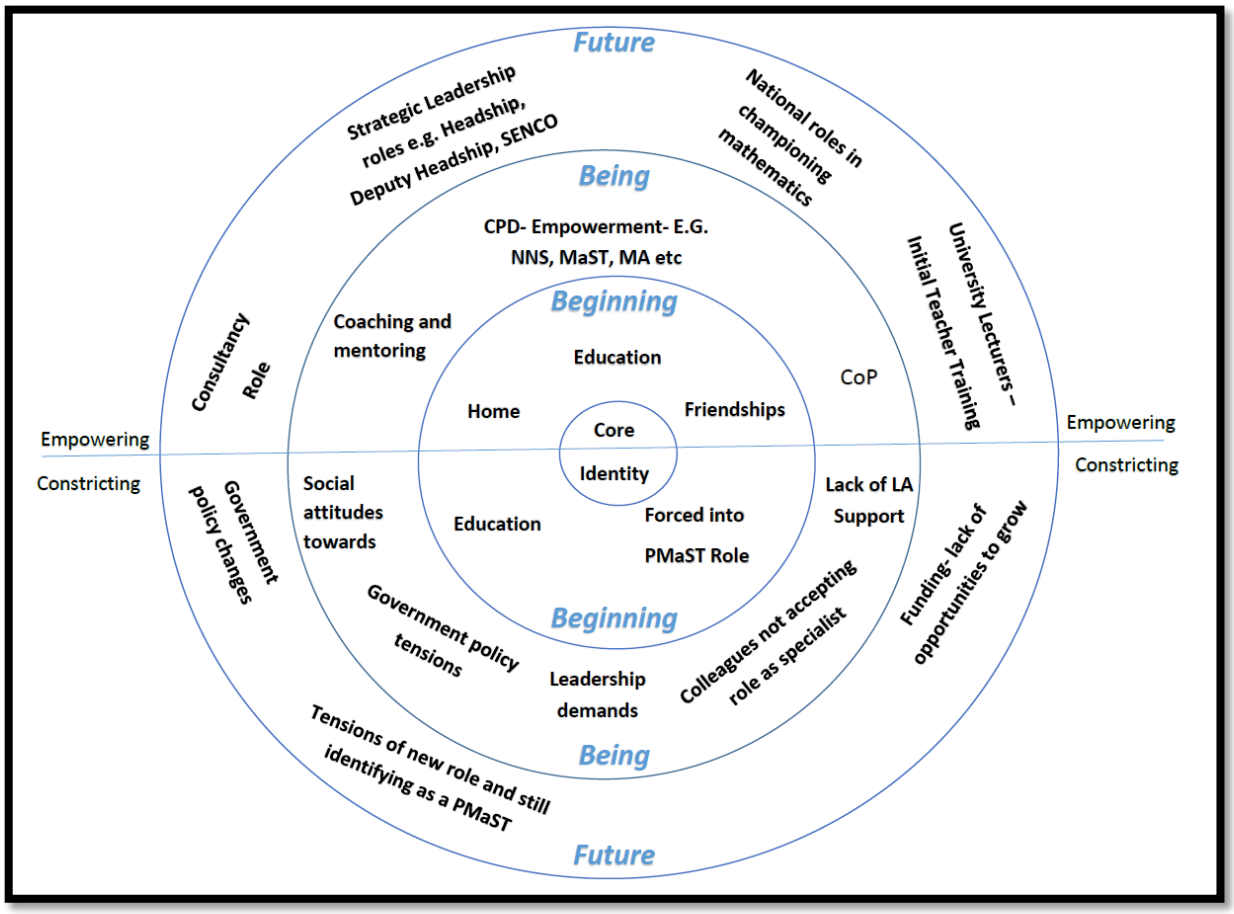


Figure 40 A PMaST identity, shaped, over time- adapted from Illeris (2014)

Core layer

The research illustrated that the *core layer* of the PMaSTs remained relatively stable, supporting the work of Illeris (2014) who argued that the core layer is generally stable nature. The relative stability of the core layer can be explained by an individual's sense of autonomy and agency in different contexts. The layer supports individuals to maintain a sense of control over how their identity is

shaped. In the context of this study, the core layer refers to how individuals perceive their sense of self and the way they may be viewed by society. These ideas are still an interpretation of a situation, a moment in time, but the interpretations are made by the individual through the understanding they have of themselves. The research also echoes Illeris's (2014) stance on how learning can have a transformative effect on the core identity, reshaping it throughout one's life.

Beginning

Figure 40 illustrates the empowering and constricting impact of lived experiences on identity development, highlighting for example how the work environment and colleagues can influence a person's sense of belonging and legitimacy as a PMaST, which in turn can nurture or damage their developing identity. These external stimuli, which individuals had little autonomy over, influenced the construction of their identity and appetite for learning mathematics and moving into a career of teaching mathematics. These experiences are positioned stemming from the beginning sphere, through to learning in a community of practice (Lave & Wenger, 1991; Wenger, 1998, 2000; Wenger et al., 2011) in the shape of adult learning experiences and training as a primary teacher. Here these CoP supported the process of developing expertise and the PMaSTs exemplified the value of being part of such communities. This finding showed the importance and value placed on CoP and the role played by such communities in shaping professional identities. Being coerced into the role of a PMaST was an unexpected finding as this would suggest that the role was taken up under pressure. A possible explanation for this could be found in how the social structures in primary schools are established, as in many cases teachers are expected to take on subject leadership roles with little previous subject knowledge development. Yet a surprising finding of this thesis was that constricting influences can be turned into empowering influences through professional learning opportunities and support from senior colleagues. This demonstrates how individuals have some agency in the way their identities are constructed, even when that might not appear to be the case in some instances. This shows how a novice primary teacher can reshape their identity into a specialist even when that was not a chosen or expected career path. This finding supports the work of Dreyfus

(1982); Dreyfus and Dreyfus (1980) on how expertise develops at different levels and therefore supports the transformation of a teacher identity from a novice to an expert, as subject and pedagogical knowledge grows (Shulman, 1987).

Being

The development of agency grew as the PMaSTs established themselves in the role. The experiences depicted in this layer that shaped their identity as a PMaST included many professional learning activities, such as national training courses, Masters level qualifications, and stretching assignments such as research projects, being coached, and coaching others. The data suggested that these courses and opportunities were achieved through supportive school leadership. These findings possibly illustrate how professional learning supported the PMaSTs to evolve and build further agency in their role. The analysis of the PMaSTs' career experiences undertaken here, has illustrated Ibarra's (1999b,2004) concept of provisional selves, where individuals 'try out' new opportunities to further extend and develop their professional selves, and in the process of doing so they experience changes to their professional identities. In this case, the primary teachers' experiences included being supported by colleagues, undertaking different professional learning courses, in order to transform into a PMaST. It can therefore be argued that the professional opportunities coupled with social support provide a strong foundation to support the development of expertise in subject leadership, certainly in mathematics and these findings will doubtless be scrutinised for their application to other subject specialisms.

In general, it appears the identities of PMaSTs were strengthened through being part of a PMaST community of practice, and this evolved through the courses they attended and through local networks they remained part of. These spaces seem to have supported the notion of providing safe, professional spaces to discuss ideas and shared tensions within the role. Hence they offer the potential to act as places where individuals supported each other as well providing an opportunity for developing pedagogical knowledge (Wenger, 1998, 2000). This research, therefore,

demonstrated how the *being* phase in figure 40 might offer a new understanding of the value of a community of practice for PMaSTs.

As illustrated in Figure 40, constraining aspects of *being* a PMaST range from negative societal attitudes towards mathematics to the demands placed on teachers, especially at the school leadership level. In some cases, a lack of alignment with the teacher's core values created tensions. Related to this, government policy was high on the list constricting factors influencing the arc of a PMaST. These results provide further insight into the barriers to PMaSTS identity development, causing existential angst in areas most out of an individual's control. Lessons can therefore be learnt from these observations to support future development of primary teacher expertise into specialist roles and areas where resilience is needed most acutely.

Future

The final layer illustrated in figure 40 represents the *future* layer of a PMaST identity. This layer shows the developing trajectory of PMaSTs moving on from being a PMaST. The data from this thesis confirms that these new roles would not have been in the reach of the PMaSTs if they had not led mathematics as PMaSTs. Skill and confidence development, within their professional spaces, was pivotal in their transition into future selves. An insightful constricting aspect of their future self was illustrated by a sense of loss expressed over the loss of autonomy for mathematics teaching and learning, for those who transitioned to a new leadership role in schools. Figure 40 provides further insight into how leadership structures, linked to subject specialist roles in primary schools could be further strengthened to support career progression within subject specialist roles. This could have benefits such as knowledge retention and supporting the training and development of future novice teachers into experts (Dreyfus, 1982; Dreyfus & Dreyfus, 1980). Further roles such as more advanced mathematics roles either in *ITT* at tertiary level, national influence in training through the mathematics hubs and consultancy roles all highlight how the socially constructed identity as a specialist PMaST not only influences individual future career progression but also serves to retain

and maintain subject-specific skills to further support the teaching and learning of primary mathematics.

Therefore it can be concluded that primary teachers' identity as a PMaST is a complex, layered construct (Ibarra, 1999a, 2004; Illeris, 2014). This identity is developed, over time, within a socially constructed reality through interactions with many actors on a personal and professional stage. These interactions, further align with the theoretical ideas of Berger and Luckmann (1966) because of the way the primary teachers become PMaSTs and sustain this identity throughout their career trajectories even when they re-establish themselves in new leadership roles. Identities are sustained and further strengthened throughout their working life as a primary educator, reinforced by professional courses, coaching and mentoring by colleagues to support their transition into new roles (Ibarra, 1999a, 2004). Finally, the importance placed by the PMaSTs' on CoP further build up the case to support the development of such learning spaces (Wenger, 1998, 2000; Wenger et al., 2011). Other scholars have noted the importance of interaction to aid the construction of pedagogic content knowledge (Shulman, 1987), found in the present study. The findings illustrate the potentially empowering effects CoP can have providing social support, facilitating the development of new pedagogic insights and ideas, and nurturing identity development. Therefore schools should support CoP to enable specialist teachers to develop, which in turn can enhance teaching and learning experiences across the school community.

7.6 Conclusion

This chapter has set out a discussion of the findings, linking them to the literature and theoretical framework of the study. Broadly speaking, the study has established aspects of tacit knowledge that individuals develop, throughout their learning of mathematics and professional careers to emerge as PMaSTs. The construct of this identity has been shown to have a distinct set of layers that ripple out from a core identity, developed through social interactions with individuals, learning spaces and professional learning courses (CPD). The findings of how novice primary teachers emerge as

specialist teachers of mathematics can support policymakers in understanding how teacher expertise can be commissioned and developed over the course of a primary teachers' career.

Chapter 8 Conclusion

8.1 Introduction – Outline of chapter

This chapter brings together and summarises the main findings of this study, in line with the research questions. The original contribution to knowledge that this thesis offers is set out, alongside the impact of this on practice and policy. The limitations of the study are highlighted. Finally, a personal reflection on carrying out this research as a practitioner, researcher and insider is highlighted, to draw together suggestions for future research directions in the field.

8.2 Summary of study with the RQs

This study aimed to understand how biographical processes and experiences shape identity development and career trajectories of Primary Teachers who become PMaSTs. The research questions that have been answered are:

SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMaSTs?

SQ2: How do primary teachers describe and understand their experience in their role of a PMaST?

SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

Each of the research questions will be discussed in turn.

8.2.1 SQ1: What are the professional and personal circumstances that lead to primary teachers becoming PMaSTs?

This study has shown that primary teachers build their professional identities as PMaSTs over their lifetime. Their lived experiences of learning mathematics both in the home environment as well as informal learning spaces such as school and adult learning centres, helped to shape their identity as mathematicians and PMaSTs. The evidence from this study suggests that individuals who struggled

to learn mathematics themselves nevertheless became successful teachers and leaders of mathematics. Additionally, having a deep personal awareness of how negative experiences could create mathematics anxiety, enabled and empowered the participants to have a more profound awareness of mathematics anxiety. This in turn showed profound empathy for pupils and adults with negative attitudes towards the subject. The participants voiced examples of how, through their interventions, a measurable change in attitudes occurred. This was noted with pupil learning, as well as with teacher confidence in the teaching of mathematics in their schools and learning communities. Taken together, these findings have extended the field of knowledge of mathematics identity development and how negative relationships with the subject can be transformed into positives. These findings have enhanced our understanding of developing mathematics expertise in primary schools, focusing on generalist teachers who later became PMaSTs, and showing how careful coaching, provision of professional development opportunities and enabling learning communities can overcome the common perception of 'not being good at mathematics'. This finding can also be mirrored for other subjects within the primary phase to support and enhance specialist teaching and learning within school communities.

Furthermore, the findings show the significant influence of the home environment's encouragement in learning mathematics. Those PMaSTs who had help with mathematics and were immersed in home environments where mathematics was actively taking place, discussed their experiences fondly and referred to it when reflecting on their career paths into becoming PMaSTs.

Participants discussed the notion of peers in both positive and negative ways. There are two lessons to be drawn from this finding, firstly, peer coaching could be an important component that would benefit both pupils and schools to increase mathematics capital in school, and secondly, peer pressure towards someone good at mathematics is particularly detrimental. Therefore, developing peer coaching would provide a positive stage for more confident mathematicians to enhance and support the learning of mathematics with their peers. Furthermore, the notion of grouping could be

reimagined and aligned with the principles of peer coaching. PMaSTs commented assertively on grouping both in primary and secondary school and how placing an ability label upon them perpetuated their negative attitudes towards mathematics. Therefore, as Boaler et al. (2000) suggest, the justification for ability grouping needs development and refinement to provide the best and most inclusive learning opportunities for all pupils. This study has therefore extended understanding of the effects of grouping in schools, from the perspective of teachers of mathematics in primary schools, and how to develop ways to empower learners of mathematics both in primary and secondary schools.

The study supports the role of the teacher being integral to building mathematics capital. The findings illustrated how teachers can inspire individuals to pursue mathematics or become part of the narrative of developing mathematics anxiety. Therefore, building further awareness, through professional development courses, throughout the careers of both experienced and beginner teachers is recommended for teachers to build skills to teach and develop mathematics in a way that is accessible to all learners. These findings illustrated the importance of the way mathematics is taught and how it needs to be reimagined to develop future, innovative learning spaces, where peer coaching could be at the heart of the learning process. This would, if done well, create collegiate and symbiotic learning spaces and foster positive attitudes towards the subject. Further research is needed to assess the long term impact of this strategy, both at the primary and secondary level.

Finally, all participants' early career experiences helped to shape their identities as PMaSTs. They all highlighted experiences of their early career development and how they started to develop their mathematics teaching. They communicated stories of leaders who empowered them to further their development of mathematics in school and start leadership in the subject. This empowerment took the shape of either being given the role of leading mathematics very early on in their teaching career or being forced into the role when the PMaSTs felt they were not ready to do so. The latter finding is of particular interest, demonstrating two things: firstly, that even when a primary teacher perceives

that they were unable to do the role of a PMaST, they took on the role because a leader persuaded them to do so. From a positive perspective, the persuasion to accept the role showed leaders in schools seeing the potential and building this with their staff. However, the research also indicates that being asked to take on the role of a PMaST, has, at times, felt like 'filling a gap' where no one else is prepared to do so. This illustrated well the need for the long term, sustainable, strategic leadership in schools to ensure that the knowledge and skills necessary for successful subject leadership are part of school development plans. Figure 41 summarise the aspects of the conclusions made for SQ1.

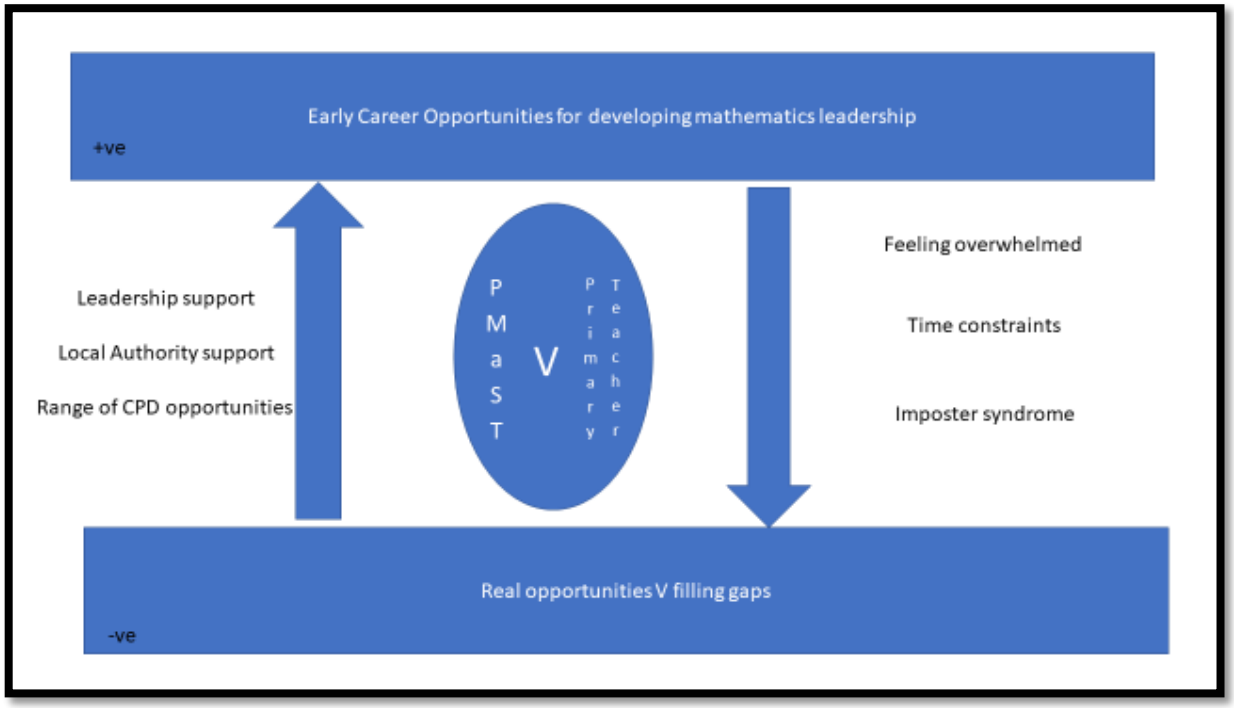


Figure 41 Early Career stages, becoming a PMaST

8.2.2 SQ2: How do primary teachers describe and understand their experience as a PMaST?

The PMaSTs' experiences of being in the role have shed light on the positive dimensions as well as challenges experienced by the participants. These challenges included working with colleagues who

initially did not wish to develop their teaching and learning of mathematics, as well as the PMaSTs being seen as inexperienced by teachers who had been part of the teaching profession for longer. Furthermore, time constraints exacerbated by multiple responsibilities of leadership, as well as being a class teacher meant that there was a great sense of frustration of not being able to do the job effectively

Further evidence from the study showed that all PMaSTs discussed, in detail, the range of professional learning opportunities that enabled them to transform into the role and therefore gain further confidence and gravitas in their position. The professional learning experiences described varied from daily courses to sustained professional learning over time. The majority of PMaSTs attended courses run through the National Numeracy Strategy, which not only developed their subject and pedagogical knowledge (Shulman, 1987), but also allowed the PMaSTs to belong to a community of fellow mathematics experts within their local area (Hutchins, 1993; Lave & Wenger, 1991; Wenger, 1998, 2000), hence widening their scope of support and mutual learning experiences. The empirical findings of this study note the training through the NNS, and more critically, the support provided by LA leads, led to the PMaSTs being nurtured and empowered them to follow a specialist path in developing mathematics in their school.

A noteworthy professional learning opportunities that demonstrated a high level of impact was the nationally funded MaST Programme (Willian, 2008). Ten out of the twelve participants completed this course and highlighted powerful narratives of increasing their mathematics capital as a result of building their subject and pedagogical knowledge, as well as their coaching and mentoring skills. This finding assertively suggests that professional learning must have measurable connectivity in how individuals, through the course, develop themselves and through this empowerment, develop others to further the teaching and learning of mathematics. This adds to the empirical evidence that professional learning builds mathematics identities as well as successfully developing career

outcomes (Ibarra, 1999a, 2004) of teachers through a strong CoP (Wenger, 1998, 2000, 2004) and reconstruction of one's sense of being a mathematician.

The study showed how being in the role of a PMaST gave participants opportunities such as pursuing research projects and moving into senior leadership roles. This strongly demonstrated the powerful impact being a PMaST had on participants' teaching and learning leadership of mathematics. Furthermore, it showed how the PMaSTs sought to engage in evidence-based research to strengthen their roles as PMaSTs. Therefore, this study extends the literature on bespoke professional learning opportunities, helping shape a professional identity.

All PMaSTs revealed their frustration at the impact time constraints had on their ability to do the job well. Many PMaSTs were expected to do the role with little time dedicated to it. On many occasions, the PMaSTs reflected upon asking for extra time to effectively carry out their duties as PMaSTs. Furthermore, PMaSTs felt the dichotomy between how they felt mathematics should be taught and how the testing regime in school forced mathematics to be taught. These tensions provided a great deal of anxiety for the PMaSTs and frustration at not being able to make the impact they envisioned. This was further aligned with parental pressures and the leadership of schools following the masses rather than being trailblazers in the best approaches to developing more effective mathematical teaching and learning. This information can be used to develop national policies relating to the time allocated to mathematics specialists in primary schools to work effectively in the role. The study also boldly suggests that the way that national testing is conducted should be reimagined, through careful consultation with PMaSTs, to build a more holistic approach to testing that is fit for the teaching and learning demands of the 21st century.

It can be concluded that the shaping of a career from Primary Teacher to PMaST, illustrated by these findings, revealed that any primary teacher, who aspires to become a PMaSTs, can, with the right leadership support and professional learning opportunities. The data showed that all twelve PMaSTs, became champions of mathematics through chance encounters within their learning environments

rather than by having a clear mapped out career path. However, they faced real and measured challenges aligned with building the teaching and learning of mathematics. These, alongside time constraints and pedagogical frustrations linked to teaching to the tests, made the PMaSTs' jobs challenging. These challenges were further exacerbated by parental demands, meaning that although they valued their roles as PMaSTs, it came with a great deal of pressure and this led to the PMaSTs moving on from the role of championing mathematics into more strategic leadership roles, such as assistants, deputies or heads of schools.

8.2.3 SQ3: How do PMaSTs' professional identity developments reshape values, practice and future career goals?

All participants demonstrated growth in their learning and career development as a result of having the role of a PMaST. Many illustrated how their professional learning journey was enhanced by being a PMaST; e.g., three PMaSTs became lecturers in primary mathematics at ITT Institutes, furthering their careers in leading mathematics as opposed to going further into school strategic leadership. One PMaST has their own, successful mathematics consultancy and another is now a national lead for mastery teaching. These findings show how some of the PMaSTs used their career development in mathematics teaching and learning to further their careers. However, the remaining participants stayed within a school setting and continued to be classroom teachers whilst being PMaSTs or becoming a deputy or headteacher. These findings assert that the role of a PMaST provided a range of ways forward in career development that the participants would not have had if they did not specialise in the leadership of mathematics in their primary schools.

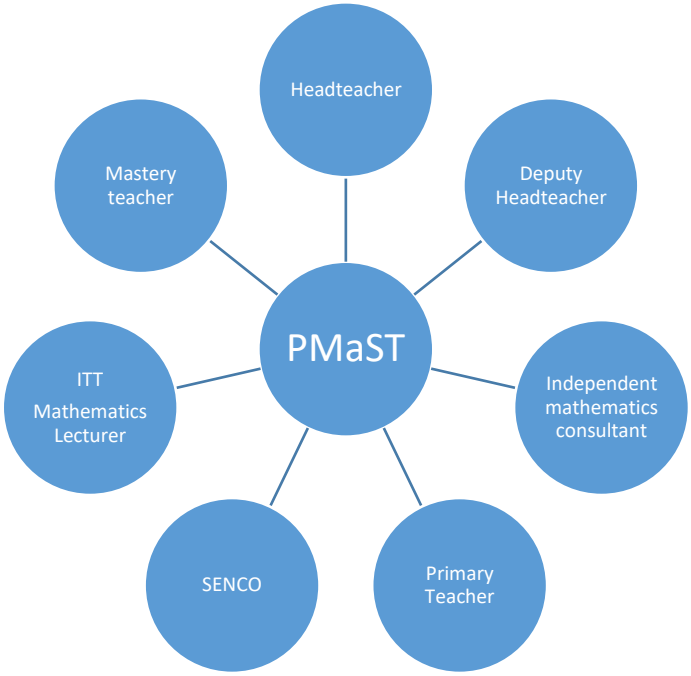


Figure 42 shows the next stage in the PMaSTs' career trajectories

The evidence of this study demonstrated how the PMaSTs continued to identify themselves as PMaST even when they had transitioned into new leadership roles, thus asserting their identity as a PMaST. All PMaSTs saw mathematics as a subject that they continued to champion, despite some of them moving directly away from leadership of the subject. Those in senior leadership roles noted how their background as PMaSTs gave them an edge in how they wanted mathematics to be taught in their schools. Therefore, this new finding adds to our understanding of how PMaSTs in England hold on to their identity as a PMaST, whilst transitioning into strategic roles in primary schools. This is encouraging as, even though there is an attrition rate of losing mathematics leadership expertise in primary schools, the skills are not always lost as they are carried forth with the PMaSTs to have a strategic impact in the schools they lead.

One final aspect of the future reshaping of values and practices is shown by the passionate way all the PMaSTs advocated for the opportunity afforded by carefully crafted and inclusive mathematics teaching and learning. They saw mathematics as a subject that has the potential to enable social

mobility and improve capability and aspirations for all. This inspired them to continue to champion mathematics to help change societal attitudes towards mathematics and reduce the attainment gaps in the learning of mathematics in both primary and secondary schools.

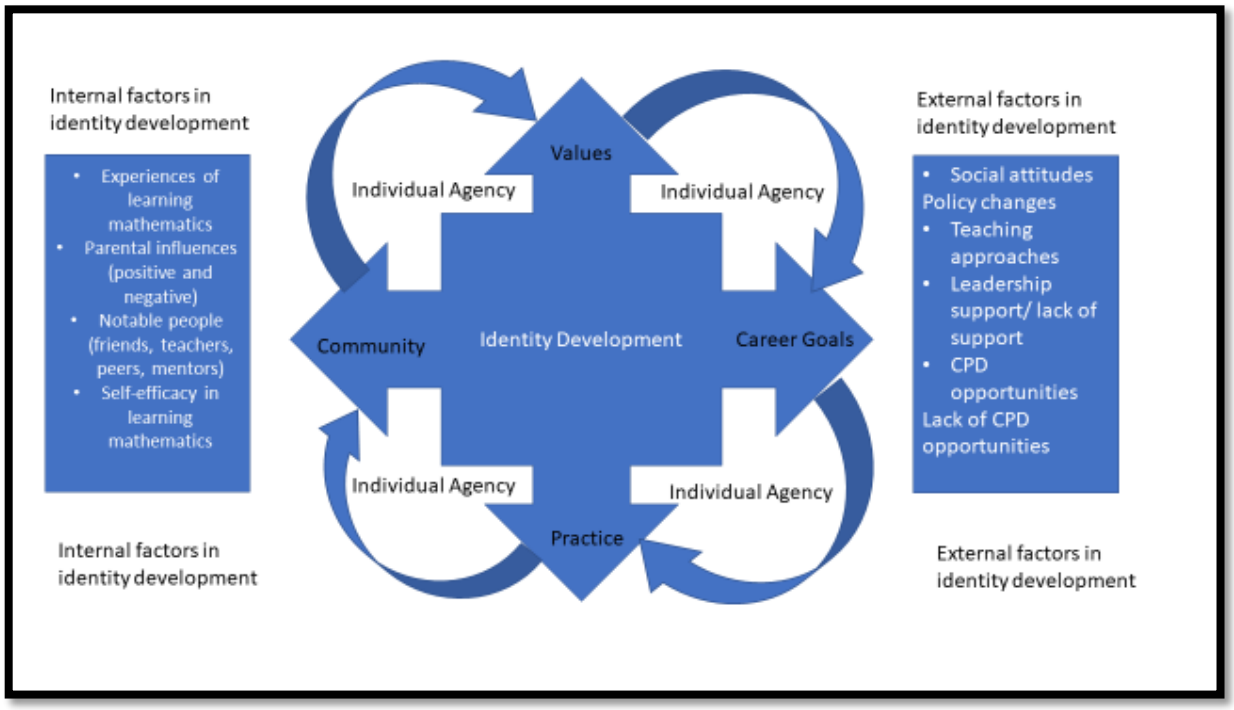


Figure 43 Diagram illustrating the factors reshaping values and practices of PMaSTs.

8.3 An original contribution to knowledge

This thesis has shed specific light on primary teacher identity in English schools, specifically how these teachers emerged as PMaSTs over time, thus reframing an understanding of how primary teachers, through their lived experiences, shaped their professional identities as PMaSTs. While each participant had a unique life history, their professional and personal trajectories demonstrated common themes that have shown how the participants of this study became PMaSTs.

The thesis has firstly provided a narrative of how individual stories and experiences shaped the emergence of a PMaST. It has concluded that personal mathematics learning experiences from a young age, shape the individual understanding of mathematics teaching and learning. This finding is well-documented, however, this thesis has contributed to this knowledge by illustrating how

individuals, who have grown up with a negative relationship with mathematics, who trained to become primary teachers with no desire to develop into PMaSTs, can and are empowered to do so. The PMaSTs highlighted notable people who acted as crucibles in their transformation of identity across their early professional careers, this metamorphosis being informed by professional learning and interaction with their CoP. The thesis has added to the theoretical understanding of how CoP is an important component in driving a primary teacher into becoming a PMaST. Therefore, building active mathematics learning communities helped in shaping mathematics identities and career aspirations of primary teachers.

An aspect that emerged from all PMaSTs was the notion of being recognised as having a talent for mathematics teaching and thus being encouraged to become champions of mathematics. This talent for teaching mathematics can also be drawn upon as an original contribution because the participants demonstrated how they had greater empathy and understanding for pupils and teachers who felt mathematics was not for them, by drawing upon their own lived experiences to make mathematics accessible to their pupils and colleagues. It is, however, important to note that some of the participants felt the role was given to them without much thought and therefore were anxious about this. The positive emergence from this point is how participants' identity emerged as PMaSTs through strong professional learning opportunities. All PMaSTs drew upon long term professional learning opportunities such as the suite of courses available to them through the NNS and especially saw courses such as The Mathematics Specialist Teacher (MaST) course as a highlight in the development of their professional identity as a PMaST. An additional aspect that arose from the work was the role of leaders and how they either enabled or disabled the development of a PMaST. Most of the participants spoke of their leaders fondly and illustrated the impact that leadership support had on their emergence into a PMaST. This support came in the form of time given to develop their role as well as an investment in professional learning.

Furthermore, the thesis has shared a depth of knowledge of how a PMaSTs' mathematics identity is shaped through the early experiences of learning mathematics. These experiences proved to be the main nodal points of the majority of PMaSTs developing a negative relationship with mathematics. The findings showed that teachers who built mathematics knowledge through careful modelling and individualised learning opportunities showed a heightened success rate in the development of positive relationships with the subject. However, when mathematics was taught without consideration of individual learning styles and an understanding of the effects that teacher interaction could have on pupil outcome, it proved to create a sense of not belonging within the parameters of successful mathematics learning. It is clear that literature around this aspect of mathematics learning exists, however, of note from this thesis, is how these participants' transformation to become confident mathematicians is directly linked to their experience of learning mathematics as an adult. The PMaSTs especially commented on being inspired and empowered by their teachers within an adult learning space. This finding builds on the literature around successful mathematics learning as it shows the role adult learning spaces play in individual empowerment in successful learning of mathematics. Once again of note here are the strong links to a CoP, and how this played an integral role in developing confidence in successful mathematics learning. Furthermore, this sheds further light on the role of the teacher in making mathematics accessible to students. All PMaSTs who learnt mathematics as adults voiced eloquent stories about their teachers and how they assisted their emergence as confident mathematicians. Therefore, this area is worthy of further exploration within the PMaST community.

Aligned with school experiences, the thesis has highlighted that because of the PMaSTs' own lived experiences of mathematics, they each had heightened awareness of the struggles pupils and adults had with learning mathematics, thus having further empathy and kindness whilst teaching the subject to pupils and developing the learning of adults. This attitude directly correlates to their own experiences of learning mathematics and therefore they ensured that their teaching would not repeat the negative experiences they had whilst learning the subject.

As a final point, the thesis has shown how peer groups can either help or hinder the learning of mathematics in schools. Therefore, it is for policymakers to think about how to further research into developing holistic learning spaces for mathematics, where peer learning opportunities are the norm as opposed to the exception to add value to the way the subject can be taught. The findings showed a strong sense of belonging when peers supported the learning of mathematics. However, negative peer pressure hindered the development of mathematics learning for many participants. This again emphasised the need to create enabling learning spaces where peers are partners and collaborate in the learning of mathematics. One final point to make here is that the skills developed through peer collaboration are essential skills for future job success. As illustrated by the up to date database developed by the OECD, the way we imagine skills and how they marry into the future workplace need careful rethinking to have a sustainable workforce for the future(OECD, 2019).

The theoretical model emerging from this thesis is an original contribution illustrating how primary teachers transformed their professional identity, over the course of their career. The rippling out into a PMaST identity from the core layer through to their future career aspirations provides insight that might inspire primary teachers who want to develop specialist roles and support the work of providers of CPD for teachers transitioning into specialist roles.

The methodological approaches used to elicit identity constructs of PMaSTs have added to the narrative approach used to gather data. By starting with the participant, through the use of a Life Graph, the study enabled a sense of deep reflection from the participant, therefore enhancing and elevating the data collected. The initial approach of using a Life Graph, unique to this study, adds to the methods already in use to elicit the lived experiences of individuals throughout their career trajectories. This approach will enhance how individual experiences can be mapped out over time, to help build a narrative about individual lived experiences. The Life Graph acted as an independent reflective, coaching tool for the participants to enable a self-analysis of their mathematics trajectories from their first memory of learning mathematics to becoming a PMaST. The follow-up

interview, in the form of a life history interview, enabled rich and in-depth data to be gathered from the participants to bring their stories to life. Therefore, it is recommended that this approach be used in future studies that seek to understand the career trajectories of teachers' professional identities.

8.4 Implications and recommendations for practice

The research has provided an in-depth understanding of how a small group of primary teachers realigned their identities as PMaSTs over their professional careers. The narrative approach gave a thorough understanding of how these individuals built their identities over time.

The thesis concludes that all primary teachers can become PMaSTs if they get the right support, such as a clear and sustained professional learning portfolio throughout their career, support from leaders and a network of colleagues to draw upon to further their development. It is important to suggest here that professional learning needs to be sustained and developed over time. Therefore, it can be recommended that government policy needs to consider professional learning within mathematics as a sustained part for the professional trajectories of primary teachers. It can be said that the new Chartered Teacher model (CCT, 2019), being piloted at present, goes some way to align with this recommendation.

The thesis further concludes that the role of peers within the learning processes in schools needs to be reimagined. This has two key components for future policy recommendations: firstly, learning spaces need to foster a creative learning space for mathematics and to empower students to understand that making mistakes is a complex way of thinking about mathematics and is a necessary part of learning the subject. Secondly, the role of peers and how they could become part of the success by being coaches to each other in developing this positive and creative approach to reimagining mathematics learning in schools. Therefore, it is suggested that the sophisticated ideas of a CoP, evolved and developed by Lave and Wenger should be aligned with developing robust and

sustainable mathematics teaching and learning CoPs, not just for teachers but also for learners Lave and Wenger (1991); Wenger (1998, 2000).

The findings of this study recommend that careful analysis and more in-depth research be done with adults who go back to study mathematics and explore their lived experiences with particular attention to the teachers and their teaching techniques in adult learning facilities. This will provide valuable insight into how the learning spaces and the teaching styles differ from schools and therefore further build our understanding of what can be done to reduce the negative attitudes that develop for the subject, particularly in secondary schools.

Finally, during the data collection process, it became clear that the DFE does not collate annual data on expert teachers of mathematics in primary schools in England. Therefore, as part of the government annual census of schools, it is recommended that this depth of data could be included as part of the portfolio of work. This could then enable us to have a better understanding of the number of PMaSTs available in England and where there are based: e.g. if the data collected suggests there are more PMaSTs in one area than another, it is appropriate to further analysis the data to understand this trend.

Eleven out of the twelve participants were from the south-east region of England. It is suggested that the scope of this study was not to generalise features of a PMaST but to deepen our understanding of how their identities as PMaSTs emerge, over time, through their lived experiences throughout their professional careers. It is therefore recommended that a further study is commissioned, using a carefully designed questionnaire to gather a national picture on the spread of PMaSTs. This survey would provide details that could be easily comparable and therefore give us valuable data to enhance and inform our understanding of mathematics expertise in England.

8.5 Limitations

This study was conducted with a small group of participants (twelve) and eleven out of the twelve participants were from the South East of England. Although detailed data was collected to

understand how this group shaped their professional identities as PMaSTs, this poses limitations on the generalisability of the data set collected. The research could be replicated to capture the lived experiences of other groups of PMaSTs, nationally or internationally to understand their professional identities as PMaSTs, therefore developing further depth in understanding this group of educators.

Further limitations to the study arise through the time when the research took place. The lived experiences communicated and analysed are frozen in one aspect of time, linked to personal, professional and political circumstances. These experiences cannot be replicated and therefore it can be suggested that if the study is repeated with a new set of participants from the same region, it can be assumed that the outcomes would have similarities but there will be personalised differences as well as variances brought on by the moment in time the research is conducted as well as the political landscapes.

The group of participants are uniquely context and subject-specific as being PMaSTs and therefore, we cannot draw conclusions on how an English specialist in a primary school may develop their professional identity by drawing on the results of this study. As ideas and trends are shaped by government policy and the geopolitical landscape, this research, carried out over a finite period has captured the lived experiences of twelve primary teachers and how their identities have been shaped by these events and their interactions within their environment. If the research was replicated now, with another twelve PMaSTs, or indeed the same sample of participants, the trends in the data would be different due to the personal, professional and geopolitical circumstances, shaping the study.

Finally, it is important to note the omission of data on chronology during the first phase of the data collection process. At the time the data collection methods were designed, it was felt that the Life Graphs would naturally evolve to provide a chronology of the life of all participants to include the years as well as the phases of their careers. Although through the narrative interview, drawing on the Life Graph, this level of data was collected, it was not consistent enough to allow measurable

comparisons between participants. If the data set included career chronology, it would have helped with further comparisons e.g. in table 2, where each participants' profiles were detailed, aspects of current career positions alongside years in teaching would have made valuable comparisons to add to the richness of the data analysis process. Hence, collecting this level of data would have given further insight into the lived experiences of the participants.

8.6 Reflections

This thesis has given me much time to reflect on my reasons to pursue doctorate level work through a professional platform. As someone, from an immigrant family and the first generation attending university, it always felt like a dream to think I could develop a professional career, let alone pursue a high level of study.

My professional trajectory has seen a development from a primary teacher to being an Associate Professor at University, the process has been a powerful one to understand how identity is shaped over time and the personal and professional conflicts that I have overcome to get to an endpoint.

Having suffered from imposter syndrome throughout different points of my life and career, I now realign my understanding of self in a way that empowers further growth and development through my professional learning experiences. The Doctorate has allowed me to understand primary teachers and their experiences of becoming PMaSTs. Furthermore, the creative approach used to gather data has inspired me to be innovative in my approach to research methods and to evolve and reimagine approaches that have been in existence for some time. I am now able to reemphasise the ideas learnt with trainee teachers, who themselves lack confidence in the subject of mathematics and suffer from the negative attitudes so prevalent in society.

Additionally, the Doctorate has diversified my scope of impact within my institution. Since starting the work, I have had the confidence to lead on the undergraduate research dissertation, and share

with trainee teachers how education research can have a lasting impact on practice. Furthermore, it has enabled me to widen the scope of my work by taking up further Masters level teaching, which I enjoy immensely. Moreover, the thesis has allowed me to start shadowing colleagues supervising doctorate students, which has empowered me to firstly learn from expert staff and secondly share my journey of undertaking a doctorate with a heightened level of empathy for students doing the same level of study.

Furthermore, studying the lived experiences of PMaSTs has encouraged me to pursue further research into how teachers move from a novice to an expert teacher. I am also interested in the notion of an expert teacher of mathematics and how this is regarded within the education community. I hope to apply for funding to conduct a national survey into PMaSTs, therefore helping me to understand the scope of a PMaST from a national level. The carefully planned survey would provide regionally specific data, enabling a deeper understanding of clusters of PMaST communities. This would further our insight into how these clusters and CoP develop and whether specific factors are enabling these communities of PMaSTs to flourish. These details would help to further policymakers' understanding of how PMaST develop and who enables this development. The survey would invite participants to take part in further research into being an 'Expert Mathematics teacher' in the primary age range and how they see this identity development, over time.

Finally, I intend to write papers extracted from this thesis. Of particular interest is the methodological approach as I feel this would provide an innovative and reflective approach to further enhance the capturing of 'Lived Experiences' not just of PMaSTs but the approach could be replicated across the primary subject disciplines.

References

ACME. (2012). *Good Practice in Primary Mathematics*. Retrieved from London:

ACME. (2013). *Empowering Teachers: Success for Learners*. Retrieved from London:

ACME. (2016a). *Beginning teaching: best in class?* Retrieved from London: http://www.acme-uk.org/media/33228/beginningteachingbestinclass2015.pdf

ACME. (2016b). *Professional learning for all teachers of mathematics* Retrieved from London:

Aiken, L. R., & Dreger, R. M. (1961). The effect of attitudes on performance in mathematics. *Journal of Educational Psychology, 52*(1), 19-24. doi:10.1037/h0041309

Allen. (2017). *The SAGE Encyclopedia of Communication Research Methods* (1 ed.). US: Sage Publications Inc.

Allen, B. J. (2005). Social constructionism. *Engaging organizational communication theory and research: Multiple perspectives*, 35-53.

Alvesson, M., Lee Ashcraft, K., & Thomas, R. (2008). Identity Matters: Reflections on the Construction of Identity Scholarship in Organization Studies. *Organization, 15*(1), 5-28. doi:10.1177/1350508407084426

Alvesson, M., & Willmott, H. (2002). Identity Regulation as Organizational Control: Producing the Appropriate Individual. *Journal of management studies, 39*(5), 619-644.

Anderson, R., Boaler, J., & Dieckmann, J. (2018). Achieving Elusive Teacher Change through Challenging Myths about Learning: A Blended Approach. *Education Sciences, 8*(3), 98.

Askew, M., Brown, M., Wiliam, D., Johnson , D., & Rhodes, V. (1997). *Effective Teachers of Numeracy*. Retrieved from London:

BERA. (2018). *Ethical Guidance for Educational Research*. Retrieved from

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality; a treatise in the sociology of knowledge*. Garden City, N.Y.: Doubleday.

Bibby, T. (1999). Subject knowledge, personal history and professional change. *Teacher Development, 3*(2), 219-232. doi:10.1080/13664539900200084

Bjuland, R., Cestari, M., & Borgersen, H. (2012). Professional mathematics teacher identity: analysis of reflective narratives from discourses and activities. *Journal of Mathematics Teacher Education, 15*(5), 405-424. doi:10.1007/s10857-012-9216-1

Boaler, J. (1997). Setting, Social Class and Survival of the Quickest. *British Educational Research Journal, 23*(5), 575-595.

Boaler, J. (2009). *The Elephant in the Classroom*. London: Souviner Press.

Boaler, J. (2014). Ability Grouping in Mathematics Classrooms. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education* (pp. 1-5). Dordrecht: Springer Netherlands.

Boaler, J. (2018). You Cubed. Retrieved from https://www.youcubed.org/

Boaler, J., Wiliam, D., & Brown, M. (2000). Students' Experiences of Ability Grouping: Disaffection, Polarisation and the Construction of Failure. *British Educational Research Journal, 26*(5), 631-648.

Bonner, A., & Tolhurst, G. (2002). Insider-outsider perspectives of participant observation. *Nurse researcher, 9*, 7-19. doi:10.7748/nr2002.07.9.4.7.c6194

Borko, H., & Livingston, C. (1989). Cognition and Improvisation: Differences in Mathematics Instruction by Expert and Novice Teachers. *American Educational Research Journal, 26*(4), 473-498. doi:10.2307/1162861

Briggs, M. (2014). THE 'RIGHT BAGGAGE' FOR MATHEMATICS? *Philosophy of Mathematics Education Journal*(28), 1-8.

Brown, M., Brown, P., & Bibby, T. (2008). “I would rather die”: reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3-18. doi:10.1080/14794800801915814

Bruner, J. (1987). Life as narrative. *Social research*, 11-32.

Bruner, J. (1991). The Narrative Construction of Reality. *Critical Inquiry, 18*(1), 1-21.

Bryman, A. (2008). *Social Research Methods* Oxford: Oxford University Press.
Burr, V. (2006). An Introduction to social constructionism.
Burr, V. (2015). *Social constructionism*. London: Routledge.
Carey, E., Hill, F., Devine, A., & Szücs, D. (2015). The Chicken or the Egg? The Direction of the Relationship Between Mathematics Anxiety and Mathematics Performance. *Frontiers in psychology, 6*, 1987. doi:10.3389/fpsyg.2015.01987
Carruthers, E., & Worthington, M. (2011). *Understanding children's mathematical graphics : beginnings in play /* Maidenhead: Open University Press
Çatlıoğlu, H., Gürbüz, R., & Birgin, O. (2014). Do pre-service elementary school teachers still have mathematics anxiety? Some factors and correlates. *Bolema: Boletim de Educação Matemática, 28*(48), 110-127. doi:10.1590/1980-4415v28n48a06
CCT. (2019). Chartered College of Teaching. Retrieved from https://chartered.college/
Cerulo, K. A. (1997). Identity Construction: New Issues, New Directions. *Annual Review of Sociology, 23*, 385-409.
Chen, C. P. (1998). Understanding career development: A convergence of perspectives. *Journal of Vocational Education and Training, 50*(3), 437-461.
Chen, C. P. (2006). Strengthening Career Human Agency. *Journal of Counseling & Development, 84*(2), 131-138. doi:doi:10.1002/j.1556-6678.2006.tb00388.x
Chirban, J. T. (1996). *Interviewing in depth*: Sage.
Clarke, D. M. (1991). *The role of staff development programmes in facilitating professional growth-*. Madison University of Wisconsin
Clarke, V., & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The psychologist, 26*(2).
Cockcroft. (1982). *Mathematics Counts. Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr WH Cockcroft*. Retrieved from London:
Cohen, Manion, L., & Morrison, K. (2017). *Research Methods in Education*: Routledge.
Cohen, L., & Manion, L. (2011). *Research methods in education*. London; New York: Routledge.
Cohen, L. B., & Marks, K. S. (2002). How infants process addition and subtraction events. *Developmental Science, 5*(2), 186-201. doi:10.1111/1467-7687.00220
Cohrssen, C., & Tayler, C. (2016). Early childhood mathematics: A pilot study in preservice teacher education. *Journal of Early Childhood Teacher Education, 37*(1), 25-40. doi:10.1080/10901027.2015.1131208
Collopy, R. (2003). Curriculum Materials as a Professional Development Tool: How mathematics textbook affected two teachers' learning. . *Elementary School Journal, 103*, 287-311.
Connelly, F. M., & Clandinin, D. J. (1990). Stories of Experience and Narrative Inquiry. *Educational Researcher, 19*(5), 2-14. doi:10.3102/0013189x019005002
Copur-Gencturk, Y., & Lubienski, S. T. (2013). Measuring mathematical knowledge for teaching: a longitudinal study using two measures. *Journal of Mathematics Teacher Education, 16*(3), 211-236. doi:10.1007/s10857-012-9233-0
Copur-Gencturk, Y., Plowman, D., & Bai, H. (2019). Mathematics Teachers' Learning: Identifying Key Learning Opportunities Linked to Teachers' Knowledge Growth. *American Educational Research Journal, 56*(5), 1590-1628. doi:10.3102/0002831218820033
Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American journal of Sociology, 106*(6), 1691-1730.
Cotton, T. (2016). *Understanding and Teaching Primary Mathematics* (3 ed.). London: Pearson.
Creswell, J. (2007). *Qualitative Enquiry and Research Design: Choosing* (Second ed.). California Sage.
Creswell, J. (2013). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (3 ed.). London: Sage.
Curtis, W., Murphy, M., & Shields, S. (2014). *Research and Education*. Oxford: Routledge.
Darragh, L. (2015). Recognising 'good at mathematics': using a performative lens for identity. *Mathematics Education Research Journal, 27*(1), 83-102. doi:10.1007/s13394-014-0120-0

Day, C. (1999). *Developing teachers: The challenges of lifelong learning.* London: Routledge Falmer

Day, C., Kington, A., Stobart, G., & Sammons, P. (2006). The personal and professional selves of teachers: Stable and unstable identities. *British Educational Research Journal, 32*(4), 601-616.

DFE. (2011). *Training our next generation of outstanding teachers* London DFE.

DFE. (2013a). *Mathematics programmes of study: key stages 1 and 2. National Curriculum in England*. London: Crown

DFE. (2013b). *The national curriculum in England Key stages 1 and 2 framework document* London: Crown

DFEE. (1999). *The National Numeracy Strategy*. London: DFEE Publications.

Donaldson, G. (2002). *Successful Mathematics Leadership in Primary Schools: The Role of the Mathematics Co-ordinator*: Learning Matters.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics Anxiety: What Have We Learned in 60 Years? *Frontiers in psychology, 7*, 508. doi:10.3389/fpsyg.2016.00508

Draper, J., Fraser, H., & Taylor, W. (1998). Teachers' Careers: accident or design *Teacher Development, 2*(3), 373-385.

Dreyfus, S. E. (1982). FORMAL MODELS VS. HUMAN SITUATIONAL UNDERSTANDING: INHERENT LIMITATIONS ON THE MODELING OF BUSINESS EXPERTISE. *Office Technology and People, 1*(2/3), 133-165. doi:10.1108/eb022609

Dreyfus, S. E., & Dreyfus, H. L. (1980). *A five-stage model of the mental activities involved in directed skill acquisition. .* University of California, Berkeley. California.

EEF. (2015). *Mathematics Mastery. Primary Evaluation Report.* . Retrieved from https://v1.educationendowmentfoundation.org.uk/uploads/pdf/Mathematics_Mastery_Primary_(Final)1.pdf

Eisner, E. (1992). Objectivity in Educational Research. *Curriculum Inquiry, 22*(1), 9-15. doi:10.2307/1180090

Elliot, J. (2011). *Using Narrative in Social Research* London: Sage

Ernest, P. (1988). *The attitudes and practices of student teachers of primary school mathematics.* Paper presented at the Proceedings of 12th International Conference on the Psychology of Mathematics Education, Hungary.

Flick, U. (2014). *An Introduction to Qualitative Research*: SAGE Publications.

Floyd, A. (2012). Narrative and Life History. In M. C. a. M. M. Ann R.J. Briggs (Ed.), *Research Methods in Educational Leadership and Management* (pp. 223-235). London: Sage.

Floyd, A., & Arthur, L. (2012). Researching from within: external and internal ethical engagement. *International Journal of Research & Method in Education, 35*(2), 171-180. doi:10.1080/1743727X.2012.670481

Foster, D. (2018). *Teacher Recruitment and Retention Strategy*. (7222). London: DFE.

Francis, B., Archer, L., Hodgen, J., Pepper, D., Taylor, B., & Travers, M.-C. (2017). Exploring the relative lack of impact of research on 'ability grouping' in England: a discourse analytic account. *Cambridge Journal of Education, 47*(1), 1-17. doi:10.1080/0305764X.2015.1093095

Fuller, C., Goodwyn, A., & Francis-Brophy, E. (2013). Advanced skills teachers: Professional identity and status. *Teachers and Teaching, 19*(4), 463-474.

Fuller, C., Goodwyn, A. C., Francis-Brophy, E., & Harding, R. C. (2010). Advanced skills teachers: Summary report.

Gaunt, C. (2008). All schools 'need maths specialists. *Nursery World, 108*(4125), 4-4.

Giddens, A. (1991). *Modernity and self-identity: Self and society in the late modern age*: Stanford university press.

Ginsburg, H. P., Duch, H., Ertle, B., , & Noble, K. G. (2012). How can parents help their children learn math? In Handbook of family literacy (pp. 51-65). . In Wasik & B. H. (Eds.), *Handbook of family literact* (pp. 51-55). New York: : Routledge/Taylor & Francis Group.

Gobo, G. (2007). Sampling, Representativeness and Generalizability. In C. Seale, G. Gobo, J. Gubrium, F, & D. Silverman (Eds.), *Qualitative Research Practice*. London: Sage.

Goodison, I. (1992). *Studying Teachers' Lives*. London, UNITED STATES: Taylor and Francis.

Goodson, I. (2008). *Investigating the Teachers' Life and Work*. Rotterdam, Netherlands: Sense Publishers.

Goodson, I. (2009). The Story of Life History: Origins of the Life History Method in Sociology. *Identity: An International Journal of Theory and Research, 1*(2), 129-142.

Goodson, I., & Sikes, P. (2001). *Life History Research in Educational Settings: Learning from lives.* Buckingham: Open University Press.

Goodwyn, A. (2010). *The Expert Teacher of English*. London: Routledge.

Goos, M. E., & Bennison, A. (2008). Developing a communal identity as beginning teachers of mathematics: Emergence of an online community of practice. *Journal of Mathematics Teacher Education, 11*(1), 41-60. doi:10.1007/s10857-007-9061-9

Goulding, M., Rowland, T., & Barber, P. (2002). Does it matter? Primary teacher trainees' subject knowledge in mathematics. *British Educational Research Journal, 28*(5), 689-704.

Graven, M. (2004). Investigating mathematics teacher learning within an in-service community of practice: The centrality of confidence. *Educational Studies in Mathematics, 57*(2), 177-211.

Graven, M., & Lerman, S. (2003). Wenger, E. (1998). Communities of practice: Learning, meaning and identity. *Journal of Mathematics Teacher Education, 6*(2), 185-194.

Grays, S. D., Rhymer, K. N., & Swartzmiller, M. D. (2017). Moderating Effects of Mathematics Anxiety on the Effectiveness of Explicit Timing. *Journal of Behavioral Education, 26*(2), 188-200. doi:10.1007/s10864-016-9251-6

Grey, D. (2004). *Doing Research in the Real World*. London: Sage.

Griffin, P. (2014). The Cockroft Report: legacy or missed opportunity. *Association of Teachers of Mathematics*(243), 15-18.

Guba, E. G. (1990). *The Paradigm Debate* London: Sage

Guskey, T. R. (2000). *Evaluating professional development*: Corwin Press.

Guskey, T. R. (2002). Professional Development and Teacher Change *Teachers and Teaching, Theory and Practice*

8(3/4), 381-391.

Gysbers, N. C., & Moore, J. (1981). *Improving guidance programs*: Prentice-Hall.

Hall, W. A., & Callery, P. (2001). Enhancing the Rigor of Grounded Theory: Incorporating Reflexivity and Relationality. *Qualitative Health Research, 11*(2), 257-272. doi:10.1177/104973201129119082

Hargreaves, A. (2001). *Changing teachers, changing times: Teachers' work and culture in the postmodern age*: A&C Black.

Harris, G., Stevens, T., & Higgins, R. (2011). A professional development model for middle school teachers of mathematics. *International Journal of Mathematical Education in Science and Technology, 42*(7), 951-961. doi:10.1080/0020739X.2011.611908

Haylock, D., & Manning, R. (2019). *Mathematics Explained for Primary teachers* (6 ed.). London: Sage.

Herr, E. L., & Cramer, S. H. (1992). *Career Guidance and Counseling Through the Life Span: systematic approaches.* New York: Harper Collins.

Hersh, R., & John-Steiner, V. (2010). *Loving and Hating Mathematics : Challenging the Myths of Mathematical Life*. Princeton, UNITED STATES: Princeton University Press.

Hodgen, J., & Askew, M. (2007). Emotion, Identity and Teacher Learning: Becoming a Primary Mathematics Teacher. *Oxford Review of Education, 33*(4), 469-487. doi:10.2307/20462350

Hodges, T. E., & Cady, J. A. (2012). Negotiating Contexts to Construct an Identity as a Mathematics Teacher. *Journal of Educational Research, 105*(2), 112-122. doi:10.1080/00220671.2010.529956

Holloway, W., & Jefferson, T. (2000). Researching the fear of crime. *Doing Qualitative Research Differently: free association, narrative and the interview method*, 7-24.

Hutchins, E. (1993). Situated Learning: Legitimate Peripheral Participation . Jean Lave, Etienne Wenger. *American Anthropologist, 95*(3), 743-744. doi:10.1525/aa.1993.95.3.02a00340

Ibarra, H. (1999a). Provisional Selves: Experimenting with image and identity in Professional Adaptation. *Sage, 44*, 764-791.

Ibarra, H. (1999b). Provisional Selves: Experimenting with Image and Identity in Professional Adaptation. *Administrative Science Quarterly, 44*(4), 764-791. doi:10.2307/2667055

Ibarra, H. (2004). *Working identity: Unconventional strategies for reinventing your career*: Harvard Business Press.

Illeris, K. (2014). *Transformative Learning and Identity* Oxford: Routledge.

Jaros, S. (2012). Identity and the workplace: An assessment of contextualist and discursive approaches. *Tamara: Journal for Critical Organization Inquiry, 10*(4).

Jones, K., Sambrook, S., Henley, A., & Norbury, H. (2012). Higher Education engagement in leadership development *Industry and Higher Education, 26*(6), 461-472.

Kaasila, R. (2007). Using narrative inquiry for investigating the becoming of a mathematics teacher. *ZDM, 39*(3), 205-213. doi:10.1007/s11858-007-0023-6

Kearney, K. S., & Hyle, A. E. (2004). Drawing out emotions: the use of participant-produced drawings in qualitative inquiry. *Qualitative Research, 4*(3), 361-382. doi:10.1177/1468794104047234

Kegan, R. (1982). *The evolving self*. Cambridge, MA: Harvard University Press.

Kelchtermans, G., & Vandenberghe, R. (1994). Teachers' professional development: A biographical perspective. *Journal of curriculum studies, 26*(1), 45-62.

Kempster, S. (2006). Leadership learning through lived experience: A process of apprenticeship? *Journal of Management & Organization, 12*(1), 4-22. doi:10.1017/S1833367200004132

Kumar, R. (2011). *Research Methodology: A Step-by-step Guide for Beginners*: SAGE.

Labour. (1997). new Labour because Britain deserves better

Britain will be better with new Labour. Retrieved from http://www.labour-party.org.uk/manifestos/1997/1997-labour-manifesto.shtml

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation,* . New York Cambridge University Press.

Lee, K., Ning, F., & Goh, H. C. (2014). Interaction between cognitive and non-cognitive factors: The influences of academic goal orientation and working memory on mathematical performance. *Educational Psychology, 34*(1), 73-91.

Lichtman, M. (2010). *Qualitative research in Education: A user's guide* (2 ed.). California: Thousand Oaks.

Luckmann, T., & Berger, P. (1964). Social Mobility and Personal Identity. *Archives Européennes de Sociologie, 5*(2), 331-344.

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education, 9*(3).

Masley, S., & Allison-Love, J. (2017). *Drawing as a research tool: what does it add? In:*

. Paper presented at the RCN International Research Conference,

, University of Oxford Examination School, Oxford, UK. Royal College of Nursing .

Matthews, S. (2011). A Note on 'image' methodology of social work qualitative research: Socially inclusive research methods for service users. *Social Work and Social Sciences Review, 15*(3), 119-127.

May, T. (2001). *Social Research Issues, methods and process*. Buckingham Open University.

McCaslin, M., L., & Scott, W., Karen (2003). the Five Question Method for Framing A Qualitative Research Study. *The Qualitative Report, 8*(3), 447-461.

McCormack, A., Gore, J., & Thomas, K. (2006). Early Career Teacher Professional Learning. *Asia-Pacific Journal of Teacher Education, 34*(1), 95-113.

McCrink, K., & Wynn, K. (2004). Large-Number Addition and Subtraction by 9-Month-Old Infants. *Psychological science, 15*(11), 776-781.

McCulloch, A. W., Marshall, P. L., DeCuir-Gunby, J. T., & Caldwell, T. S. (2013). Math Autobiographies: A Window into Teachers' Identities as Mathematics Learners. *School Science and Mathematics, 113*(8), 380-389. doi:10.1111/ssm.12041

McCullouch, J. (2016). THE CONTRIBUTION OF TEACHER CONFIDENCE TO 'EXCELLENT' MATHEMATICS TEACHING. *Philosophy of Mathematics Education Journal*(30), 1-12.

McMullen, R., & de Abreu, G. (2011). Mothers' experiences of their children's school mathematics at home: the impact of being a mother-teacher. *Research in Mathematics Education, 13*(1), 59-74. doi:10.1080/14794802.2011.550727

Mile, M., Huberman, A., & Saldana, J. (2014). *Qualitative Data Analysis: a methods source book (3rd ed)*. London: Sage.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis*: SAGE Publications.

Mizala, A., Martínez, F., & Martínez, S. (2015). Pre-service elementary school teachers' expectations about student performance: How their beliefs are affected by their mathematics anxiety and student's gender. *Teaching and teacher education, 50*, 70-78. doi:10.1016/j.tate.2015.04.006

Mohr-Schroeder, M. J., Jackson, C., Cavalcanti, M., Jong, C., Craig Schroeder, D., & Speler, L. G. (2017). Parents' Attitudes Toward Mathematics and the Influence on Their Students' Attitudes toward Mathematics: A Quantitative Study. *School Science and Mathematics, 117*(5), 214-222. doi:doi:10.1111/ssm.12225

Montague- Smith, A., & Price, A. (2012). *Mathematics in Early Years Education* Oxford: Routledge.

Moustafa, A. A., Tindle, R., Ansari, Z., Doyle, M. J., Hewedi, D. H., & Eissa, A. (2017). Mathematics, anxiety, and the brain. *Reviews in the Neurosciences, 28*, 417+.

NCETM. (2017). Maths Hubs. Retrieved from https://www.ncetm.org.uk/resources/46070#ItemActions

NCETM. (2018a). Mastery. Retrieved from https://www.ncetm.org.uk/resources/47230

NCETM. (2018b). Primary and Secondary Teachers sought to take forward teaching of mastery. Retrieved from https://www.ncetm.org.uk/news/51599#ItemActions

Nias, J. (2002). *Primary teachers talking: A study of teaching as work*: Routledge.

O'Sullivan, R. H., Yung-Chi, C., & Fish, M. C. (2014). Parental Mathematics Homework Involvement of Low-Income Families with Middle School Students. *School Community Journal, 24*(2), 165-187.

Obara, S. (2010). Mathematics coaching: a new kind of professional development. *Teacher Development, 14*(2), 241-251. doi:10.1080/13664530.2010.494504

OECD. (2015). *Programme for International Student Assessment (PISA) Results from PISA 2015 Country Note: United Kingdom*. Retrieved from https://www.oecd.org/pisa/PISA-2015-United-Kingdom.pdf

OECD. (2019). Skills for Jobs Database. Retrieved from https://www.oecd.org/els/emp/skills-and-work/changing-skill-needs.htm

Olson, A. M., & Stoehr, K. J. (2019). From numbers to narratives: Preservice teachers experiences' with mathematics anxiety and mathematics teaching anxiety. *School Science and Mathematics, 119*(2), 72-82. doi:10.1111/ssm.12320

Osteen, L., Owen, J. E., Komives, S. R., Mainella, F. C., & Longerbeam, S. D. (2005). Developing a Leadership Identity: A Grounded Theory. *Journal of College Student Development, 46*(6), 593-611. doi:10.1353/csd.2005.0061

Palmer, A. (2009). 'I'm not a "maths-person"!' Reconstituting mathematical subjectivities in aesthetic teaching practices. *Gender & Education, 21*(4), 387-404. doi:10.1080/09540250802467950

Palmér, H. (2016). Professional primary school teacher identity development: a pursuit in line with an unexpressed image. *Teacher Development, 20*(5), 682-700. doi:10.1080/13664530.2016.1202311

Peavy, R. V. (1993). Envisioning the future: Worklife and counselling. *Canadian Journal of Counselling and Psychotherapy/Revue canadienne de counseling et de psychothérapie, 27*(2).

Philipp, R. A. (2007). Mathematics teachers' belief and affect. . In F. Lester (Ed.), *Second Handbook of research on mathematics teaching and learning* (pp. 257- 315). Reston, Vancouver National Council of Teachers of Mathematics

Picker, S. H., & Berry, J. S. (2000). Investigating pupils' images of Mathematicians *Educational Studies in Mathematics, 43*(1), 65-94.

Povey, H. (1997). Beginning mathematics teachers' ways of knowing: the link with working for emancipatory change. *Curriculum Studies, 5*(3), 329-342.

Punch, K. F. (2014). *Introduction to Social Research: Quantitative and Qualitative Approaches*: SAGE Publications.

Radovic, D., Black, L., Williams, J., & Salas, C. E. (2018). Towards conceptual coherence in the research on mathematics learner identity: a systematic review of the literature. *Educational Studies in Mathematics*. doi:10.1007/s10649-018-9819-2

Renwick, R., & Brown, I. (1996). The Centre for Health Promotion's conceptual approach to quality of life. . In R. Renwick, I. Brown, & M. Nagler (Eds.) (Eds.), *Quality of life in health promotion and rehabilitation: Conceptual approaches, issues and application* (pp. pp.75–86). California: Thousand Oaks, CA: Sage.

Rhodes, C. (2006). The impact of leadership and management on the construction of professional identity in school learning mentors. *Educational Studies, 32*(2), 157-169.

Richards, L., & Morse, J. M. (2013). *Readme first for a user's guide to Qualitative Methods*. Thousand Oaks, Calif.: Sage.

Richardson, H. (2015). L'Oreal agree to change 'bad at maths' boast advert. Retrieved from http://www.bbc.co.uk/news/education-31658852

Riessman, C. (1993). *Narrative Analysis*: Sage

Robson, C. (2011). *Real World Research* Padstow, Cornwall: TJ International Ltd.

Rosenwald, G. C., & Ochberg, R. (1992). Introduction: Life stores, cultural politics and self-understanding. In G. C. Rosenwald & R. Ochberg (Eds.), *Storied Lives: The cultural politics of self- understanding* (pp. 1-18). New Haven, CT: Yale University Press.

Rugg, G., & Petre, M. (2007). *A Gentle Guide To Research methods* England: McGraw Hill

Saidin, K. (2017). INSIDER RESEARCHERS: CHALLENGES & OPPORTUNITIES. *Proceedings of the ICECRS, 1*. doi:10.21070/picecrs.v1i1.563

Saldana, J. (2013). *The Coding Manual for Qualitative Researchers* London: Sage.

Sawyer, W. W. (1949). *Mathematician's Delight* London: Pelican Books.

Schnee, E., & Bose, E. (2010). Parents Don't Do Nothing: Reconceptualizing Parental Null Actions as Agency. *School Community Journal, 20*(2), 91-114.

Seaton, M., Parker, P., Marsh, H. W., Craven, R. G., & Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: juxtaposing academic self-concept and achievement goal orientations for mathematics success. *Educational Psychology, 34*(1), 49-72.

Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*: Teachers college press.

Shapiro, S. (2011). EPISTEMOLOGY OF MATHEMATICS: WHAT ARE THE QUESTIONS? WHAT COUNT AS ANSWERS? *The Philosophical Quarterly, 61*(242), 130-150. doi:10.1111/j.1467-9213.2010.658.x

Shulman, L. S. (1987). Knowledge and Teaching: foundations of the new reform. *Harvard Educational Review, 57*, 1-22.

Sibieta, L. (2018). *The Teacher Labour Market in England*. Retrieved from London:

Silverman, D. (2010). *Doing Qualitative Research*. London: Sage

Skagerlund, K., Östergren, R., Västfjäll, D., & Träff, U. (2019). How does mathematics anxiety impair mathematical abilities? Investigating the link between math anxiety, working memory, and number processing. *PloS one, 14*(1), e0211283. doi:10.1371/journal.pone.0211283

Skog, K., & Andersson, A. (2015). Exploring positioning as an analytical tool for understanding becoming mathematics teachers' identities. *Mathematics Education Research Journal, 27*(1), 65-82. doi:10.1007/s13394-014-0124-9

Skott, J. (2013). Understanding the role of the teacher in emerging classroom practices: searching for patterns of participation. *ZDM, 45*(4), 547-559. doi:10.1007/s11858-013-0500-z

Sparks, D., & Hirsh, S. (1997). *A new version of staff development* USA: Association for supervision and curriculum.

Strauss, A., & Corbin, J., M. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. California: Sage

Stutchbury, K., & Fox, A. (2009). Ethics in educational research: introducing a methodological tool for effective ethical analysis. *Cambridge Journal of Education, 39*(4), 489-504. doi:10.1080/03057640903354396

Sumsion, J. (2002). Becoming, being and unbecoming an early childhood educator: A phenomenological case study of teacher attrition. *Teaching and teacher education, 18*(7), 869-885.

Sztajn, P., Hackenberg, A. J., White, D. Y., & Allexsaht-Snider, M. (2007). Mathematics professional development for elementary teachers: Building trust within a school-based mathematics education community. *Teaching and teacher education, 23*(6), 970-984.

Taylor, E. W. (2009). Fostering Transformative learning In J. Mezirow & E. W. Taylor (Eds.), *Transformative Learning in Practice: Insights from community, workplace and Higher Education.* . San Francisco, CA: Jossey- Bass.

Thomas, G. (2017). *How to do your Research Project* (3 ed.). London: Sage.

Van Zoest, L., & Bohl, J. V. (2008). Mathematics Teacher Identity: a framework for understanding secondary school mathematics teachers' learning through practice. . *Teacher Development, 9*(3), 315-345.

Vorderman, C., Porkess, R., Dunne, R., & Rahman-Hart, P. (2011). *A world- class mathematics education for all our young children* Retrieved from

Walker, M., Straw, S., Jeffes, J., Sainsbury, M., Clarke, C., & Graham, T. (2013). *Evaluation of the Mathematics Specialist Teacher Programme* Retrieved from London:

Weiss, R. S. (1995). *Learning from strangers: The art and method of qualitative interview studies*: Simon and Schuster.

Wenger, E. (1998). *Communities of Practice: learning, meaning and identity.* Cambridge: Cambridge University Press.

Wenger, E. (2000). Communities of Practice and Social Learning Systems. *Organization, 7*(2), 225-246. doi:10.1177/135050840072002

Wenger, E. (2004). Knowledge management as a doughnut: Shaping your knowledge strategy through communities of practice. *Ivey Business Journal Online, 68*, 1.

Wenger, E., Trayner, B., & De Laat, M. (2011). Promoting and assessing value creation in communities and networks: A conceptual framework. *The Netherlands: Ruud de Moor Centrum, 20*, 2010-2011.

Whealer, R., Ager, R., Burger, B., & Sizmur, J. (2014). *Achievement of 15 Year-Olds in England: PISA 2012 National Report (OECD Programme for International Student Assessment)*. Retrieved from London:

William, P. (2008). *Independent Review of Mathematics Teaching in Early Years and Primary Settings*. Retrieved from Nottingham:

William, T., & May, T. (1996). *Introduction to the Philosophy of Social Research*. London: UCL Press.

Williams. (2008). *Independent review of mathematics teaching in early years settings and primary schools*. Retrieved from

Wilson, E. (2013). Research Design. In E. Wilson (Ed.), *School-based Research. A Guide for education students* (pp. 357): Sage.

Wilson, S. (2018). UNDERSTANDING MATHS ANXIETY IN PRE-SERVICE TEACHERS THROUGH A QUALITY OF LIFE FRAMEWORK. *International Journal of Child, Youth and Family Studies, 9*(4), 168-187.

Young, R. A., & Collin, A. (2004). Introduction: Constructivism and social constructionism in the career field. *Journal of vocational behavior, 64*(3), 373-388.

Appendix A- Ethical Approval Form

University of Reading

Institute of Education

Ethical Approval Form A

Tick one:

Staff project: ___

Postgraduate project Ed.D : ___X__

Name of applicant(s): **Nasreen Majid**

Title of project: **How do primary teachers in England develop their professional identities as mathematics specialists?**

Name of supervisor (for student projects): **Dr Karen Jones (karen.jones@reading.ac.uk) and Dr Carol Fuller (c.l.fuller@reading.ac.uk)**

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		√
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) Have you taken the online training modules in data protection and information security which can be found here: http://www.reading.ac.uk/internal/imps/InformationComplianceTraining/imps-information-compliance-training.aspx	√	
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
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, will you obtain 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 11a is "yes", does your research comply with the legal and ethical requirements for doing research in that country?		
13a. Does the proposed research involve children under the age of 5?		√
13b. If the answer to question 12a is "yes":		

[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.

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		

PLEASE COMPLETE **EITHER SECTION A OR B** AND PROVIDE THE DETAILS REQUIRED IN SUPPORT OF YOUR APPLICATION, THEN SIGN THE FORM (SECTION C)

A: My research goes beyond the 'accepted custom and practice of teaching' but I consider that this project has **no** significant ethical implications.	

Give a brief description of the aims and the methods (participants, instruments and procedures) of the project in up to 200 words. Attach any consent form, information sheet and research instruments to be used in the project (e.g. tests, questionnaires, interview schedules).

Please state how many participants will be involved in the project**: it is intended that 20 participants will be involved in this study. All the participants will have undertaken a professional qualification in order to pursue a career as Primary Mathematics Specialists (PMaSTs). The study has not made any significant claims around gender, therefore, it would be appropriate to have a good gender balance within the 20 participants but if this does not happen, it will not affect the outcomes of the overall research.**

The aims of this study are to understand how Primary teachers in England develop their professional identities as mathematics specialists. The factors influencing the decisions to be a teacher and then a mathematics specialists will be explore, additionally, an insight into how these teachers see mathematics as a subject and as a result impart this understanding to colleagues is a key area of exploration. The influence of being a PMaST on other colleagues will be explored and how the PMaST see their identity development not just in personal context but a professional context will be key areas of exploration.

The data collection will take two key and distinct stages, they are explained in detail below:

1. **Your PMaST will be asked to do a pre task which will involve drawing out a 'Life Graph' of significant events that have developed their career and influenced their desire to pursue a mathematics specialism, this will then be analysed by myself in order to develop bespoke questions for a narrative interview to follow. This pre task will be discussed with your PMaST in person or via telephone or skype and an example will be provided in order for the PMaST to develop their own Life Graph. The Life Graph will then be collected or sent back to me by post for analysis. It is anticipated that the pre meeting or telephone/ skype conversation will last for 30 minutes. The Life Graph itself will take approximately 1 hour to complete. This hour might be spread over time as the task involves some reflection time.**

2. **Once I have analysed the contents of the Life Graph (this will take two week from the point of receiving the Life Graph), I will develop a range of bespoke questions, using the content of the Life Graph, for the PMaST. These questions will be linked to their professional career and their motivations to pursue a mathematics specialism in primary education. I will then return to your school, at a mutually convenient time, to conduct an in-depth interview with the PMaST. This will take approximately 45 minutes and with yours and the PMaST permission, I would like to audio record the contents of the interview for transcribing analysis.**

It is the intention of the researcher that the outcomes of this study will provide further evidence to quantify the importance of having a mathematics specialist in every primary school in England, in line with the recommendations made by Sir Peter William in his independent report on Primary Mathematics, (P. William, 2008).

This form and any attachments should now be submitted to the Institute's Ethics Committee for consideration. Any missing information will result in the form being returned to you.

B: I consider that this project **may** have ethical implications that should be brought before the Institute's Ethics Committee.	

Please provide all the further information listed below in a separate attachment.

1. title of project
2. purpose of project and its academic rationale
3. brief description of methods and measurements
4. participants: recruitment methods, number, age, gender, exclusion/inclusion criteria
5. consent and participant information arrangements, debriefing (attach forms where necessary)
6. a clear and concise statement of the ethical considerations raised by the project and how you intend to deal with then.
7. estimated start date and duration of project

This form and any attachments should now be submitted to the Institute's Ethics Committee for consideration. Any missing information will result in the form being returned to you.

C: SIGNATURE OF APPLICANT:

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 **Nasreen Majid 09/12/16**

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……

Date……

(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.

Appendix B- Head teacher Information Letter

INFORMATION SHEET FOR HEADTEACHERS

Research Project: **How do primary teachers in England develop their professional identities as mathematics specialists?**

Researcher: Nasreen Majid

n.majid@reading.ac.uk

Supervisor: Dr Karen Jones (**karen.jones@reading.ac.uk**) and

Dr Carol Fuller (**c.l.fuller@reading.ac.uk**)

I would like to ask your permission to work with a Mathematics Specialist Teacher in your school.

What is the study?

The study is part of my Ed.D thesis. I am exploring the professional identities of primary teachers who have completed an additional qualification to become mathematics specialists. The study intends to explore the notion of professional identity and I am especially interested to explore this with Primary Mathematics Specialist Teachers (PMaST) working in primary school.

Why have I chosen your school?

Your school has been chosen because I understand you have a PMaST working in your school.

Do I have to take part?

It is entirely up to you whether you wish your PMaST to participate in this study. You may also withdraw your consent to participation at any time during the research, without any repercussions to you, by contacting me directly using the contact details above or by contacting my supervisors (see details above).

What will happen if I take part?

If you agree for me to work with your PMaST, he/she will be asked to participate in two activities:

1. Your PMaST will be asked to do a pre task which will involve drawing out a 'Life Graph' of significant events that have developed their career and influenced their desire to pursue a mathematics specialism, this will then be analysed by myself in order to develop bespoke questions for a narrative interview to follow. This pre task will be discussed with your PMaST in person or via telephone or skype and an example will be provided in order for the PMaST to develop their own Life Graph. The Life Graph will then be collected or sent back to me by post for analysis. It is anticipated that the pre meeting or telephone/ skype conversation will last for 30 minutes. The Life Graph itself will take approximately 1 hour to complete. This hour might be spread over time as the task involves some reflection time.

2. Once I have analysed the contents of the Life Graph (this will take two week from the point of receiving the Life Graph), I will develop a range of bespoke questions, using the content of the Life Graph, for the PMaST. These questions will be linked to their professional career and their motivations to pursue a mathematics specialism in primary education. I will then return to your school, at a mutually convenient time, to conduct an in-depth interview with the PMaST. This

will take approximately 45 minutes and with yours and the PMaST permission, I would like to audio record the contents of the interview for transcribing analysis.

What are the risks and benefits to your school for taking part?

All names, including the name and location of the school, will remain anonymous in the write up of this research. Any personal information will be retained confidentially. Participation in this study is voluntary and you, as the headteacher, have the right to withdraw from the study at any time. If you wish to withdraw from the study, please write this in a letter or e-mail to myself or to my supervisors. Your school will not be identifiable in any published piece resulting from the study. It is intended that the findings of the study will be shared through a range of media, including writing in journals and presenting at subject specific conferences.

It is anticipated that the findings of the study will be useful for government policy and the sustained need for mathematics specialists in primary schools. Therefore, an opportunity to work with your PMaST will be invaluable to understand the drivers for the PMaST in order to develop mathematics in primary schools.

What will happen to the data?

Any data collected will be held in strict confidence and no real names will be used in this study. The records of this study will be kept private. No identifiers linking the participants or the school to the study will be included in any sort of report. Participants will be assigned a pseudonym and will be referred to by that pseudonym in all records. Research records will be stored securely in a locked filing cabinet and on a password-protected computer and only the research team (my supervisors and I) will have access to the records. The data will be destroyed securely once the findings of the study are written up, after five years. If you would like a brief summary or an electronic copy of the final thesis of the findings, you can e-mail me directly using the contact details above.

What happens if I change my mind?

You can change your mind at any time without any repercussions. If you change your mind after data collection has ended, we will discard the data that represents your school in the study.

Who has reviewed the study?

This study has been reviewed following the procedures of the University 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.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**) at the University of Reading's Institute of Education by email.

Where can I get more information?

If you would like more information, please contact me via email on: n.majid@reading.ac.uk

What do I do next?

I do hope that you will agree for your PMaST to participate in this study. If you do, please complete the attached consent form and return it by e-mailing it back to n.majid@reading.ac.uk

Thank you for your time.

Yours sincerely,

Nasreen Majid

CONSENT FORM FOR TEACHERS

Research Project: **Hoe do primary teachers in England develop their professional identities as mathematics specialists?**

Researcher: Nasreen Majid

n.majid@reading.ac.uk

Supervisor: Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**)

I have read the Information Sheet about the study and received a copy of it.

I understand what the purpose of the study is and what is required of me as the Headteacher. All my questions have been answered.

Please tick ('√') as appropriate:

	Yes	No
I consent to my PMaSTs participating in this study and to the use of anonymised quotes in the researcher's thesis and subsequent publications		
I consent to the audio recording of the interview		

I consent to my PMaST's participating in this study according to the terms mentioned in the Information Sheet.

Name of Headteacher:	
Name of School:	
Signed:	
Date:	

THANK YOU VERY MUCH FOR YOUR KIND ASSISTANCE!

University of Reading

Appendix C- Teacher/ Participant information letter

INFORMATION SHEET FOR TEACHERS/ Participants

Research Project:	**How do primary teachers in England develop their professional identities as mathematics specialists?**
Researcher:	Nasreen Majid n.majid@reading.ac.uk
Supervisor:	Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**)

I would like to invite you to take part in a study of primary teachers in England who have gained a mathematics specialists qualification.

.

What is the study?

The study is part of my Ed.D thesis. I am exploring the professional identities of primary teachers who have completed an additional qualification to become mathematics specialists. The study intends to explore the notion of professional identity and I am especially interested to explore this with Primary Mathematics Specialist Teachers (PMaST) working in primary school.

Why have I chosen your school?

You have been chosen because you have an additional qualification that has developed your expertise in mathematics in order to become a PMaST.

Do I have to take part?

It is entirely up to you whether you wish to participate in this study. You may also withdraw your consent to participation at any time during the research, without any repercussions to you, by contacting me directly using the contact details above or by contacting my supervisors (see details above).

What will happen if I take part?

If you agree to take part, you will be asked to participate in two activities:

1. You will be asked to do a pre task which will involve drawing out a 'Life Graph' of significant events that have developed your career and influenced your desire to pursue a mathematics specialism, this will then be analysed by myself in order to develop bespoke questions for a narrative interview to follow. This pre task will be discussed with in person or via telephone or skype and an example will be provided in order for you to develop your own Life Graph. The Life Graph will then be collected or sent back to me by post for analysis. It is anticipated that the pre meeting or telephone/ skype conversation will last for 30 minutes. The Life Graph itself will take approximately 1 hour to complete. This hour might be spread over time as the task involves some reflection time.

2. Once I have analysed the contents of the Life Graph (this will take two week from the point of receiving the Life Graph), I will develop a range of bespoke questions, using the content of your

Life Graph. These questions will be linked to your professional career and your motivations to pursue a mathematics specialism in primary education. I will then return to your school, at a mutually convenient time, to conduct an in-depth interview. This will take approximately 45 minutes and with yours and your headteachers' permission, I would like to audio record the contents of the interview for transcribing analysis.

What are the risks and benefits to your school for taking part?

All names, including the name and location of the school, will remain anonymous in the write up of this research. Any personal information will be retained confidentially. Participation in this study is voluntary and you, as the participant, have the right to withdraw from the study at any time. If you wish to withdraw from the study, please write this in a letter or e-mail to myself or to my supervisors. Your school will not be identifiable in any published piece resulting from the study. It is intended that the findings of the study will be shared through a range of media, including writing in journals and presenting at subject specific conferences.

It is also anticipated that the findings of the study will be useful for government policy and the sustained need for mathematics specialists in primary schools. Therefore, an opportunity to work with you will be invaluable to understand the drivers for you as a PMaST in order to develop mathematics in primary schools.

What will happen to the data?

Any data collected will be held in strict confidence and no real names will be used in this study. The records of this study will be kept private. No identifiers linking the participants or the school to the study will be included in any sort of report. Participants will be assigned a pseudonym and will be referred to by that pseudonym in all records. Research records will be stored securely in a locked filing cabinet and on a password-protected computer and only the research team (my supervisors and I) will have access to the records. The data will be destroyed securely once the findings of the study are written up, after five years. If you would like a brief summary or an electronic copy of the final thesis of the findings, you can e-mail me directly using the contact details above.

What happens if I change my mind?

You can change your mind at any time without any repercussions. If you change your mind after data collection has ended, we will discard the data that represents you in the study.

Who has reviewed the study?

This study has been reviewed following the procedures of the University 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.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**) at the University of Reading's Institute of Education by email.

Where can I get more information?

If you would like more information, please contact me via email on: n.majid@reading.ac.uk

What do I do next?

I do hope that you will agree to participate in this study. If you do, please complete the attached consent form and return it by e-mailing it back to n.majid@reading.ac.uk

Thank you for your time.

Yours sincerely,

Nasreen Majid

CONSENT FORM FOR TEACHERS

Research Project: **Hoe do primary teachers in England develop their professional identities as mathematics specialists?**

Researcher: Nasreen Majid

n.majid@reading.ac.uk

Supervisor: Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**)

I have read the Information Sheet about the study and received a copy of it.

I understand what the purpose of the study is and what is required of me as a participant. All my questions have been answered.

Please tick ('√') as appropriate:

	Yes	No
I consent to participating in this study and to the use of anonymised quotes in the researcher's thesis and subsequent publications		
I consent to the audio recording of the interview		

I consent to participating in this study according to the terms mentioned in the Information Sheet.

Name of Headteacher:	
Name of Participant (PMaST)	
Name of School:	
Signed:	
Date:	

THANK YOU VERY MUCH FOR YOUR KIND ASSISTANCE

Appendix D- Risk Assessment Form

University of Reading

Institute of Education

Risk Assessment Form for Research Activities February 2014

Select one:

Staff project: PGR project: ☑ MA/UG project: ☐

Name of applicant (s): Nasreen Majid (n.majid@reading.ac.uk)

Title of project: **How do primary teachers in England develop their professional identities as mathematics specialists?**

Name of supervisor (for student projects): *Dr Karen Jones (**karen.jones@reading.ac.uk**) and Dr Carol Fuller (**c.l.fuller@reading.ac.uk**)*

A: Please complete the form below

Brief outline of Work/activity:	**There are two data collection points for this study:** **1: After a 30 minute briefing, the participant will independently produce a 'Life Graph' of significant personal and professional events linking to their Primary Mathematics qualification and work.**

	2: The Life Graph will be used to develop a bespoke narrative interview, this interview will be audio recorded and will take approximately 45 minutes to complete.

Where will data be collected?	**The data will be collected in schools where Primary Mathematics Specialist Teachers (PMaSTs) have agreed to participating in the study**

Significant hazards:	**Are no significant known hazards that will impact on the participant, their wider professional community or the researcher.**

Who might be exposed to hazards?	N/A

Existing control measures:	**N/A**

Are risks adequately controlled:	Yes ☑ No ☐

If NO, list additional controls and actions required:	Additional controls	Action by:

B: SIGNATURE OF APPLICANT:

I have read the Health and Safety booklet posted on Blackboard, and the guidelines overleaf.

I have declared all relevant information regarding my proposed project and confirm risks have been adequately assessed and will be minimized as far as possible during the course of the project.

Signed: Print Name Nasreen Majid Date 0/12/16

STATEMENT OF APPROVAL TO BE COMPLETED BY SUPERVISOR (FOR UG AND MA STUDENTS) **OR** BY IOE ETHICS COMMITTEE REPRESENTATIVE (FOR PGR AND STAFF RESEARCH).

This project has been considered using agreed Institute procedures and is now approved.

Signed: …… Print Name……. Date……

* 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.

Appendix E – Example of Interview Questions

Participant 2, Interview questions

1. Tell me about your schooling in primary schools, especially relating to your learning of mathematics?
    a. You mention your maths teaching and learning up to the age of 10 lacked understandings- can you tell me more about that.
    b. You consider yourself as a mathematician in year 6, can you tell me more about this transformation, who enabled this and how it made you feel? (support by parents/ job share teacher)
2. I am quite interested in home influences in your education, especially mathematics? What aspirations did your parents have for you? Prompt, role model? Prompt- Experience?
3. You state that you felt disempowered when starting secondary school and throughout Key Stage 3, can you tell me about this?
    a. Friend taught you the maths…. Expand on this(CoP)

4. Your Life Graph moves into a high leading up to taking your GCSE, can you tell me more about this?
    a. Can you tell me more about your teacher, what was distinctive about the teacher that you remember?
5. Your Life Graph dips slightly when you talk about not pursuing mathematics at AS/A Level, can you tell me more about your reasons for showing this?

6. What were your main motivations for pursuing a career in primary teaching?

7. You did an undergraduate programme with an English Specialism…

    a. I am really interested to learn more about the mathematics modules, can you expand on this from your Life Graph?
    b. You talk about having empathy with pupils who struggled with maths whilst on teaching placement; can you give me more detail around this? Why were those feelings so relevant for you?

8. It is interesting that with an English Specialism, you took on a maths Subject leader job as an NQT, How did this come about?

    a. I am particularly interested in the individuals you mention in the Life Graph who supported you, can you tell me more about the role of the local authority colleague played in developing your confidence?
    b. What was the specific role the 4 headteachers played in developing your role?
    c. You talk about training events helping things become clearer, can you describe this in more detail?

9. Your Life Graph continues on a high with moving to a new school and retaining your role as a maths lead teacher.

    a. It was here that you talk about delivering CPD and working with an NQT to develop their teaching in maths? Can you tell me more about this?
    b. You talk about being satisfied in the role and being fully recognised by your colleagues? Can you tell me more about this?

10. How/ who did you hear about the PMaST programme?

a. Tell me more- story around finding out about the course
b. How did you feel when you started the course?
c. Tell me about your experience on the course? – prompts
d. Did you feel differently about yourself after taking the course? How?
e. Tell me about your participation and engagement with people in the PMaST programme at that time? (prompt - was it a good/bad experience – why?)
f. What was the most important aspect of that community? (prompt – why?)
g. To what extent have you kept in contact since completing the programme? How do you feel about that community? (prompt – is it important to you or not? In what ways?) around changes to self from own perspective and from the community perspective (personal and professional) -
h. Can you sum up the PMaST course in three words for me?

11. What role did leadership and colleagues in your school play in your development as a PMaST?

12. How did you make use of the expertise you developed on the course? How did it feel at the time? How do you think other people saw you? How do you know? Prompt - Did they comment/tell you that?

13. Your work with the National College sounds really interesting; can you tell me more about this?
    a. I am particularly interested in your identifying yourself as a maths teacher and an expert, what were the drivers for this?

   b. You mention the NQT whom you supported with maths undertaking the PMaST programme, how did that make you feel? How do you think the NQT saw you? Are you still in contact with this NQT?

14. You mention going back to a small school and leading maths, can you tell me more about the support you gave to colleagues and the support you were given there to undertake your role?
    a. You mention the word 'accomplished' – can you elaborate on this?

15. You have moved onto becoming a maths consultant at a local authority and now you are self-employed as a maths consultant. Can you tell me more about this and the people you have worked with?

    a. You talk about making a positive impact in school? Why is this important to you?
    b. Can you tell me what you mean by 'felt knowledgeable about less' over time?

16. What value do you think is placed on mathematics within society? Does this link to opportunity and ideas of social justice?

17. How do you see mathematics now and does this influence your work with educators?

18. Do you have anything else to add?

Appendix F- Example Interview Transcript: Participant 3

Interview transcription participant 3 interview took place on Friday 27th April 2017

NM: So Good Morning

XX: Good morning!

NM: Thank you so much for agreeing to take part in the research.

NM: I want to start by off by just getting your views on how you felt about doing your Life Graph, specifically linked to mathematics and the process that you went through in doing it?

XX: I really enjoyed it, it was really nice to go on my maths journey. I had a very negative (hesitated) view of maths and actually when I'd finished it I realised that in my later life that it was all very positive, there was a real positiveness about it and it was really nice to look and go oh yeah that really good that's, I really do feel positive about it emm where it had started from quite a negative concept it was nice to see.

NM: I's going to start the interview with you experiences of learning mathematics, I know you've kind of talked about it within the Life Graph. Can you elaborate on the learning of mathematics that you've mentioned in your Life Graph?

XX : So I cannot really remember maths before secondary school and that's probably something to do with my age, so emm and I can remember being at secondary school and it was just like someone was talking Japanese to me, I couldn't understand it didn't, I just didn't know anything about it at all and I left secondary school really failing in it and I went onto college for a year and I took maths and it was on a Friday and in the end I just bunked off because I just hated it , I used to sit there and I just, I couldn't not understand it, and I remember, I now still, you know it is quite a lot of, thirty odd years ago, I still remember sitting in the class sitting, thinking I don't know what you are talking

about I have no understanding at all of what it was and you know I used to, you know you added a zero or you moved the decimal point and it was just, it was just a different language.

NM: How did that make you feel because you made a decision not to go to the classes?

XX: Well yeah, I used to go and sit in the coffee shop and smoke instead, you know that was in the times when you could smoke anywhere you wanted to. It just, I've put dread there (referring to Life Graph) it actually made me feel horrible about just not getting it. I just…it was an awful feeling and it wasn't anything like not being about to do literacy or you know I was quite articulate I passed my English and I passed my English literature and language passed my history passed all my others that I'd gone to college for I didn't do very well at school, I didn't like school very much but I went back to college and I did okay. It was just maths that I couldn't crack and I felt that I was one of those people that would turn around and say I'm just not very good at maths I'm just not very good at maths and that would have been my line.

NM: The people around you, so in that class you obviously didn't stay in the class for very long (XX Laughs) but do you recall the individuals in that group?

XX: No, that was such a long time ago I don't really, but I remember sitting next to somebody who tried to help me and they'd obviously you know we were all there because we hadn't done very well at school so we went to college for a year to redo o levels and I remember him sitting there and trying to help me and being really grateful that somebody had taken the time to actually help but I still didn't get it. And that is the feeling of I sat here he sat there and remember him trying to and just like still that pit in my stomach that feeling in my stomach, feeling quite sick of just hating it, absolutely hating it.

NM: Moving on now and talking about the night school and the teacher who made those connections possible for you? Can you tell me about that experience?

XX: (voice changes) oh my goodness, I actually, there isn't enough room on the Life Graph where my feelings went. So I was 17 when I left college and this was how many years later I had had my child, I 'd got my son and I had done English A' level at while Tom had gone to nursery I wanted to do more, and so I enrolled on an English a level course and loved it and loved going and doing that and then I though do you know what I'm goona go for my maths again I'm gonna try because XX goona go to school, I don't want to be that person who doesn't help him while he is at school. So went to this night class and this teacher was just amazing (high excited pitch voice) and it wasn't even, I can't even say what he did he just made it, it was just like, this it, this is maths, this is what you do this is it! And I can't, I can't even say what he, it was like you know I think about all the teaching strategies I use now, I don't think he used any of them but he was like this is maths, this is what you do. And he must have done something there must have must have been some connection he must have gone back thinking about it now and thinking about my own teaching he must have gone back far enough for us to start somewhere and then build on and then I flew and it as just I absolutely loved it and I could not understand why I had never loved it before. And, he was just the most amazing person.

NM: So he created those connections without letting you realise that those connections were being created?

XX: Yeah, but he just made us, and it was all of us I remember, you know we were all in night school because we hadn't done maths we were all mature students emm and we hadn't got maths and we were all quite, I suppose quite frightened of it I think that's that's a real fear there is and you know I see it, there is a real fear of maths and I had it then and all of a sudden it was just like he opened my eyes and it was just amazing, it was absolutely amazing ….no, it was kinda like, it was I keep using the word amazing and I think if I'd said to him now you were amazing he probably would just think you know that was my job that was what I did I don't think he probably realised how, well maybe he did because I then went onto do A' level maths so that was…

NM: You talk about other students within that group as well the fact that you were all at night school and you know you were doing the maths because you found it difficult earlier. Can you tell me a little bit about the students, anything that you can remember about them and if there was a kinda community feel about working together?

XX: There was definitely a community feel because we used to go to the pub afterwards, there was definitely a community feel, and there was a definite feeling of achievement for all of us that just understanding what we were doing emm and there was a feeling of probably more because there were students in there that were younger so they would have been about seventeen who didn't quite join in there were a bit disjointed but the ones who were mature there was a sense of community, there was a sense of achievement, there was a sense of enjoyment and we used to go for coffees and you know and the break time you'd have coffee and you'd chat and that was probably the first time I'd ever felt that oh so that community of we are all achieving at the same time and it was a really nice feeling it was a very positive year for me. Yeah, but I don't think he would have known, he was a very old hippie teacher… laughs… and he used to I'm sure he used to smoke joints in between teaching us emm he just had this whole, this is maths there wasn't any stress about it and it was like this is what you do…laughs… and I'm sure there must have been this is why you do it because I it really clicked instead of teaching me the tune you add a zero, you move the decimal point I understood what I was doing and whether or not that was just the right time for me I'd got back into education again because of my son and because of doing English A' Level I'd got back into education I wanted to learn emm I think it just all came together.

NM: You went onto do you're a' Level and you talk about the fact that 'I can't believe I've got an A' level in maths?

XX: No.

Tell me a little bit about that part of maths?

So when I went to night school emm I'd done I'd taken a year and I'd done my biology then, I'd gone onto to do a science because I hadn't got science I'd gone on to do a science GCSE and I'd said are you doing A' level (maths) and he (science teacher) said no, so said I'm going to do it so I went to my local secondary school (laughs…) for (deep sighs) five week, it was horrible and I'd said can I come and do A' level with you and they said yes, absolutely fine but I was in a room full of 18 year olds, I felt very much a fish out of water emm the teachers had a very much a kind of attitude of emm my name of Mr so and so, I thinking hang on a minute I'm an adult, I'm not calling you this I'm not doing this. So then I went to him (teacher from night school) and said are you doing A' Level, he said yeah I'm doing A' level I said okay so laughs….. can I came and joins yours, during the day, again it was with 18 year olds it wasn't with or with 19 year olds it wasn't with mature students and that was a down side there wasn't that kind of comradery there wasn't that kind of not for me because you know I was married I've got two step children I'd got a son there was a very much a I wasn't part of that group. However, I still loved maths it was a just it was like people were giving me puzzles every day and it was like I'd get to the end of it and the feeling of achievement and the feeling of just wanting to do more and I used to go home, because I'd done intermediate GCSE I had to do extra work to get up to the higher standard and I did all my extra work and I did everything else and I came out with a B on my AS and it was just, it was the best feeling ever that I'd achieved something which, you know, fifteen years earlier I thought, I thought, I was a failure at that wasn't the feeling of failure not being able to achieve it and now being able to achieve it was like it was a WoW, yeah.

NM: You mention the young individuals in the class and you actually mention one particular person's name who sticks out!

XX: XX of I hated him, when we got onto A2 (maths syllabus) in pure 3 there were two of us in the class, there was Loui and there was me and Loui was one of those, he got everything so quickly so I'd be like I hated pure 3 and it actually taught me a little but like that emmm emmm, (pause thinking) the Zone of Proximal Development (Vygotsky learning theory) that whole kind of thing that actually

there is a point where I could not go any further my brain felt too slow it was sluggish it just it could not keep up that pace and he just got it. And the bless him, I mean he was younger than I was it wasn't he wasn't young young he hadn't just come out of school but he tried really hard not to get things quickly and not to say things and I still hated him he just was, he was just there and I could see him doing it and I could not remember anything and you had to pull in so many different pieces for pure 3 that I got post it notes around the house I'd got people to we've got this thing what can't you start a revolution without- pi I now have no idea what that means but we can only remember that started with pi and then you had a revolution. Emm there were all these things and in the end I got to the pure 3 paper and I kinda felt like I write my name waited for half an hour and just left because it was, it was ….but it really brought my grade down but it didn't make any difference I'd kinda felt like all the other modules I scored really well on and I'd done well it was just that pure 3 really hated it and Loui…

NM: you mention Loui but you also mention the fact that he really tried hard not to…. Get it

XX: Oh yeah he walked that process probably because I was like daggers at him across the classroom and the fact that there were two of us and I'd kinda go you know you are doing all these things… oh it was just, it was I remember that feeling but it took me I really had to constantly you know tell myself I was good at maths I was good at maths its just I didn't get this bit but as an adult I had those feelings and I'd had those feelings of negativity again about really you know I had to get into my mind set emm, no I am , all the rest of it had been great but just find this but too difficult it was too hard to link everything and it was making the links and I feel like now I understand maths is so much like, how I teach my children (pupils in school) its so much like a brick wall that its you pull and you start building up and then you'd have to keep using and applying those skills to get further and further up. It was just at that point I could not use those skills anymore I couldn't be quick enough to kinda remember what was there and what shouldn't have been.

NM: You are very proud of your achievements and that comes out very clearly in the discussion and the Life Graph as well.

XX: When I went I applied to go the University and this is a long process of teaching, you know and not knowing what to do and obviously a very mature students when I ended up going into teaching but I remember going and writing my UCAS form and the person saying oh you've got A' Level maths and literacy she said like that is really a big thing and I hadn't looked at it like that before said you don't get many people like this, they either go down the maths route they go down the literacy route there's not many people that have it and you need to make more of that and it kinda made me feel like oh okay then that's really nice, more aware of what I'm supposed to be doing.

NM: it was like a superpower you were not aware of?

XX: Yeah, totally not, I really you know and then people spoke about it you know and it wasn't anything I though was, we come from a family where my sister, you know and I you know if we can do it anybody can do it. So it never felt like it was an achievement or it was just you know it was just like most people can do this I've just caught up to most people it wasn't till people started saying well, no most people don't do this, you kinda realise oh okay, it is a little bit better than I thought it was going to be.

NM: before moving onto your teacher training I just wanted to unpack about your home influences, early on and parents, siblings grandparents and how they influenced your learning in any way if at all?

XX: I don't remember

NM: You went onto do a teaching degree and you recall nicely around the maths sessions and how you really enjoyed them? Can you tell me a little bit more about the memories you have around that and the students you were with as well?

XX: I remember going into it, we had again an amazing maths tutoring and she didn't teach all the time we were always really disappointed when she didn't arrive at the lesson and it was somebody else but she was one of those that it was just like this is maths this is what you do this is how it is you know it was just a very simple relaxed not stressed but what I… we had to do one of those you remember the people on the tree and you had to say where you were in your maths and the amount of students that were still so scared of it and it was really sad that, you know I'd gone on a really big journey and never thought I'd be going to university never thought I'd be doing a degree but I'd already gone on that journey and so I was sort of I was on top of the tree I'm smiling, I love maths everybody else were, people who were hugging the tree that were put themselves, and it was a real shock that people didn't like it and people were still scared of it, going to university and going to become a teacher and that they still had the hang-ups about maths and it was much more than anything else. So if you said science, everybody probably would have been completely different, or literacy or history maths was a really big thing that people didn't like and would quite openly say I don't like it, I can't do it and it was, it was kinda feeling of puzzlement I suppose more than anything I didn't thing people really, I thought I felt like this but didn't think everybody else did.

NM: So you were immersed in that do you remember going in and supporting these students or did you just do your own bits?

XX: No there was sigh… I think we came as a group but think there were other people in the group that liked maths so as a group you kind of supported your table or your friends, you know I ended up with a good group of mature students friends and I didn't need to support them in maths but they knew that I liked it so that I had a passion for it and that I enjoyed being there. So it wasn't , its not as quite as starker when I went into teaching that it was still more we were all together some people have strengths in other things you know I found spelling quite difficult so I used to people used to help with that and that kind of thing, so.

NM: You move on and you talk about your journey in developing as a teacher and specifically around having empathy for children who didn't get maths? Can you tell me a little bit more about that?

XX: I see them and you see the fear and its…pause…its very I can pick out, each year, I can pick out children that I have taught when they have got to year 6 you know have not understood it are frightened of it are like myself is in a totally different language and I can really emphaticise with that and so that part of that it takes me back to how I felt and I know that I got through it so I use those skills to help them achieve and maybe they don't like maths at the end of it but they are not quite as frightened of it as they used to be

NM: You moved on and you went into your teaching career and you talk significantly about year 6 teaching because you went into it straightaway?

XX: I was a year 5 teacher first then went into year 5 and 6. But yes was always part of that and then went back into your 5 and then ended up in year 6 for quite a long time after that it was one and a half form entry emm and so we used to stream for maths and I would take the top set and then I took the bottom…the lower group and again it wasn't it wasn't I don't agree with streaming however, I year 6 it got the results that we were able to you know support the school so.

NM: And by streaming just to contextualise it you mean setting for ability within a primary school?

XX: yes, and it was only two classes so we had the lower set and the higher set there was no middle set. So and yes so we just set.

NM: How many adults were involved including teachers who were working with these children?

XX: So we would have LSAs or TAs for each class, however I think, did the more able, probably not have a TA, the TAs went with the lower ability set because, the more able were able to get, you know there wasn't, we made sure that that higher set was a higher set and the lower set was the kind of mid lower so it was children who understood maths and got it quite quickly.

NM: And you talk about these adults did you meet for planning or did you do your own individual planning?

XX: No we did our own individual planning because we planned, although we might, we were following the framework (National Numeracy Strategy) at the time, so you would follow, A or B or whatever it was emm but you would do your own planning emm, we shared it for literacy but not for maths because you, you planned for your individual plans so there were things that they might have done slightly quicker although we followed the same curriculum we just took ours at a slightly slower pace and made sure that number was the biggest thing was first and palace value so we would just, although we were doing the year 6 curriculum it was just at a different pace.

NM: was there movement in the groups with pupils moving across as well or?

XX: yeah, but we tried not to…pause…hesitated…. Because it had a real negative effect and I know that setting can, you know it doesn't have a overall positive effect it got results for us emm but we tried not to because then it really did have a negative effect if you had somebody that was in the higher group and they had to come to me, that was really horrible and even then, you know we'd have people able should have gone into the higher set I wanted to keep because it's quite nice for other people to see what mathematicians can do and you know you should be able to share that but then that was almost a negative effect on then because they should have been in another classroom and then sometimes they feel they feel a fish out of water because it is going at such a faster pace so there were yeah….

NM: Were there any professional conversations you would have with the other teachers?

XX: yea, no yeah professional…, all the time, so we'd be talking about, I became, although I started as an NQT in the school, people knew I really liked maths and I became a real champion of maths and children knew I liked maths so they would come and tell me and they would talk to me and say ohh I did this in maths today and when I became more senior in the school lots of children would come up and talk to me about their maths, you know you'd get year 3s year 4 year 5s you know I've done this in maths, I've done this in maths, so I became a kind of champion but also when I started doing my other things I would come back and I would share ideas and we would all share ideas oh this worked really well this worked really well or I have done this activity and it worked really well emm you had those hind of conversations or supporting new members of staff when their maths wasn't going quite right and you know how this hasn't gone right you know have you got any advice about this, so those kind of conversations, professional dialogue were happening all the time it was very open to do that.

NM: You say as a very low point on the graph, you hated year 6 maths, it became just about passing SATs, can you elaborate on that, you talked a little bit about it?

XX: It was I got to the end, the last year in year 6, I got to the end and I remember starting the year and I have got to go through this again (emphasised) and it wasn't so much that emm it was because I'd got the lower set, it was having children that had had never done maths before that you know had made no progress over the four years….three years of being in key stage 2 and all of a sudden I had to get them yet again back up to a level 4, and I didn't mind it, it wasn't like I was just like I can't keep doing this I cannot keep having to go over the same things and keep going back constantly going back back back back back until we hit something and then we can go forward this is ridiculous! So I said I want to move into year 3 4 I don't want to keep having this problem that we are just in year 6 I've got to make all this progress in year 6 and that people aren't doing anything, so I was lucky I kinda went out of it and then went into year 3 4 and it was fantastic and I kinda you know

next year I put my, I want my teachers to go into year 3 because they are like little sponges and I think if you had been in year 6 and you know where you've got to go it was easier to kind of move them forward it was so much easier to move that forward and my class made really good progress and I loved teaching year 3 4.

NM: So you made those connections of actually what needs to be done lower down in order to sustain that progress in year 6

XX: And I knew that I didn't need to teach them like one of the things that kept coming through is the same as I'd had,you know, you add a zero, somewhere, I borrow something I do this and it was like arggggggghhhh ohhhhhh, soyou know in year 6 we had to go right back to what year 3, what should have been you know we'd get the numicon we'd get the dienes we use the expanded methods but as soon as they had got it we very quickly move on. So it was that kind of , in year 3 and year 4 we just took it slow we used the expanded method all the time, we used everything, you know we used the resources they knew they were subtracting what they had to do, why they were moving things across from one place to another what they were actually doing, and I know that then that would have been sustained as they went higher up the school but its one of those we'd worked really hard here to go from those expanded methods to children we said right at the beginning, children don't understand place value they don't get it it's just that think that happens so we worked really hard in putting that in place here. Within that its like we go back so we get thoses firm foundations and we make sure that they understand so you know with we are following a slightly scheme of work at the moment but I am and I think that that's what my journey has been its allowed me to be much more confident at saying, hang on a minute if they don't understand this theny cannot do this so there is no point in us going on to that and then supporting NQTs with the same like, look you know and bless her our NQT is working really hard but she has done equivalent fractions and she was like, I'm using multiplication, I was like um um um um, no okay, you've got to start with that image, they have to understand what's happening and once they have understood it

then they'll start making the links to multiplication and they will see a pattern and then all of a sudden you can see what's the pattern between these and how do I get there so if you get that bit then the year 5 teacher can take it on further but we have to get that understanding and that pictorial understanding and that image for them to be able to understand it or else they are just gonna end up singing the hymn and not knowing any of the words and you know probably got that analogy the wrong way around!

NM: So you are trying to get the NQTs to use appropriate equipment?

XX: Yes, we got the little, no they are not dienes, the little rods!

NM: Cuisenaire rods!

XX: but also getting them throughout I try to get them to draw an image so if they don't understand it what does it look like do now draw me another image so that when all those things are taken away from them we do it side my side so we do the resources and we do the image so that when you say right draw me a picture what's it look like, how then they still have got that skill of being oh I don't know it but if I try this that might work. So then I can figure it out.

NM: Thank You! So you talk about a research project that you did between 2008-2010 and that sounded really really interesting around problem solving, can you tell me how you found out about it in the first place?

XX: so I had a very very very supportive key stage leader she was brilliant and I started doing a emm she got three of us that were very young in our careers to carry out an educational research project within the school. So we'd lead teams and then we'd talk to governors at the end of it and told them what we had done. And mine was on guided groups do it was looking at how we use guided groups in maths and how we can use it for either pre teaching or we can use it to plug gaps or we can use it to develop ideas further but also that the guided group didn't have to be like I'm working with lower

set today and I'm working with the middle group actually it should be fluid and it should be I'm drawing these children in because they don't get it or I'm drawing these children in because they have got it and I want to push them further so not being so set in your ways of doing that and then I went onto do we went onto do ehh the first year of our masters and the schools had got together and said they will support so many young teachers doing their masters and I started it and I did one of them was maths and I did a research project on problem solving, I had to set maths and I'd given them the SATs papers and they were so many that left gaps and I said what are you doing, I know you can do this, and they were like it's too complicated it was too hard. So I did a week on problem solving and I said right we' re doing this week I'm gonna give you so many problems during the day and we did like a chart how do you feel about maths how do you feel about problem solving we looked at our feelings and then I said you can do what every you want you can work wherever you want you can do whatever you want but you can't do is ask me and I took myself right out of the picture and we started off with easy problems and every day they got progressively harder and at the end of it there was a bit where it was too difficult they could again a bit like me they could not make the connections but they had a puzzle and they'd go, oh no this is really good, oh I've done it. It was all NRIch staff (problem solving website ring by University of Cambridge) Oh I've completed it, at the beginning I thought that was a really hard and now I have completed it and we talked about and we built up some kind of success criteria what is it that you have used we came out with the biggest one was trial and improvement so we tried something and we didn't know we tried something else we put them together we made links and we completed it and it transformed them and I'd got children who was who were meant to be more able children who were struggling to get a level 4 went onto level 5 completed all the paper even if they could not understand it at the end they were trying something and it was just amazing to see that what had stopped it was their own fear it was that fear of I don't want to make a mistake so I don't know how to do I'm not even going to try. And over the week we took away that and we kind of said what's the worst thing that is going to happen. You know you do have all these skills you might not be able to know how to solve that

problem but drawing a picture, trying something all those kind of things linking your skills enabled them to go further and to start realising that they could do it.

NM: So quite an empowering process for the pupils as well?

XX: Yea, and I have used that every year since kind of I've kept going there and just giving them you know with year 3s we did one where you can use whatever you want and what we came up with which was really good for year 3s I thought was like some resources don't help (laughs…) because they had got everything out it was like did you actually solve that problem….no…. right that's a really good learning we need to get the appropriate resources to help us.

NM: You talk about it with such enthusiasm and clearly it's a great tool kit that you have developed that you carried on using as well. How have you worked with other colleagues and sued it as a training tool with them as well?

XX: Emm the problem solving I quite often leading maths emm at staff meetings in my last role I became maths co-coordinator and obviously maths specialists and I used to lead a lot of maths staff meetings I would encourage people , we'd encourage problem solving all the time, encourage especially the creating their own success criteria so they own in here we call them steps to success whatever you want to call them but it was empowering children enabling children to come up with their own they'd also you know, how do we solve problems you'd use a RUCSAC (strategy for reading and doing maths problems) method and then you'd kind of you'd unpick it and they had no idea what on earth they were doing so it was really encouraging and making sure that we put weeks in to say you know I learnt a lot about leadership that asking somebody to do something is not necessarily gonna get it done so it was giving people opportunities to say right during this week we going to do problem solving I want you to in your class come up with a success criteria you're then going to have it on the board for children to use and can you send me pictures can you send me this at the end of it so that we can put it altogether and celebrate it we'd have a celebration assembly with that and we did it over cross curricular so instead of being a literacy week it's gonna be a maths

week and everything has to be maths related. So there was lots of I kinda feel like, hopefully I empowered people to just be a little bit more free with their planning and with their ideas and sharing ideas.

NM: you know through the conversation we've just had I feel that there was a really lovely transition from being a class teacher to actually becoming a maths expert ? Can you tell me a little bit more about that?

I think the MaST course was that was the turning point. I'd done lots and lots of different things with maths and I'd been I'd done my little educational research project I'd worked with the primary strategy team looking at creating little games that went with the framework and that's where I'd heard about the MaST and I was like I wanna do that so I wanna do this so I sort of said, they said email this person so I emailed this person and said how do I get involved and the next minute I got this email back going its starting here can you just fill in the paperwork and I was like whhhhatt that, I don't know anything about it I thought I'd give it a go and just meeting people that were liked maths because even in school I had so many people who used to really frustrate me teachers saying I don't like maths well don't tell me that that's horrible and also the worst ones, I can't do year 6 maths pause… really you are an adult because and also you are a teacher why can't you do year 6 maths, this is ridiculous that you are telling me this, this is awful… (whispers), had to keep those feelings buried. And then all of a sudden you met ten twelve people who loved maths and it was a bit like going, I always say it's a bit like going to an AA meeting you'd stand up and say hello my name is XX Stuart and I really love maths that kind of feeling and it was such a feeling of you were altogether you might not have been the greatest mathematician you know there were people who were better at maths than you who got it quicker made the links quicker but you were just altogether you were championing your maths and being that person who said no I really am a maths geek and I love it and there is nothing wrong with that and we love maths this was it and it was just brilliant, absolutely brilliant and then this kind acme into my head because somebody else was

maths co-ordinator and going I should be maths co-ordinator and he (headteacher) was going okay then, not that they weren't doing a very good job but also I am going to do a better job than that and he was like oh okay you can be maths co-ordinator and it was like brilliant. And then it was just learning like how to deal with people how to get what you wanted but the MaST made me confident enough to say no, we need to do it this way I changed the whole calculation policy I changed the way maths was taught you know we got Numicon we had the primary strategy team people coming in to teach they were doing the XX it was for the LSAs to do, we got LSAs trained but we also had the primary strategies team coming in to over a year it was unfortunately the year I left but over the year to train up other so we paid for that we made sure that maths was a really important thing and it wasn't acceptable if children didn't make progress and that was a really big think, okay what are we doing how are we supporting these children and for me it was a real focus on year 3 4 because it was that they hadn't they weren't frightened of maths they were quite happy to use all the bits and pieces some of them didn't get it some of them struggled but they weren't there was no kind of on now I'm going into maths lesson they were all like yay its maths and the more you got excited about it oh I love maths you know the more children get excited about it. You know I'm not the maths lead here but they will come and talk to me about maths and they children will say look what I've done they know you are passionate about it. I don't know how that seeps out, it must seep out somehow.

NM: You've talked a bit about the MaST course, you've told me how you got involved with it as well and your feelings of when you started the course. Can you tell me about experiences during the two years and if anything really sticks out because you elaborated quite a bit already?

XX:I used to love going to the kind of network meetings where you just met up I used to love those. XX (colleagues on LA who ran the course with the HEI) were just brilliant and XX I can't remember her second name, she went onto XX emm and she was another person who had done so much with

maths and it just it just they all have this very relaxed atmosphere about them and just like really calm and this is just maths and this is you know it was just lovely just lovely being in that atmosphere and I used to love going to those meetings and just getting idyeas where they would give you new ideas and you would take them back to the school and you would try them and then you'd say this to a colleague, oh try this or try this or try this and they'd try them and it would just be a really great filtering down system and then you would do CPD about how to change things around and to do more open questions emm going to Reading when we stayed over, I was really nervous about that that was really it was funny I just was really worried but really not now but I kinda a very shy person so it too me a long time to get involved and there were so many people and I wasn't sure about it and we had that first day and it was just great and then being in the bar at the end of the day it was just lovely and other people were equally as nervous and shy.

NM: Do you still keep in touch with anybody on the course?

XX: I don't unfortunately although I did when I was still in XX so from that I ended up doing some work with the primary strategy team and we'd go into schools but I also did at the conference worked with somebody else about problem solving and about how to take it into schools so we did like a little section on that emm we used to kind of still meet up but then it changed my group everybody had gone like that and ten there were new people coming in who I didn't know so much so although I still worked with people I kind of lost touch with everybody.

NM: Can you elaborate what you meant by going like that?

XX: oh people sort of so one person went to XX one person changed their job so wasn't maths co-ordinator one person still did it and was part time one person was part time and still didn't do it anymore so there was lots of and then there was another person who was still there and I used to

meet up occasionally with him but it wasn't quite so, it wasn't that little group anymore, that had changed but people do people change, people move on and you know it didn't feel like a sad things but like that's what happens.

NM: Can you sum up the MaST course in three words?

XX: Oh my goodness….a big pause (6 seconds later) do they have to link

NM: They don't have to link just what you feel about the course

XX: big pause (6 seconds) empowering, positive I can't I want to say something like fantastic but I know that's not the correct word but it was just brilliant I can't do it, it was just great.

NM: I just want to have a little bit of a chat about leadership and colleagues in leadership in the schools that you worked in emm in your career and their role in developing you as a PMaST?

XX: Emm the main one was my key stage leader who then went onto be my deputy head and I would say that she was the one that just said go for it you know just go for it, you know if its you know I'd be grasping at everything and it was like my headteacher was just like if you want to go for it go for it so he was a bit sort of he wasn't that person he's sort of get into headship, he was sort of like le se fair and that kind of thing but my key stage leader was a really dynamic person you know shaped my teaching career and then said why would you not go for it why would you not have this opportunity so that leadership has been great. But then my headteachers again allowing me to do other things outside. You know I started chairing our maths co-ordinators meetings and he would give me time to lead that he would release me for going to do the primary strategy team. He saw the benefit of that in the wider community do me being a maths specialist was a good thing for his school. But he still allowed that to happen, he gave me the freedom to be able to do things I think because you work hard, you actually put a lot into the school so he gave me the time and the time to do whatever I wanted to do. So if I'd go to him and say can I do this he'd go yes, so I suppose that did give me, or I

want to change this he'd go yeah okay that you know he was quite le se fair, he was he did recognise that actually what I was going to do was of benefit to the school.

NM: You talk a lot about how you use and continue to use the expertise that you have developed with your mathematics and the individuals around you do you notice how they see you, because the children you were saying earlier come over and talk to you about maths and everything so you created this image of maths in the school?

XX: I think there is still, although I am not the maths lead here I do work very closely with the maths lead and she will come and its gaining experience and gaining confidence there is a little bit of, you know I did have a lot of responsibility in my last school and I worked hard for that and so I do have that kind of feeling (laughs) I want to do this and so I'm going to do it and I know what I am doing and have that kind of feeling of I do know what I'm doing and its empowering her to be able to say, no you do know what you are doing you do have these good ideas, you do know what direction you want to be you want the school to go in and what you understand at maths, she is equally as passionate about maths. We have talked about ways that we can develop it within the school. There is a little bit sometimes of her coming over and saying is this okay, yeah that is right I might do it that way but you know that's a little bit of advice about which direction of how to lead people more around the actual content of what is important in maths.

NM: So as a school leader and your background in mathematics do you see that as a real strength in driving the change in maths in school?

XX: yea, not just driving the change in maths but also emm now being on the SLT that whole feeling of driving lots things so you the literacy as well supporting the literacy co-ordinator in things like moderation feeding back to the rest of the school changing the direction of where we are going and really I kind of feel like this is your subject you need to lead it and again kind of helping steer that but not being the one that says this is what we do and that's again, we are a new school, next year we we'll have more pupils there will be more co-ordinates so its that kind of understanding that this is

your subject and actually you need to be the expert in your subject so when people come to you and say I'm doing this history topic you need to be the one they says oh this is a really good idea so just pointing people in the right direction of history association or geographical association or things where I use research all the time, if I don't know something I will research it and I know who to go to and the places to go to to find the answer and just making sure that those people know that as well.

NM: You've actually already answered the next question which is linked to the primary strategy team and the co –ordinating meetings that you led. Was this a direct link to your MaST programme as well?

XX: yeah, Xx who was on the MaST as well, he got a role in that and then became the leader for MaSTs going into schools to support schools, so it was working closely with him and I really enjoyed it although I am not sure I liked going into schools very much I am not sure that was me.

NM: You've talked about shifting responsibilities now just had that conversation emm you say that you miss being involved with the maths emm can you tell me a little bit more about that?

XX: Yeah, I think it's just you know it is really hard to sometimes take a step back when I know and I can see and I would do the staff meeting like this and I would do it like this and I'm having to take a little step back and go its not my responsibility and I have to not push my, you know I can advise and I can hopefully steer in the right direction but actually it has to be somebody eases responsibility and I can't take that away from them but I do miss that you know feeling of you know I'd be doing this you know I'd be jumping and I used to every time we had staff meetings I'd be like yeah yeah no I want two staff meetings for maths this week, this year, this term they would say right you want another maths staff meeting yes yes yes another maths one and if we do this can we link it to maths and there was lots of that and that isn't quite here and I want to grab it and do that but I have to take a step back but I do miss it and I miss having that focus of maths its just like this lovely subject and next year I'm taking an even bigger step back because I'm not going to be teaching I'm, at the moment I have half a class with someone, I have a job share and next year I'm not I 'm just going to

be teaching for a day although I am going to be teaching year 6 maths I'm only going to be teaching for a day and that's going to be hard., I love planning maths I love planning I love thinking about what have they going to do and how are they going to do it.

NM: That's almost like a puzzle isn't it

XX yeah, it really is part of the enjoyment and I'm thinking I am going to print out, because we are using the maths hub stuff, oh its not me teaching it next year and oh okay…big sigh…..

NM: And how do you see mathematics now, its come out really clearly in the discussion we have had and how does this influence your work as an educator and with educators?

XX: I think it's I still feel it's the second subject, I still feel like we have such a literary curriculum and I would love to turn it around and it is so slow it's like trying to turn a barn, it's just, it's not quick enough. Literacy is everywhere and its everything and I don't it's still not given the same weighting and it's so important you know when you think about the links people make when they can do it in maths they can do it in other subjects and it's this hour that its given, sometimes it's given a little bit more than that if you out it in science you know that kind of thing but yeah, reading writing it goes everywhere and I know they are trying to do that now I know it's trying to come in its just it's so slow its creeping slowly I still have we still have people who aren't confident in maths coming through and that really worries me that I look like and I find it very hard to switch off from the experiences that I have had to what I was like as an NQT or as a student but I still feel I had a lot more passion about maths being a student and an NQT you know we have students who you know we add a zero…(frustrated voice) no we don't add a zero you know ahhhhhhghhhh. This is not something that has been around for the past fifteen years we don't add a zero, we don't move the decimal point we do not do that we've got to teach them the correct method. Yes we can teach them those tricks but teach then the tricks later we need to get that underpinning you know why aren't we using the stuff why haven't we got the resources why are your children using these resources so it still feels like there is a slog to go and I wish there was more people who had that good understanding.

NM: You've shared your really interesting journey into primary education and then maths specialism and then leadership as well. So where do you see yourself now a primary teacher a maths specialist or it's a new identity?

I think it's a new identity, next year it's going to be much more going into the deputy headship I am still key stage leader but I am having to take a step back it's the first time I have ever been, not had a class and I'm you know being a mature student there is a kind of like I'll give it a go, if I don't like it I will go back there is a much more freer and confident understanding of I don't need to be doing this if I don't want to do this if I want to do this I will do this. Emm I'd love to just teach maths, if I could I would just love to teach maths I think that would have been my ideal and here we've got a lovely opportunity because we are part of a through academy so they arrive in reception, they leave at post 18 emm there might be opportunities that I could go and teach year 7 maths you know there are other opportunities for me that might arise emm but at the moment its taking a path into deputy headship and taking a step outside the classroom and seeing how that goes…. (laughs)

NM: I hope it goes well

XX: Yeah I do, you know I sort I like ohhI kind like really like being in the classroom love teaching. I chose this career I didn't at 18 and like I want to be a teacher no I chose this career this was the only thing I wanted to do when I had my children so not teaching fulltime is going to be a bit odd.

NM: I know you have elaborated on the value that is placed on mathematics within society would you like to tell me a little bit more about your feelings around that?

XX: Em I think just that I still feel quite sad when people you know teachers especially will turn around and go I don't think I can teach year 6 maths and that worries me and that's why people don't want to go into year 6. No one turns around and says I can't do year 6 grammar you know no body's every said that to me I can't tach year 6 English but year 6 maths is always a big deal or just

key stage 2 maths some people say, oh I can't go into key stage 2 because I can't teach the maths whatttt….you know and parents who say I can't do maths you know society as a whole it is still acceptable to say I can't do maths and I can't I was that person so I have changed and I keep trying to change it and we have a real growth mind set I can't do maths, we can't do maths yet, we can't do it yet, of course we can't we are learning you know we will learn and we will try and we will get better at it so we are trying to change the mind set of children that isn't there of courser that's not there yet, we are are gonna find things difficult we use our learning pit we should be in the pit, if we are not in the put we are not learning anything we've got to be in the out if you are out of the pit you have to get back in the pit those kind of things so children know there is a journey on that that it is not going to be easy they are going to find some things tricky and then when they get it oh its easy of course it is that that's what happens. I'd like we are doing it bit by bit with our children I know other schools are doing it bit by bit with their children the more maths specialists we have the more that we give this the kudis that it should have I am hoping it will change.

NM: Do you think that is intrinsically linked to opportunity where people say I am not good at maths and the ideas of social justice and movement into job opportunities?

XX: Emm I think if (pause) I don't know really I don't know because that is maybe just education in itself I think that you know that is the biggest factors about social movement is education and but at the moment I still think it is literacy based I still think that if children aren't articulate and they can't read and write that is going to stop them more than not knowing their maths but if somebody is amazing at maths I think that there are opportunities for them that maybe if you are amazing at literacy I think there, is you know I know children that are absolutely amazing at maths, I used to love the things that they came up with you think wow I never thought of that you know they are going down a specific path it is not going to be a broader that's the path they are going to go down and they are probably going to do very well in that path if they have got that family support behind then to be able to say actually y you are really good at maths this is the way you are going to go.

NM: Thank You very much. That's the end of my questions, is there anything else you would like to add to the interview.

XX: No, I don't think so, I'd probably said it before though I think you know the MaST course really did change the direction of my career and I think, I wish we had more I wish there were more opportunities for people to go on courses and to have that expertise and so they can bring it back into schools and be better maths teachers.

Word count:10,640

Appendix G- Example of Data arranged by theme- Primary schooling

Primary Schooling

Nicola: I loved maths at primary school, really enjoyed maths my father spent a lot of time with me at home teaching me his strategies emm, in year 3, and I can be really specific, I can go right back to that day , negatives stick with you don't they…, my teacher had shown us how to do long multiplication, as it was known then and I didn't get it. I went home and my Dad showed me how you did it, so I filled up a whole note book because I got it, how my dad showed me, the method, not the understanding of the number but I got the method and so I was so excited and so eager to please my teacher, I took it [notebook] in and she… ripped it up because I hadn't used the method she had shown. She told me I was stupid because I didn't get it and from then on that was my default I didn't get maths so….maths stopped making sense because I believed I couldn't get it and it was my lowest subject I got at GCSE.

Nicola: In front of my class and it….(hesitant) stopped me bothering really once I… I have always wanted to please my teachers, I am very helpful, I always want to learn, I always want to do better emmm, my parents raised me to do whatever you want, just keep trying and she [teacher] took my passion away.

Gregory: okay, so in terms of primary so I can always remember feeling more at ease when learning areas to do with English, both reading and writing. With the maths creating a greater level of anxiety, it's very hard to say precisely where the anxiety came from emm… possibly enforced by the self-perception that I wasn't one of the higher attainders in the class so I possibly in comparison with social peers emm gave that feeling. And once that feeling was in place, looking back now was hard to change and it was only really in when I got to year 6 that I found a teacher who had some belief in me as a mathematician and that went on to allow me to develop a level of confidence. Ironically that teacher was a job share and so for half of that week I (laughs) perhaps I had that level of anxiety but for the other half I sensed a shift and then I recall a parents evening in year 6 where it was verbally

fed back to my parents whilst I was present that I had made some steps forward. I guess the very final memory from primary school was being the very first year of the KS2 SATs testing and having looked back at more recent years I was predicted a level 3 which would have been the first time around and hence the level of assessment may or may not have been easy to gauge, so although I was predicted a level 3 I did attain the level 4 on the test which I find quite ironic looking back

Gregory: Becoming a mathematician felt empowering in the sense that I understood the teaching and learning that was going on and tying it back to your previous question, my parents I would describe as working class, my dad would go out to work and my mother was a stay at home mum for various reasons and nobody in the family had ever gone through to further education in terms of University so going back to then your next question I would say that becoming a mathematician was linked with feeling competent in understanding the maths because I don't doubt for a moment I had times I could get answers established in accurate way but the solid understanding wasn't there so much, and I think the feeling of being a mathematician was linked to conceptual understanding.

Sharon: That is really quite high on the graph because that is one of very very few memories that I have of primary maths I have a really negative one that we will probably talk about later in what will be equivalent to year 6 now and when I search back through my memory to think of any emm memory that I had of learning maths, that was really the only one apart from one that I didn't document on the Life Graph, I remember in reception drawing triangles and circles and squares into relevant places and thinking this is quite good, I am quite good at this I have joined up all my 2d shapes but there are huge gaps from sometimes years at a time when I don't recall learning maths at all nothing specific in the way that this was specific and it's really jumps out from my memory because of I have a really strong memory of walking into the classroom in the morning and there being a fruit and veg stall set up in my classroom and I was just so excited to see that. It had the, I'm guessing it was plastic, it would have been wooden at the the time, fruit on it and a basket for us to

go shopping with there were purses with pretend money inside and the whole ideal of being able to play maths emm I don't know whether it even struck me that it was maths I know now, looking back that it was a math lesson but at the time it was something that it was really really fun that I knew that all of us would have a chance to be involved in both as shop keeper and a shopper and it was terrific and as I say I don't really have any other memories a few years after that.

Sally: Yeah, I think that was kind of nice having more challenge because there was a definite point where I… primary school was quite tricky I had quite a lot of bullies and that sort of stuff emm and so it was really nice for them to kind of see me in a different light which I found really interesting. Funnily enough I was one of the first years to do SATs emm and I was one of those people who took forever to mine and when I came out they said on you took forever you must have been rubbish at it but actually I got like, I think I was second or something in the class. But yeah it was really interesting but they kind of, the fact that they took so long to kind of being recognised that I was okay at doing it was interesting.

Emma: Yeah, like I say, primary school I didn't remember a lot of it, I think I remember sort of quite enjoying it and very much sort of arithmetic and we are going back into the sort of 60s as such when I was at school emm but I did put as a low point that I remembered on a Friday that we used to have these special cards and you took certain cards and you had, I guess problem solving activities to do that were a lot to do with what I now know as being sort of more measure, shape more practical maths as opposed to the arithmetic and I think that always gave me sense of the fact that I remembered doing I enjoyed doing that. So, I obviously quite liked it and there must have been you just had your answers and that I found easier.

Roseanne: Primary as far as maths is concerned, I can quite honestly say absolutely zero! I don't know whether that's my age or what else. I can actually quite vividly remember some subjects I remember the literacy side of things and history side of things and the fact that I really enjoyed

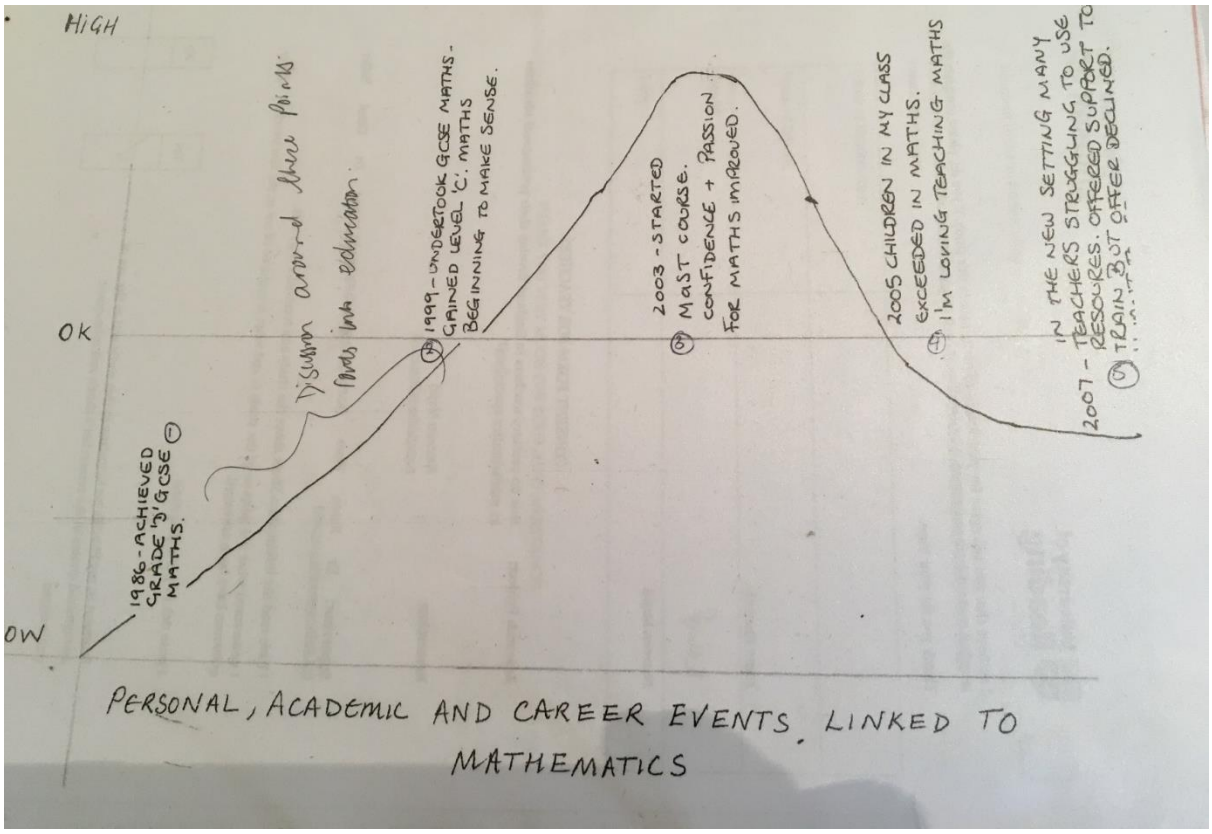
writing and more creative and I can remember science lessons and trips and I can absolutely remember nothing about maths in primary, nothing at all.

Belinda: Primary, So maths at primary school was we worked through a scheme called Peak Maths where we basically were given a textbook and we worked through it and emm I was always the furthest ahead from everybody else and that just as simple as that emm I don't remember being taught maths I don't remember maths lessons I just remember working through the books and I remember being able to explain to other people who got stuck on pages, how to work it out.

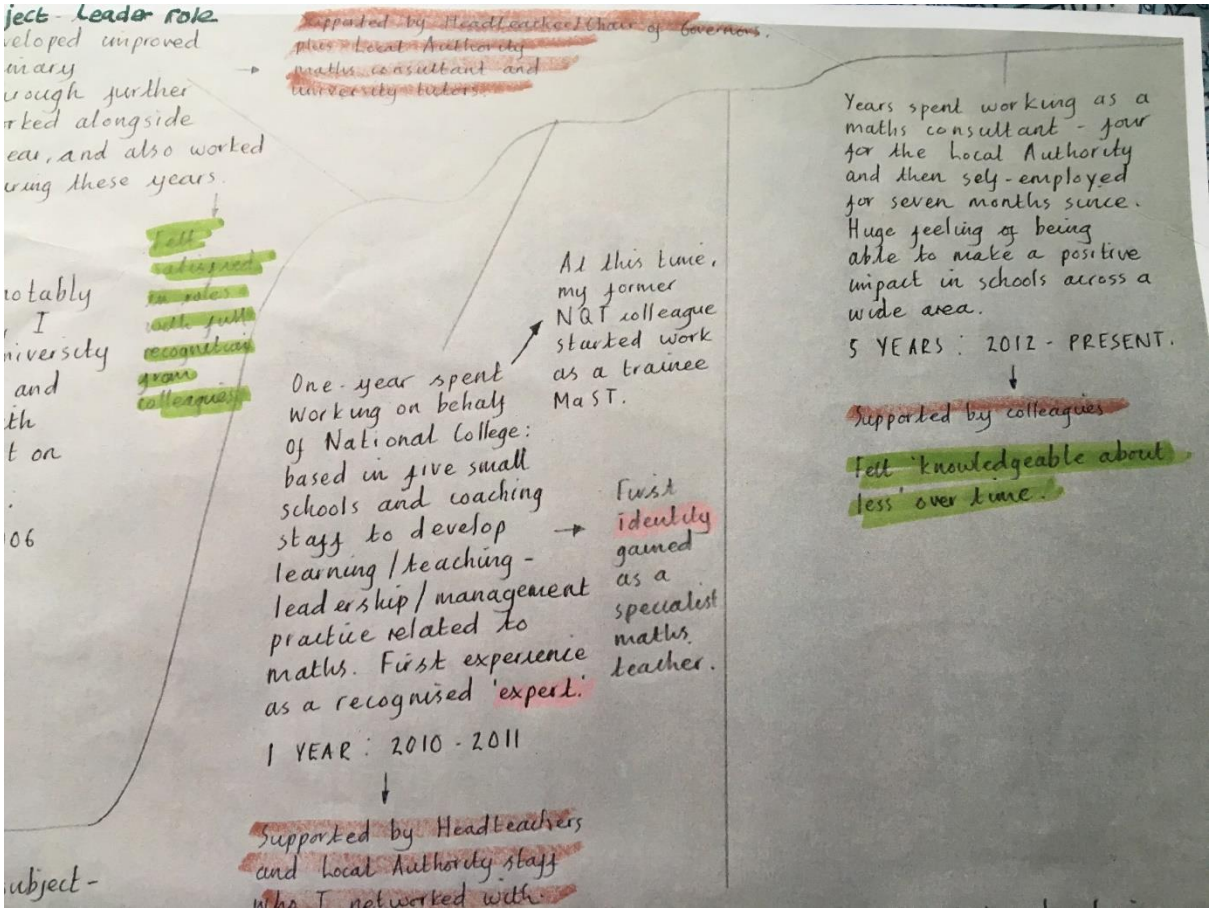
Michelle: Yeah, I don't feel like I have that much to say about primary in particular because I just have so few memories of learning maths specifically in primary school emm really the only memories I have are sort of sitting down, having a list of sums on the blackboard and sort of copying them out in my book and I found that quite safe and comforting because I was given the formula, I knew what to do and I could kind of finish off my sums quite neatly and I quite enjoyed doing that. My husband sometimes talks about his primary experience of sort of problem solving in maths. I don't really relate to that, I don't remember sort of problem solving type challenges or any practical equipment or anything like that.

Appendix H- examples of Life Graphs- take photographs of all Life Graphs to add here.

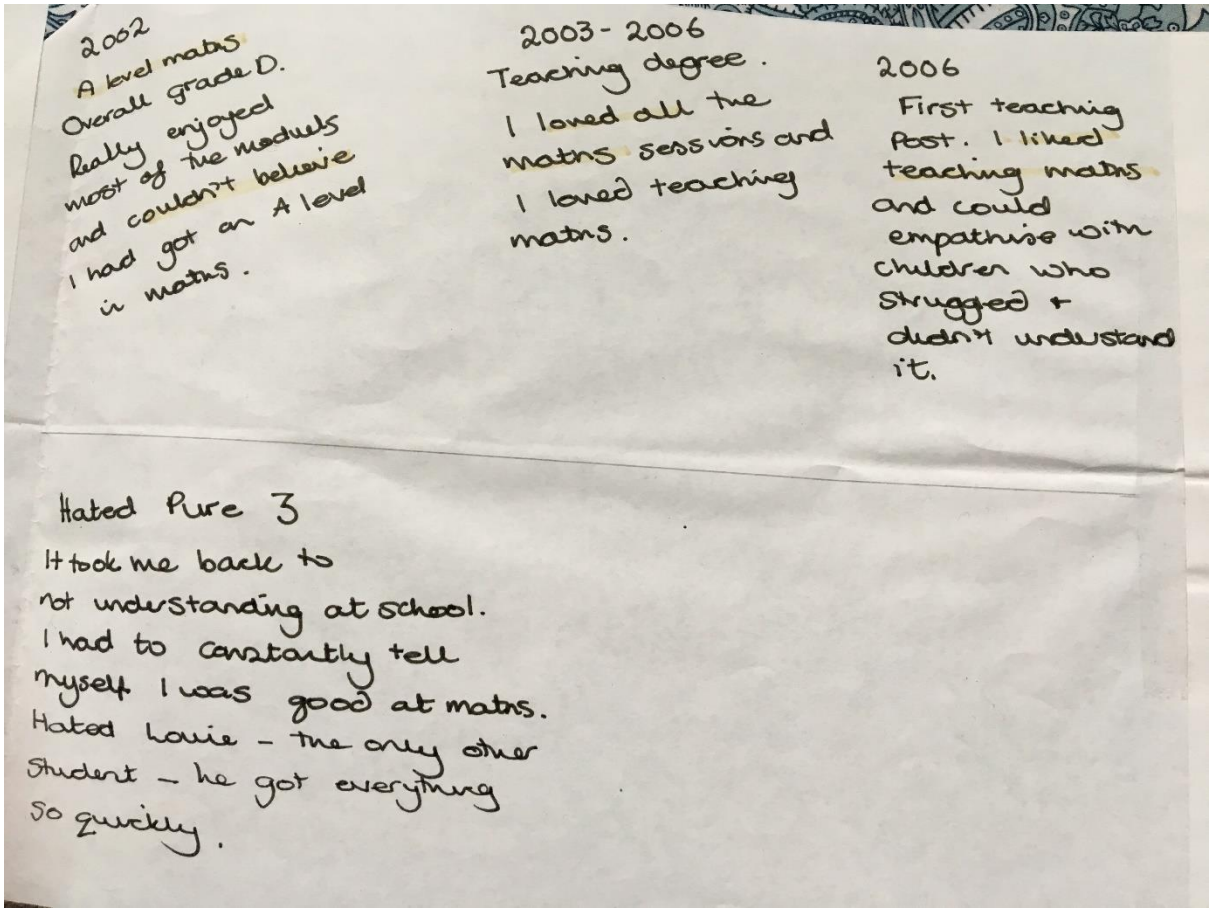
Extract from Nicola's Life Graph



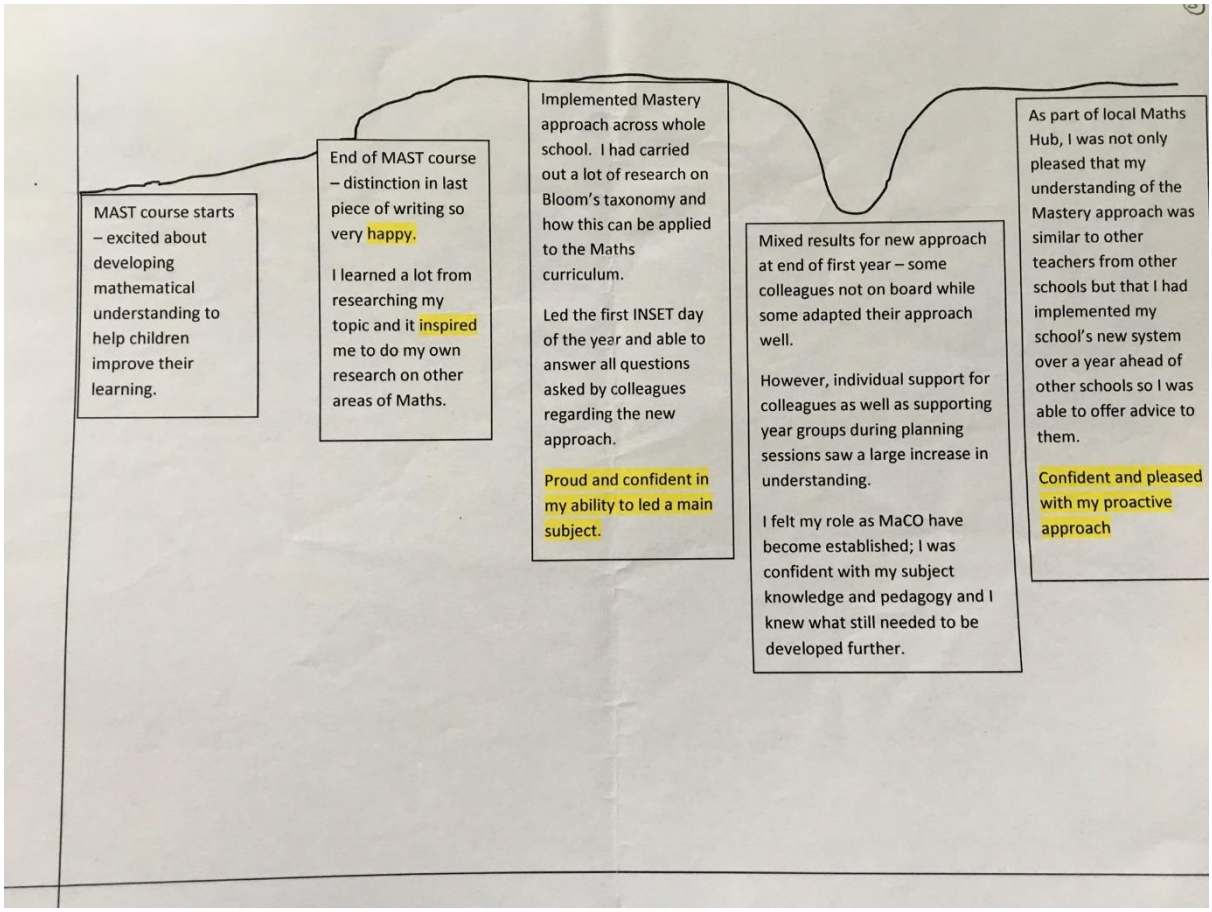
Extract from Gregory's Life Graph



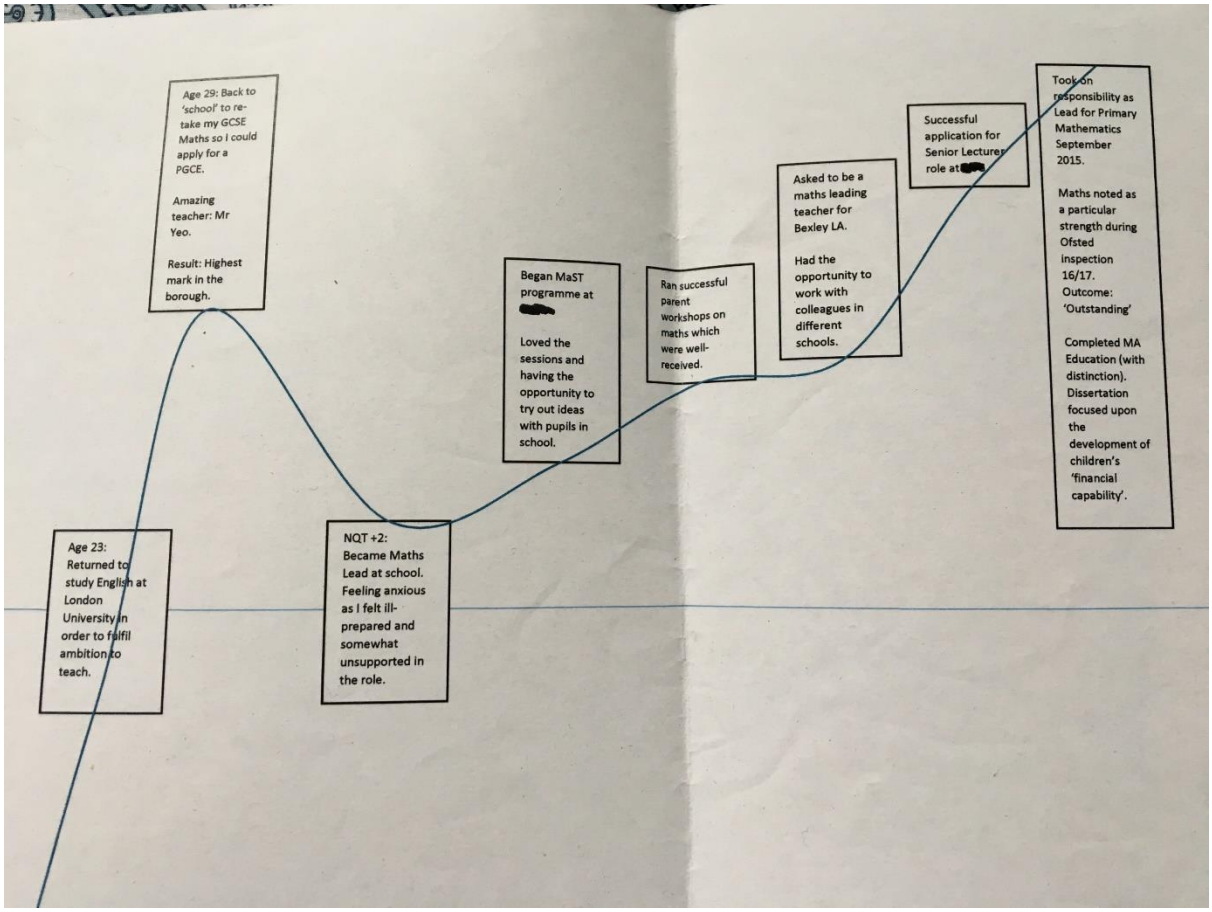
Extract from Reece's Life Graph



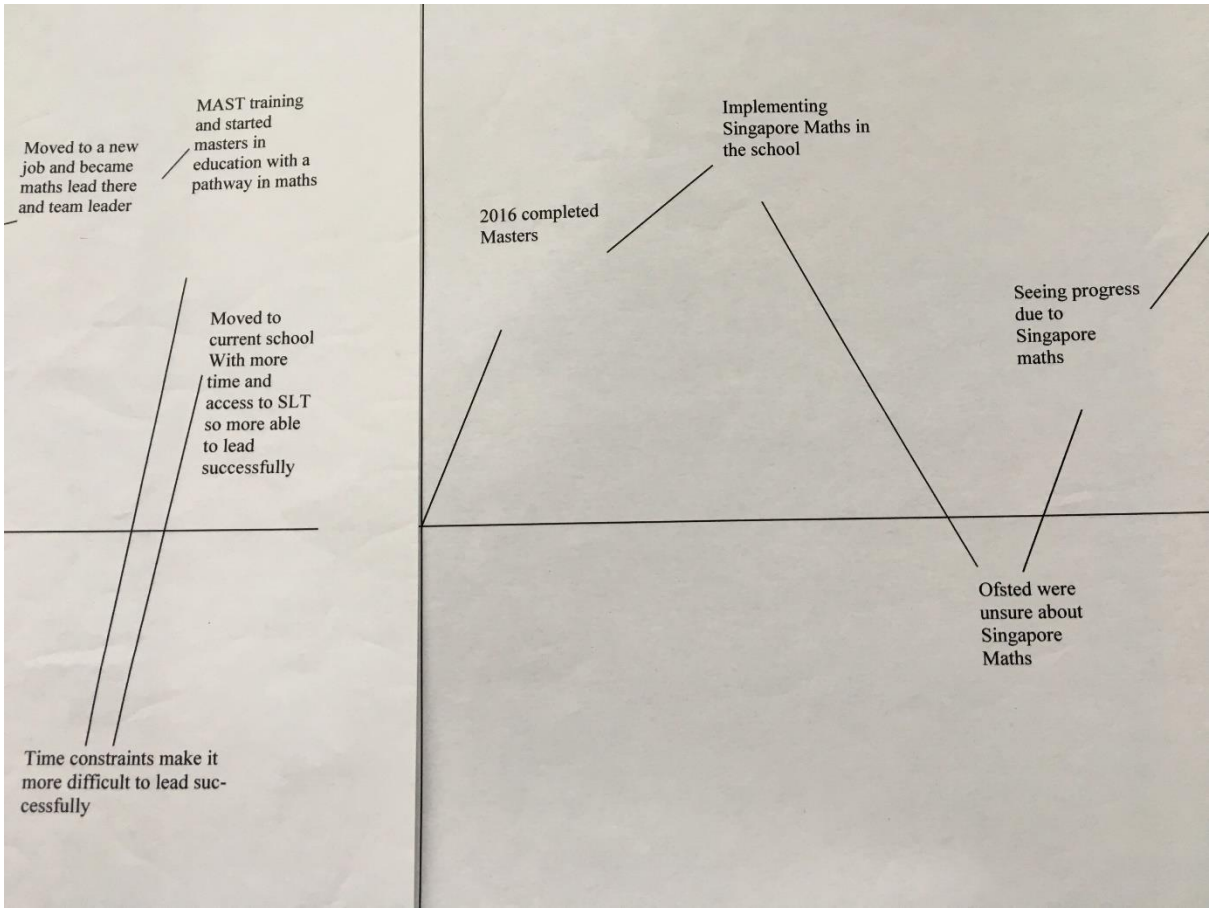
Extract from Thomas' Life Graph



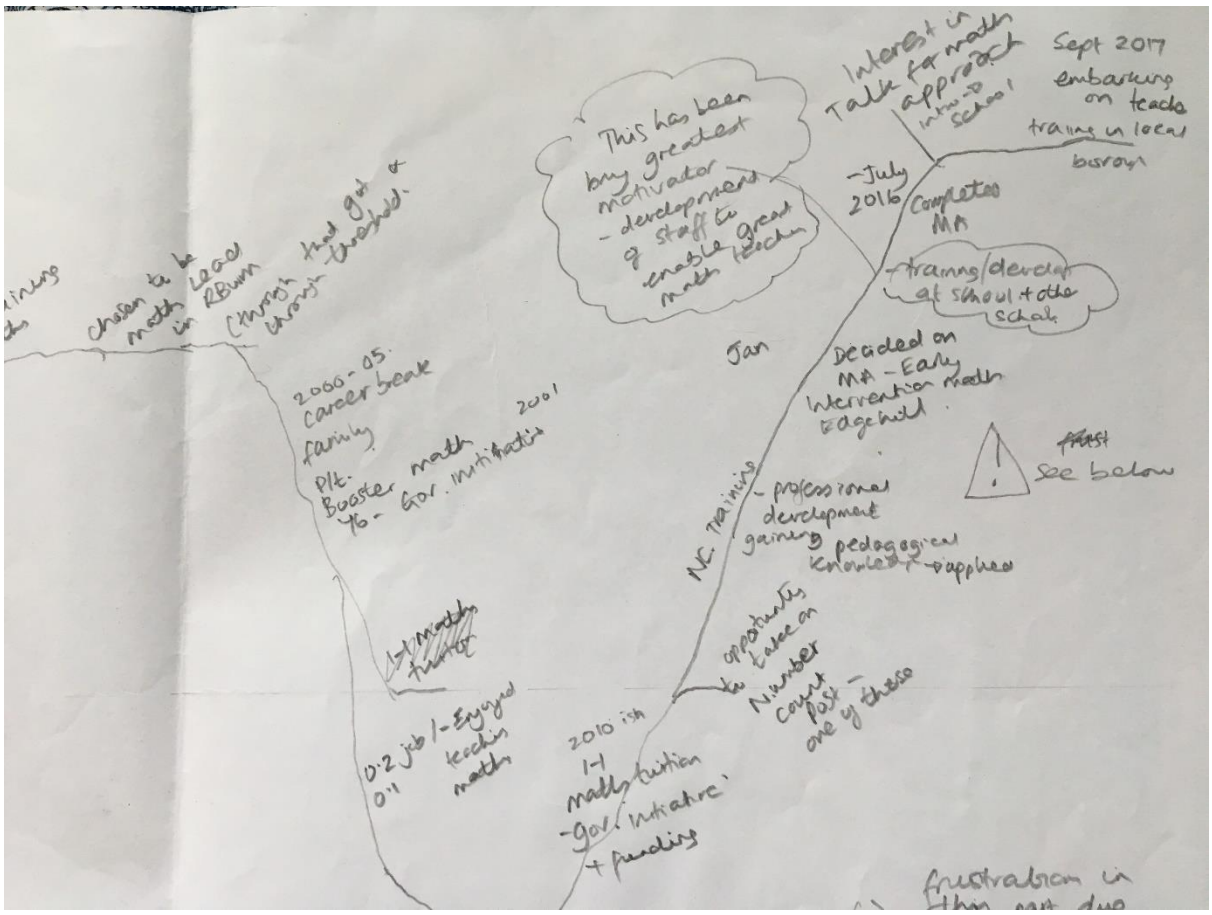
Extract from Sharon's Life Graph



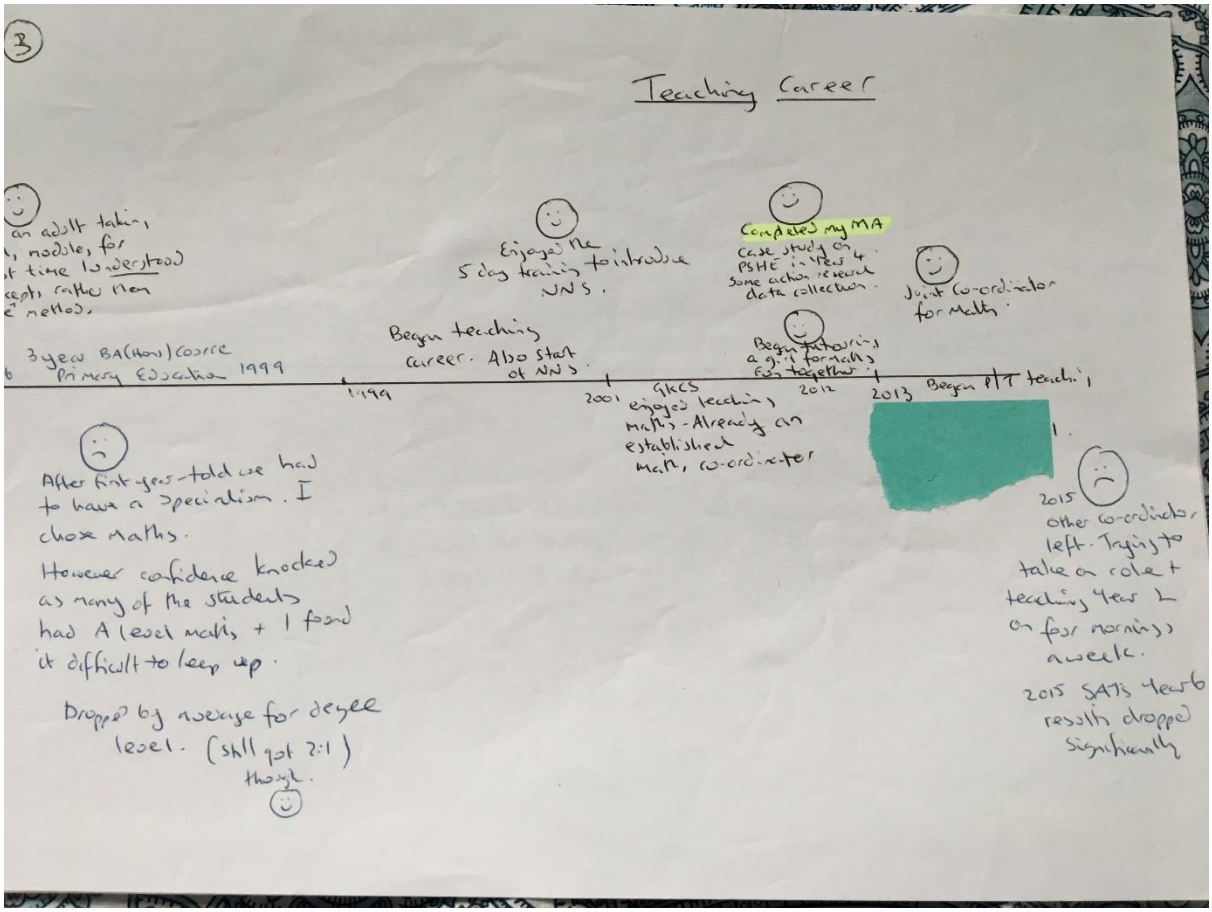
Extract from Sally's Life Graph



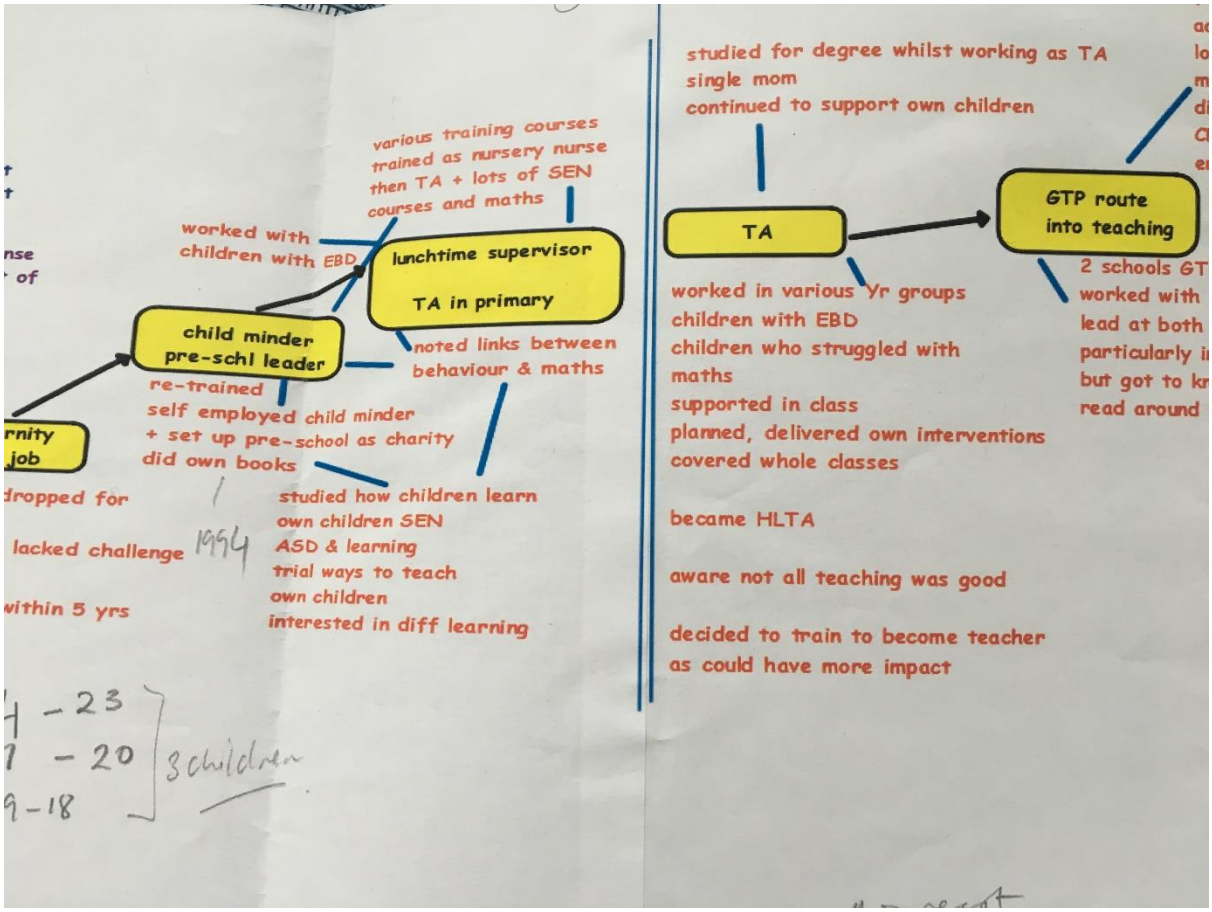
Extract from Sandra's Life Graph



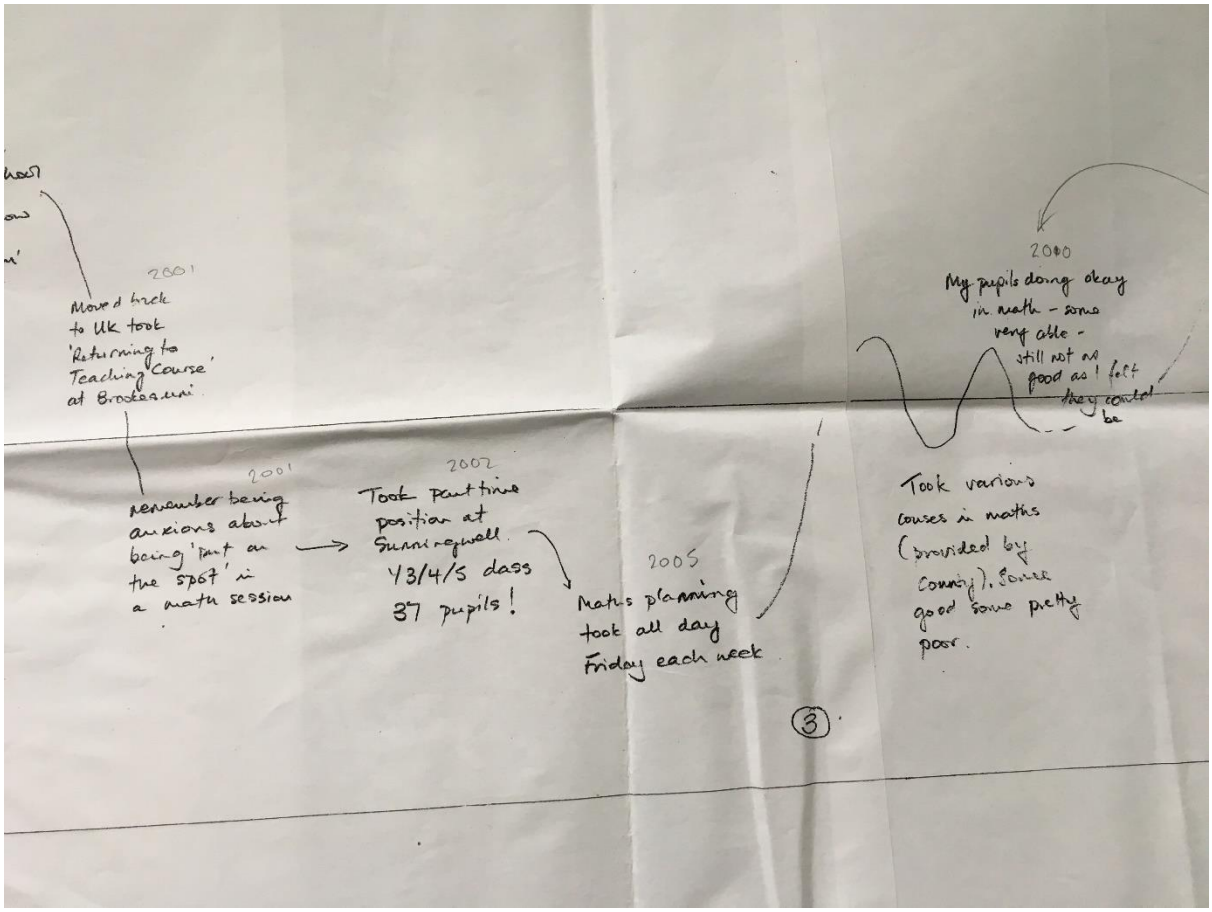
Extract from Emma's Life Graph



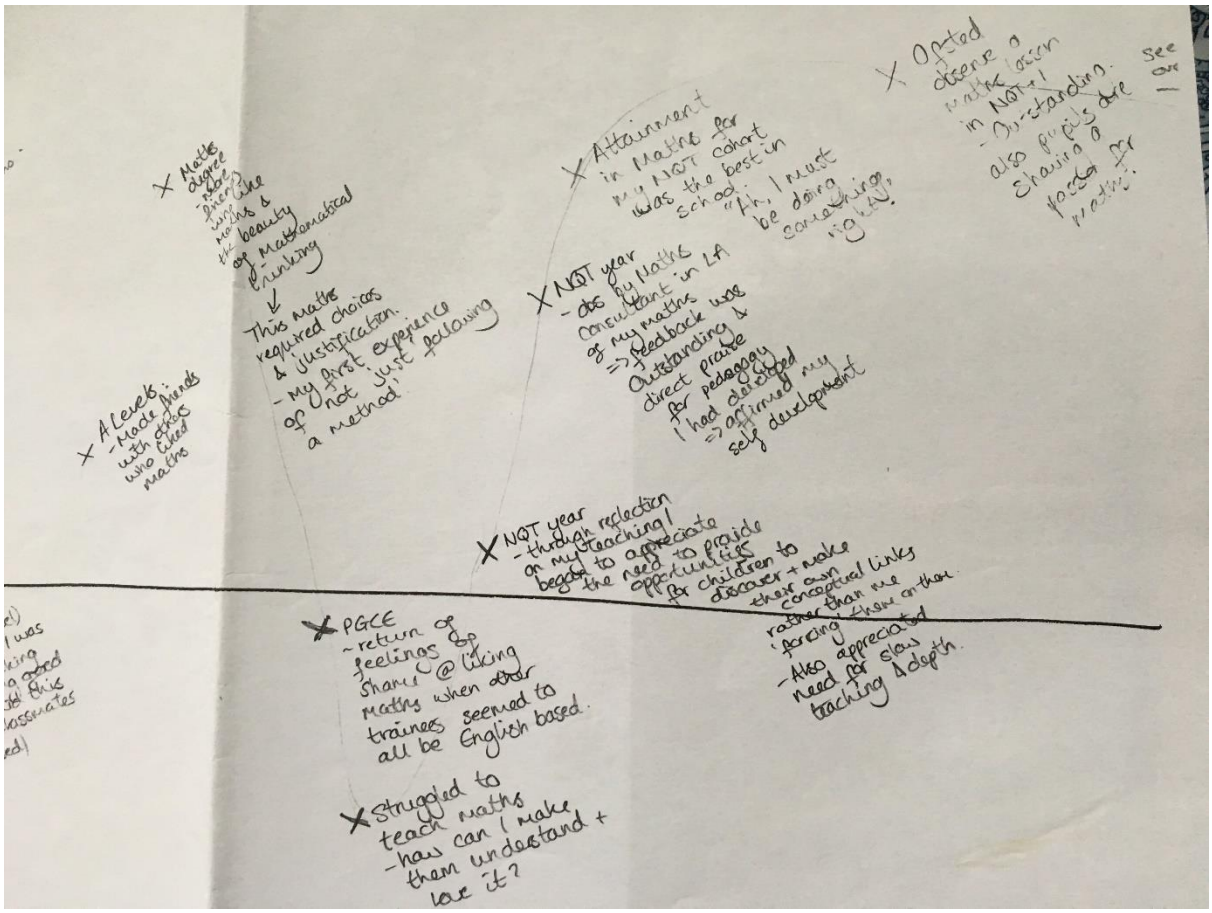
Extract from Roseanne's Life Graph



Extract from Daisy's Life Graph



Extract from Belinda's Life Graph



Extract from Michelle's Life Graph