Learning to Love Maths. A qualitative investigation mapping Early Primary ITE undergraduates' evolving perspectives on Mathematics and Maths teaching.

Kate Aspin

A thesis submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

The University of Huddersfield

School of Education and Professional Development

May 2024

Copyright Statement

Abstract

Learning to Love Maths. A qualitative investigation mapping Early Primary ITE undergraduates' evolving perspectives on Mathematics and Maths teaching.

This research investigates and interprets the experiences of eight trainee and early career Primary school teachers, whose ITE course focuses on teaching 3–7-year-olds. The study encompasses their journey from the start of their teacher training undergraduate degree at an English university, through graduation and into their first year as Early Career Teachers (ECTs) in English primary schools.

The research objective is to explore the trainee teachers' perceptions of mathematics and their understanding of subject and pedagogical content knowledge, with a particular emphasis on personal development, self-efficacy and their idiographic journey. Additionally, the study investigates the influence of public attitudes towards mathematics and the impact of performativity on the participants.

Howell's (1982) Conscious Competency Matrix (CCM) is applied as a conceptual lens in the research to interpret the trainee and early career teachers' evolving awareness of their developing teacher persona. The research reveals insights into their experiences, highlighting the significance of personal beliefs and professional identity throughout their teacher training journey.

The research adopts a qualitative, longitudinal case study approach with the eight participants. Methods of data collection incorporate creative and diverse research tools such as sculptures, personal reflections, journey maps and qualitative interviews in order to construct a rich picture of the participants' experiences, and to diminish the influence of the researcher. Data is analysed using Reflexive Thematic Analysis (RTA) (Braun & Clarke, 2021) and Interpretative Phenomenological Analysis (IPA) (Smith et al., 2022). The IPA analysis utilises a 'treble hermeneutic' in which the researcher reflects upon participants' own on-going reflections of their current and previous perceptions of their experiences as trainees and ECTs.

The implications of the research are of value to various stakeholders:- from trainees, teachers, those involved in ITE and ECT programmes and mentors. The findings contribute to the development of trainee teachers by informing strategies for enhancing their mathematical competence and self-efficacy; suggesting potential areas of focus to better support trainee teachers' attitudes towards mathematics; and by making recommendations about the design of initial teacher education (ITE) curricula. The need for mentor training programmes to facilitate effective guidance and support for trainees and early career teachers during the crucial early years of teaching is also addressed. The Conscious Competency Matrix is developed and extended, and a new, accessible metaphor suggested to aid discussion of the trainee teacher journey, between mentors, tutors, and trainees.

This research contributes to the broader scholarly discourses on primary mathematics education and early teacher development. It emphasises the importance of nurturing positive attitudes towards mathematics amongst Primary school teachers, before, during and after their ITE experiences.

Acknowledgements

To my supervisor, Dr Emma Salter, who has constantly believed in me and my research, re-focused and supported and challenged me through this entire process.
To Dr Mary Dyer, my second, who asked pertinent questions and helped me to reframe and dig deeper.
To my Primary team colleagues and manager, Dr Jo McEvoy, who have found space and time for me to focus on completion, appreciated.
To my friends and family, especially Su, for pragmatic encouragement, Beth for straightening me out as only a sister can and, Rob, for being my rock.
To the trainees/participants, for allowing me into your thoughts and to witness your personal stories, a privilege for which I am grateful and remain fascinated.
This is for my children, to demonstrate that you are never too old to learn and to just keep going.
And finally:- to my Mum, I know you would have been proud, you can tell Grandad up there that there was some point in all that ‘book learning’, after all.

Contents

Tables

Figures

Acronyms and Initialisms

Abbreviation	Explanation
APA	American Psychological Association
AS Level	Advanced Subsidiary Level
BA	Bachelor of Arts (degree title)
BEd	Bachelor of Education (degree title)
BERA	British Educational Research Association
CCF	Core Content Framework
CCM	Conscious Competence Matrix
CPA	Concrete, Pictorial, Abstract
DfE	Department for Education
DfEE	Department for Education and Employment
DM	Development Matters
ECF	Early Career Framework
ECT	Early Career Teacher
EEF	Education Endowment Foundation
ERA	Education Reform Act
EYFS	Early Years Foundation Stage
FSM	Free School Meals
FSM6	Free school Meals Six
GCSE	General Certificate of Secondary Education
GDPR	General Data Protection Regulation
GETs	Group Experiential Themes
IPA	Interpretive Phenomenological Analysis
ITE	Initial Teacher Education
ITT	Initial Teacher Training
KS1	Key Stage One
KS2	Key Stage Two
MARS	Maths Anxiety Rating Scale
MaST	Mathematics Specialist Teacher programme
MEd	Master of Education
MTAS	Mathematics Teaching Anxiety Scale
NCETM	National Centre for the Excellence in the Teaching of Mathematics
NLS	National Literacy Strategy
NNS	National Numeracy Strategy
NPQ	National Professional Qualifications
NQT	Newly Qualified Teacher (term prior to ECT)
NFER	National Foundation for Educational Research
OECD	Organisation for Economic Cooperation and Development

Ofsted	Office for Standards in Education, Children's Services and Skills
ONS	Office for National Statistics
PD time	Personal Development time
PETs	Personal Experiential Themes
PISA	Programme for International Student Assessment
PK	Pedagogical Knowledge
PCK	Pedagogical Content Knowledge
PGCE	Post Graduate Certificate in Education
QTS	Qualified Teacher Status
RTA	Reflexive Thematic Analysis
SK	Subject Knowledge
STEM	Science, Technology, Engineering and Maths
TDA	Training and Development Agency for Schools

Chapter One

1.Introduction

1.1.Micro-Rationale

"I hate this, Kate, it is stupid and doesn't make sense!", the second-year undergraduate trainee teacher threw their pen down and left the classroom, clearly annoyed, and upset, with me or with themselves or both, it was hard to distinguish. This was not the first time that I had witnessed that type of emotional and somewhat angry reaction in a taught undergraduate maths Initial Teacher Education (ITE) session. The first time it had happened to me I reflected afterwards on my teaching (as all teachers are encouraged to do) and modified my approach, focused more on basic skills, scaffolding and positive support, but it then happened again, and several times since, with different cohorts. I have received verbal outbursts, intense emotions or even tears. The focus of this particular taught session was about learning how to do and then teach multiplication and division procedures, notably the longer versions of these procedures (Department for Education, 2013). These are quite challenging maths techniques but necessary for Primary school teachers to know and be able to teach as it is part of the Key Stage Two National Curriculum (Department for Education, 2013). The participants involved in this research were training to become primary school teachers, BA Primary undergraduate trainees with a focus on 3–7-year-olds. Although the focus of the course was on the Early Years Foundation Stage (EYFS) and on Key Stage One, the trainees still required the requisite subject knowledge to be able to teach the entire primary curriculum, from EYFS to Key Stage One and Key Stage Two. In England, gaining Qualified Teacher Status or QTS enables you to teach in state funded schools at primary, secondary or tertiary level.

Maths is taught as part of a module entitled 'Core Subjects', the core subjects cover English, maths and science. The participants received maths taught input in the first and second years of the degree course and one day in their third year offering an overview of new initiatives and resources as a 'top up'. The maths ITE curriculum has been designed to build trainees' subject knowledge and their knowledge of effective pedagogy in terms of what to teach in maths and how to teach maths to 3–

7-year-olds (with extra input to extend to 11-year-olds in Key Stage Two). The maths ITE curriculum was created by me, in my role as Primary Maths Lead with input from other ITE tutors in the university and current school leaders (with an interest or expertise in maths) (Aspin, 2022). These school leaders are integral to our partnership training, to ensure rigour, sequencing, progression and currency in our curriculum.

For the past seventeen years I have been a professional primary teacher educator and the leading primary maths tutor for the Primary ITE courses at my university. During that time, I have noticed that the trainees' responses to learning to teach primary maths, and to the subject of maths itself are often radically different to their responses to the other core subjects (English and science) (Department for Education, 2013) and to the foundation subjects in the Primary curriculum. Even though the level of challenge and content can be equally difficult or rigorous in the other subjects, they appear to not provoke such an emotional and visceral reaction nor such outward negativity.

Whereas trainees often take learning other curriculum subjects in their stride, when confronted with teaching primary maths, frustration behaviours such as those described above, are sometimes displayed. As Bibby (2002) points out, "mathematics is often experienced as an intensely emotional subject" (p.705). However, I have also observed that, over the duration of their initial teacher education (ITE) programme, the emotional and negative initial reactions to learning about primary maths gradually subsides for most trainees and is replaced by much more positive behaviours and even enthusiasm. By the completion of their ITE programme, the now Early Career Teachers (ECT) have often embraced the subject and at graduation many explain how much they now enjoy teaching primary level maths. Most Primary trainee teachers' would not necessarily describe themselves as 'maths teachers', but they all do become 'teachers of maths' as it is an essential part of the primary school curriculum. Askew (2011,p 25) suggested it was unreasonable to expect all primary teachers to care for mathematics but that primary teachers have a 'duty of care' to recognise the relevance and importance of maths and to promote curiosity in children around it. This is similar to my own desires around trainee development in maths, and I know that some do progress on to leading the subject successfully in their subsequent primary teaching careers.

It was in witnessing this evolution and at points, this transformation, of perspective and attitude over time that led me to want to know more and to probe deeper into the thoughts and inner experiences of the trainees, from the start of their teaching journey, through three years of training and then, into their first teaching year as ECTs. Therefore, the impetus of this research was to understand and interpret this phenomenon of trainees' transforming relationships towards maths and maths teaching, through close examination of their lived experiences and personal journeys.

1.2.Personal Biography

As part of situational honesty and reflexivity within this research, it is important that my own experiences and personal journey within teaching and maths teaching is explored. This section is a personal biography to explain, situate and explore my own history and stance as this forms part of the impetus for the study.

My own journey in maths and as a primary teacher of maths is worth documenting as a declaration of my own positionality and considering my own reflexivity. Cohen et al. (2017) and Holmes (2020) suggest reflexivity is a notion that must be revealed and exposed by researchers aiming to understand their influence on and part in their research. Reflexivity is the conscious exploration and revelation of the researcher's own values and beliefs (Hellawell, 2006). Reflexivity and my insider/outsider position as an ex-teacher and now as an initial teacher education tutor, is explored further in Chapter Four.

My own lived experience and relationship with mathematics is varied and diverse. At secondary school in the 1980s I struggled with maths, my teaching as a pupil had been variable with a succession of supply teachers and so my parents paid for a tutor to support me for my GCSEs (General Certificate of Secondary Education). I was in the first ever GCSE cohort in the English education system, so the content and exam structure were very much unknown to parents, teachers and pupils. After a personal tussle I achieved a grade C and felt happy to move onto Sixth form leaving maths, I felt, far behind. After my A levels I went on to university to study a B.Ed. degree in primary teaching. This was a 4-year course covering (as does the current BA QTS) the subjects taught in primary schools and all the ancillary aspects of teaching and effective pedagogy. I had teaching practices in a range of primary

schools. I very much enjoyed my teacher training and my maths confidence developed due to the positive influence of an inspiring maths tutor (although the subject knowledge required was challenging). I really enjoyed the pedagogical content aspect of maths and teaching children, especially those who, like me, struggled to understand the concepts. Gradually, over the succession of my teaching practices, I began to enjoy teaching maths and, to my surprise I found that I was quite effective at it, despite my own personal battles (or maybe because of). In my first teaching role as a then NQT (Newly Qualified Teacher) of a year 5 class (now ECT) I had an Ofsted inspection. At the time, inspections lasted a week and observations occurred and feedback was given. One of my maths lessons was observed by Ofsted and the feedback was positive, again, this bolstered my confidence in my ability to teach maths effectively. After four years, I moved school, and my next head teacher was incredibly supportive of staff development. In the year 2000, primary school maths and English were undergoing rapid change, a new national curriculum was implemented. There were also two new national strategies, the National Numeracy Strategy (NNS) and the National Literacy Strategy (NLS) (DfEE, 1999). Although these new schemes of work were not statutory, the political 'lean' was dominant into schools accepting them and most English primary schools did decide to accept the NNS as their maths scheme of work for all planning and maths teaching.

The methodology by which primary maths was taught was fundamentally altered by the advent of the NNS. The NNS folder was a complete scheme of work, it had a clear progression sequence of knowledge and procedures. It also embedded a very structured approach to the teaching sequence, with a starter and then a main teaching session and finally a plenary. This was quite different to the plethora of worksheets and maths schemes that had been deployed previously, with schools determining their own route through the maths curriculum and their own lesson structure. A specific planning structure was defined, and subject content was divided into year groups, and it even suggested how many days to teach each aspect and in what order. This level of direct government interference into the minutiae of practice rather than keeping political engagement at the higher policy level, was new in the New Labour era of government and was hotly debated and controversial at that time. As part of the implementation of the NNS teachers were trained as leading maths

teachers to support existing staff through the change. I volunteered for this role and was trained specifically to support others. This involved having experienced teachers come to my lessons and observe me teaching the new NNS content and structure. I would then lead discussions and talk to the teachers about how they could implement the NNS into their lessons and hopefully encourage them to engage with the changes. The NNS was the first direct governmental intervention in the methods and resources deployed to teach maths at primary level, interventions that continue and have indeed, deepened and accelerated to this day (Alexander, 2011). Leading to what Ball (2018, p 235) deemed a state of 'deliverology' and "The behemoth of performance" with the state intervening and micromanaging education.

Becoming a leading maths teacher and being the year 6 teacher extended and deepened my knowledge and confidence in my maths teaching ability. Having others come to observe and comment on my teaching allowed me to develop my initial interest in teacher development and education and set me on the pathway towards working within teacher education in later years.

After another school move and 5 years as a deputy head and being acting head three times, I decided to move into university-based teacher education. I gained a post at a northern university in a very small team (two of us) working on an undergraduate primary 3-7 QTS focused course. After 2 years I was asked to lead the maths teaching on the course. This was a natural move from my previous leading maths teacher experience. I also completed an MEd with the Open University during this time. As part of the master's course there was an option to examine primary maths teaching pedagogy and, again it was logical to explore more deeply the pedagogy behind effective maths teaching and develop and extend my personal knowledge. The work of John Mason and Sue Johnston-Wilder (Mason & Johnston-Wilder, 2004) was explored in depth on the course and resonated with me, from a personal reflection point of view and as an educator of trainee teachers. The notion of 'critical incidents and the art of 'noticing' both in yourself, and in those you are researching, began to intrigue me and sowed the seeds for this study. The impact of these notions around development and personal confidence in maths seemed especially relevant when reflecting upon my own maths journey, and later, when observing externally, the progress of my ITE trainees. Mason (2002a) stated: - "One of the features of individual development is that sensitivity to notice, is different

at different times. Things which seem obvious now may have been invisible in the past, and things invisible now may becoming blindingly obvious in the future." (p.2)

1.3.Macro-Rationale

Historical overview of context

This section provides a macro rationale and contextualises and situates this research in its historical and social context. Since the influential Cockcroft report into the state of maths teaching in schools (1982), concerns have been noted about primary teachers' maths knowledge, from policy makers, the Department for Education and the Office for Standards in Education, Children's Services and Skills (Ofsted). In 2008 the William's Review of Mathematics Teaching in Early Years Settings and Primary Schools (Department for Children, Schools and Families, 2008) made direct links between pupils' low attainment in assessments and Primary school teachers' poor mathematical subject knowledge. The report was broadly welcomed as the first in depth focus into maths in primary since the inception of the National Numeracy Strategy in 1999. The report supported further maths specialisation for teachers and more training for primary schools in the most effective methods of maths teaching. William's recommended "at least one mathematics specialist in each primary school, in post within 10 years, with deep mathematical subject and pedagogical knowledge" (2008, p 7). This has now been resurrected as an idea in the current Prime Minister, Rishi Sunak's speech in April 2023 where he stated: - "And we're strengthening maths in primary schools……including with a new fully funded professional qualification for those that are teaching it." (Sunak & Prime Minister's Office, 2023).

The MaST (Primary Mathematics Specialist Teacher) courses developed from the William's Review in 2008 and then vanished swiftly due to funding cuts, however, aspects have become embedded within the maths Hubs training and development courses. NCETM (National Centre for Excellence in the Teaching of Mathematics) has produced just over 1000 Mastery Specialist Teachers across the country who have undergone continuing professional development in seven cohorts since 2015 (Noyes et al., 2023). More recent studies such as Kullberg et al., (2017) consider how the teaching methods used in other countries (notably Shanghai and Singapore) have led to developments in policy and practice around the notion of 'Mastery

Mathematics' and the use of government supported maths 'Hubs'. These 'Hubs' and the National Centre for Excellence in Teaching Mathematics (NCETM) are designed to support the professional development of teachers in maths teaching and learning. Indicating a policy based acknowledgement that there has been a history of problems and a dearth of input around professional development of primary teachers in maths (About the NCETM, n.d.).

Haylock and Manning (2018) explored student teachers' views of maths using the work of Puteh (2002). They suggest that negative prior learning experiences in maths as a child can lead to low self-confidence and impacts upon working memory and leads to avoidance of doing and exploring maths in adults. The importance of ensuring that primary teachers are both skilled and knowledgeable enough themselves, and then empowered to support children to avoid continuing this negativity is clear.

The Teacher Standards (DfE (Department for Education), 2011) are a statutory set of standards that all qualified teachers in England need to meet as a minimum standard to be able to qualify as a teacher. These make it explicit that all teachers should have 'strong' subject knowledge and a good grasp of appropriate strategies, reflecting the view that both of these aspects are vital to effective teaching. There are no competency measures for teaching, the Teacher Standards are the only threshold measure of performance and suitability.

Standard Three states; "have a secure knowledge of the relevant subject(s) and curriculum areas, foster and maintain pupils' interest in the subject, and address misunderstandings".

"If teaching early mathematics, [teachers should] demonstrate a clear understanding of appropriate teaching strategies". (DfE, 2011)

The Teacher Standards are a direct governmental DfE policy that reinforce strategic department policy direction and values. The Teacher Standards make it clear that teachers should have secure subject knowledge and understand appropriate methods of teaching, so their pedagogical content knowledge. In the Teacher Standards, 'early mathematics' refers to 3-5 (often called 'Early Years') as well as all the primary age phase (5-11), not just the very youngest children. This description of

early maths and the importance of a strong understanding includes all the ITE trainees involved in this study.

1.4. Mathematics as a problematic subject

Although there are 13 subjects in total that Primary educators teach, maths has a high profile and, a potentially challenging image within the primary school. The British public persona and social attitude towards maths is explored more fully in chapter two, highlighting the societal aspects and negative labels and myths that are applied to the subject. Within the primary school, maths is a 'core' subject and so a 'high value' subject as the data gathered from the statutory assessments provide information for Ofsted and for league tables. These tables rank schools by outcome and may be utilised by parents to decide the destination of their offspring. This spotlight of attention can lead to greater stress upon teachers and a top-down pressure from school leaders to ensure children achieve in maths compared to other subject areas, performativity and compliance issues can therefore be more visible in maths than in other less high-profile foundation subjects. The choice of maths scheme and teaching structure may reflect a drive for consistency across cohorts and key stages, reflecting the importance of maths results across the school.

Schemes provide a clear structure and even scripts to follow, these may give teachers who lack confidence or have aspects of anxiety around maths greater confidence. Thus, enabling them to have a structure to construct a lesson upon from rather than having to plan, design and resource from the curriculum base. This also ensures that school leadership can be assured of coverage and consistency of 'delivery' across the staff. Schemes and structures such as the evolution of maths 'hubs' and the role of the NCETM (as explored in section 1.3) in providing CPD (Continuing Professional Development) for teachers have led to a more centralised system for professional development and led to the dominance of DfE approved schemes such as 'White Rose' and 'Maths No Problem'. It is within this increasingly centralised and performance focused, highly structured context that the participants in this study have trained and begin their teaching careers as ECTs. However, the trainees have been part of this system from the start of their training so they may not view structures in the same way.

1.5.Terminology

There has been a longstanding debate over the terminology used to describe teacher initial education (Furlong et al., 2006). The two phrases, 'Initial Teacher Training' (ITT) and 'Initial Teacher Education' (ITE) are often used. The term 'training' has notions of implying that teaching is a craft and technically based, rather than a reflective and philosophical pursuit as in the term 'teacher education' (Davies et al.,2016). In this study ' initial teacher education' has been adopted as a term of deliberate choice, asserting the values that I hold around the term. Trainee or student teacher is equally debated as terminology, in this study the term trainee is deployed as that is what the DfE and the wider sector deploy (DfE., 2011), and is not implying any specific viewpoint or perspective. I prefer the term trainee as the word student has become diluted in recent years and is now utilised to mean a person at school, college and at university rather than someone doing purely university level study. As such deploying that term may potentially cause confusion, for example, the student teaching the students. Thus, for clarity in this study, the participants are deemed as trainees whilst undergoing initial teacher education (ITE) and participants once they achieved QTS status.

1.6.Original Research Strategy

The original intent of the research, in 2018 was to gain a holistic, rounded view of each trainee, from themselves, their mentors, the pupils and from lesson observations. Thus, enabling a 'Polyhedron of intelligibility' (Foucault, 1981), attempting to consider the trainees' development from a variety of lenses and perspectives. The original intent was to analyse all the data using a Reflexive Thematic Analysis model (RTA) (Braun & Clarke,2006,2019, 2021) and then apply a reflective model, such as Brookfield's lenses (Brookfield, 2002) to enable a deeper level of personal observation, analysis and reflection from a range of viewpoints.

However, the impact of Covid 19 prevented direct access to the trainees in school on both their second and final teaching practices. Online meetings were held with trainees and their mentors, but university tutors were unable to physically enter the classrooms to observe the trainees and could not interact with pupils, due to the policies and restrictions placed on schools because of Covid-19. These strict limitations required a complete rethink of the research design strategy, as the

original data collection methods were no longer possible. Face to face class mentor access for conversations and direct lesson observations were also impossible. The feasibility and the original structure of the study had to be reconceptualised, the need for an alternative methodology and analysis structure became apparent. The concept of IPA (Interpretative Phenomenological Analysis) as a methodological tool was explored and became the methodological tool of choice (Smith et al.,2009, 2022) for the later stages of the re-developed research. IPA, with its focus on the perceptions of the individual in an idiographic frame fitted effectively with the research aim of considering the whole learning journey and reflect the first-hand experiences of the participating trainees, whilst removing my own influence as much as possible from the research. IPA embeds reflection within the notion of the double hermeneutic and then, going further in this study the 'treble hermeneutic' is developed, as explored further in Chapter 4. IPA enables participants to reflect on their own development from an historical and chronological viewpoint, which in this case, was the personal journey from the initial stages of the ITE degree course through to graduation and then onto their first year as a qualified primary teacher. A range of qualitative data was collected from participants when they were ITE trainees and analysed using RTA. The same participants were interviewed as ECTs, and their interview data analysed using IPA, they also reflected back on the RTA data in their IPA interviews .The revised research aims and questions are presented below.

1.7.Contribution to Knowledge

The study encompasses unique aspects and contributes to the existing research around Primary trainee teachers and their relationships with maths, in several ways. Firstly, it employs Interpretative Phenomenological Analysis (IPA) as a tool for examining Early Career Teachers (ECTs) which is an approach not previously utilised in this context and combines RTA and IPA data analysis strategies. Secondly, it stands out as a novel study since the majority of established research on Initial Teacher Education (ITE) and primary mathematics has focused on PGCE trainees or individuals studying the 5-11 age phases. In contrast, this study specifically investigates trainees working within the 3-7 age range. Lastly, the research examines the Conscious Competence Matrix (CCM) and applies it to both trainee and Early Career Teachers, and it introduces a new potential metaphor for the CCM, to use with school mentors that is further developed and explored.

1.8. Research Aims and Questions

Title:- Learning to Love Maths. A qualitative investigation mapping Early Primary ITE undergraduates' evolving perspectives on Mathematics and Maths teaching.

Aims 1.8.1.

1. To analyse and interpret primary ITE trainees' perceptions towards Maths as a subject, during their training and into their first year of practice.

2. To analyse and interpret primary ITE trainees' perceptions towards Maths teaching during their training and into their first year of practice.

3. To evaluate and develop Howell's (1982) 'Conscious Competence Matrix' for application to initial teacher education.

Research Questions 1.8.2.

To achieve these aims the following questions will be answered: -

1. How do undergraduate Primary ITE trainees' perceptions towards maths and teaching maths change over the duration of their training and into their first year of teaching?

2. How useful is the Conscious Competence Matrix (Howell, 1982) for understanding the development of trainees' self-evaluation of their teaching competency: drawing on the experience of primary maths trainees.

3. What are the implications for ITE and ECT programmes in supporting Primary trainee teachers and Early Career Teachers in light of the CCM.

1.9.Thesis Structure

An outline of the chapters in this thesis now follows, starting with the literature review.

Chapter Two presents the search strategy for the literature review and considers the key areas that published research has indicated as being of relevance to the development of trainee teachers and mathematics, These include:- maths and wider social attitudes, maths anxiety, the role of subject knowledge and pedagogical content knowledge and the role of self-efficacy and personal growth on the idiographic trainee journey. This chapter situates the study within the wider research context.

Chapter Three explains and explores Howell's (1982) Conscious Competence Matrix (CCM) which is the analytic framework adopted for this research. It explores the rationale, relevance, and background for the deployment of the CCM and how it can be a helpful contribution to the understanding of the professional development needs of trainee and Early Career Teachers and be utilised as a tool to explore stages of competency with school-based mentors and to share a common language.

Chapter Four delineates the phenomenological methodological approach and the wider philosophical background. The axiology and positionality of the researcher to the participants is developed and the insider/outsider relationship of myself as the researcher to the participants is explained. The moral and ethical implications are presented, and the safeguards explicated. The research design deploys two different data collection methods. The first data collection method is Reflexive Thematic Analysis (RTA) which is used for all the data sets gathered whilst the participants were trainees and the second is Interpretative Phenomenological Analysis (IPA) which applies to all data gathered when the participants were ECTs.

Chapter Five presents the findings from the Reflexive Thematic Analysis (RTA) data sets which encompass all the data sets gathered during the three years of the undergraduate degree while the participants were trainee teachers. No supporting literature is deployed at this point.

Chapter Six presents the findings from the Interpretative Phenomenological Analysis (IPA) data sets. This data is derived from the semi structured interviews with the participants when they were fully qualified primary teachers. No supporting literature is deployed in this chapter.

Chapter Seven discusses the combined findings from both the RTA and IPA datasets, with reference to published literature to explicate and illuminate the significance of the findings. The relevance of the CCM is then explored to both trainee and early career teachers and to their professional development.

Chapter Eight addresses the research questions in turn in light of the research findings; and draws conclusions about the suitability of the CCM for application to teacher training. The chapter challenges the linear progression model inferred by the CCM, and suggests a metaphor of journeying through varied, often difficult terrain as a more accurate representation of trainees' transitions from novice trainees to early

career teachers. The chapter concludes the research by making recommendations for maths ITE curriculum development, sequencing and planning in light of the findings, and by suggesting further potential research.

1.10. Conclusion

In conclusion, this chapter has established a solid foundation for the research by providing a comprehensive context and situational background, to both the researcher and the research. The inclusion of both micro and macro rationales has further strengthened the study's significance and currency. The problematic nature of maths as a subject has been introduced. Moreover, by situating the research within the personal context and history of the researcher, a deeper understanding of the motivation and perspectives behind the research has been achieved. The structure of the thesis has been outlined and each chapter's foci and purpose explained. The next chapter will discuss and develop the literature base, the search terms deployed and elucidate the previous research studies that have considered the relationship of mathematics to novice and newly qualified primary teachers.

Chapter Two

2.Literature Review

In order to situate the research basis for this study, this chapter will begin with an overview of the literature search process and strategies deployed, then move to an explanation of the specific search terms used to gather the pertinent information. This chapter will situate the study into the current political and social debate around maths and the public perceptions held around it. Additionally, I will examine the current state of initial teacher education in England, as this context plays a crucial role in understanding the backdrop against which the study takes place. The essential role and significance of subject knowledge (SK) and pedagogical content knowledge (PCK) is discussed. Maths anxiety as a concept and the potential application of this to the study is then explored alongside the impact of cognitive load on trainee and early carer teachers. Self-efficacy and confidence are vital elements in the development of trainees, and their relevance to the study will be explained. Recognising that the journey of a trainee primary teacher is a complex and individualised one, I will acknowledge the lasting impact of their prior school experiences, which often loom large in shaping their background and consequently the attitudes that they apply to the subject, early in their ITE development. This literature review serves as a stepping stone towards a comprehensive study that adds to the ongoing discourse around effective primary ITE and pedagogical practice in mathematics.

2.1.Literature Search Criteria

This section develops the context and methodology deployed to search the large body of relevant literature, as scoping and, 'funnelling down', as recommended by Fink (2019), was necessary. Considering a range of appropriate search terminology was also required as trainee teacher or student teacher is common parlance in England and the wider UK, but in other countries terms such as pre-service, prospective and novice teacher are more commonly deployed. These terms were all used in the initial searches. Primary school is also the term that denotes the first

stage of education in the UK, but pre-K, kindergarten, and elementary are all terms used globally and so were all used too.

Other studies focusing tightly on trainee (pre-service etc) and primary school/elementary teachers and mathematics were scoped when reviewing the literature. Studies that focused solely on secondary school teachers and tertiary stage/further education studies were deemed as outside the scope of the study. The rationale for this situated around the differing roles of each. Secondary school maths teachers have made a conscious choice to teach and study maths, they usually have higher qualifications in the subject and at least part of their degree or a subject knowledge conversion course has been undertaken to improve their maths knowledge. Therefore, their whole teaching persona and professional identity centres around mathematics. Whereas a primary school teacher must teach maths alongside all the other areas of the curriculum. For a primary school teacher, the whole curriculum must be taught, and their teaching persona centres around the children and educating them; maths is just one subject, from a plethora. Teaching maths cannot be avoided by a primary teacher, but for some, it may be a favourite subject and one they choose to lead at a later date or, one that they tolerate as a necessary evil. This difference in professional identity and persona meant that secondary or tertiary specific phased research was 'bracketed off' as being outside of the relevant subject area (Fink, 2019).

Another important aspect is that the participants in the study were all trainee teachers with a speciality focus on the education of 3–7-year-old children. This means that their assessed block teaching practices were all with children between 3 and 7 years. The trainees do go into Key Stage Two for short, informal placements and are taught how to teach Key Stage Two material. However, the focus is on teaching the youngest children and covering the EYFS framework (Department for Education, 2014) and the National Curriculum (Department for Education, 2013) up to the end of Key Stage One. On my scoping of the literature (Fink, 2019), there was very little published literature that had this group as a specific focus, they were mentioned as part of larger studies (Askew et al., 1997, 1997) but not as a unique grouping. Much of the British research in this area has focused on primary as a more general term (i.e., 3-11 or 5-11 years) and many focused on the one-year PGCE (Post Graduate Certificate in Education) Primary trainees and their progression

across their one year of ITE training. Wider global research evidence that has been utilised focuses more broadly upon the 4-11 age phases.

Across my initial scoping searches, it became very clear that most of the academic peer reviewed research conducted around primary teachers and maths, focused on PGCE participants completing one year post graduate study (Haylock,1995, 2018) and most research in this area had been completed by questionnaires reflecting on self-auditing or quantitative exam style measures rather than by interpretative and phenomenological approaches as I have done. Notably, none of the previous studies had applied an Interpretative Phenomenological Analysis (IPA) approach to Initial Teacher Education (ITE) and mathematics. This study has a specific emphasis on idiographic journeys so similar research was sought. Literature about teacher education and education policy was mainly selected from English contexts, as this is most relevant to my research. Literature around the broader topics, such as maths anxiety, subject knowledge and pedagogical content knowledge were grouped into themes, and at times, literature was drawn from international research to gain a deeper perspective on these topics, and to illuminate English attitudes on these topics compared with other nations.

2.2.Current Socio-Political Context

Establishing this study into its current socio-political and educational context is important, as is ensuring that the focus remains on the idiographic lived experience of the trainee Primary teachers and their lived experiences undergoing initial teacher education in England from 2018-2022.

From the Cockcroft Report (1982) to the inception of Ofsted in 1994 and to the William's Independent review of Maths Education in 2008, the role of the Primary teachers as maths teachers has been discussed and debated, policies produced, and subject focused reviews have been conducted. More details on the history of primary maths teaching can be found in Chapter One. However, the need to increase the knowledge and expertise of the primary maths teacher has been under greater scrutiny since the revision to the Ofsted inspection framework in 2019. When the curriculum and the subsequent teacher knowledge within the curriculum has become the main focus of the inspection framework. Alongside this focus, new

Ofsted frameworks for ITE and the development of the Core Content Framework (CCF) for ITE and the Early Career Framework (ECF) for newly qualified teachers and new NPQ (National Professional Qualifications) for serving teachers, have put subject knowledge and pedagogical subject knowledge front and centre of teacher development and training. The next section will consider the wider social and public perceptions of mathematics.

2.3.Public Perceptions of Mathematics

Mathematics holds a strange place in the pantheon of taught subjects in England, although it is a core subject within the National Curriculum (Department for Education 2014) and has been seen as vital since the inception of the first National Curriculum back in 1990 and before that to the Education Reform Act of 1988. It is still viewed by those outside of education as a niche subject and many myths have formed around the subject. The current version of the National Curriculum describes the study of mathematics as: 'a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment.' (Department for Education, 2014)

This positive policy view can contrast vividly from the way maths is often portrayed in the wider media, which promotes eye rolling and negative commentary, that other subjects, such as English, do not publicly receive. Maths can often be viewed as the remit of "'mad scientists', 'nerdy' boys, and the socially inept" (Epstein et al., 2010) especially when portrayed on film and television, influencing the way we perceive both the subject and those who practise it. Films such as: - 'Good Will Hunting' (1997), 'A Beautiful Mind' (2001) and 'The Imitation Game' (2014) portray mathematicians and mathematical scientists as (usually male) experts unable to communicate well without chalk, blackboards, and equations for company. Films such as 'Hidden Figures' (2016) and 'Agora' (2009) attempt to explore the role of women and marginalised groups in the world of maths, however the fact these are seen as unusual stories reinforces the notion that maths is very much viewed as being the domain of a narrow field of white men. Other portrayals tend towards viewing mathematicians as radicals and naysayers, such as Jeff Goldblum's

character in ‘Jurassic Park’ (1997), the mathematician is strange, different and although admired for brilliance always different and an outsider, not the same as ‘us’.

To counteract this perception, there have been well publicised campaigns in the media such as the ‘Make Britain Count’ (Telegraph, 2012) and Carol Vorderman’s popularist report for the Conservative party in 2011 (“A world-class mathematics education for all our young people”) but appear to have had little sustained impact so far, on the way maths is viewed, especially when viewed through a lens. Recent series and podcasts such as ‘Magic Numbers’ (2018) presented by the mathematician, Professor Hannah Fry, are making a determined effort to undermine the gender labelling and alter public perceptions. Parents were happy to speak to me at school when I was a teacher and confess that they were ‘rubbish at maths’ in a way that they would not speak about English or other subjects, this ‘maths is difficult’ and ‘not accessible’ for all image does not appear to be changing or evolving swiftly. Lim (2002, in Haylock & Manning, 2018, 2024) surveyed 500 UK adults and identified three widespread myths about maths: that it is difficult, only for clever people and a male domain;- these appear to be stubbornly persistent. Cole and Sinclair’s recent book, ‘I Can’t Do Maths’ (2022) echoed similar issues and Rishi Sunak’s speech in April 2023 suggested again that we remain stuck as a nation holding onto outdated notions around maths.

In 2008, Sir Peter Williams was invited by the then Labour Government to review the state of maths teaching in Primary schools and Early Years settings in England and make recommendations for improvements. His review was based on a broad-based consideration of quantitative data from national and international exams and qualitative interviews and discussions with schools, teachers, and maths bodies and employers. He found that: “The United Kingdom remains one of the few advanced nations where it is socially acceptable – fashionable, even – to profess an inability to cope with mathematics.” (Williams 2008, p44).

This negative view, Williams felt, transcends from parent to child and from generation to generation and potentially from teacher to pupil, thus proving that there is necessity within this study to investigate perceptions, as the trainee teachers may potentially be communicating this negativity, consciously or unconsciously, to the children they teach.

The impact of this wide spread of cultural negativity towards maths, may be noted in the functional skill level of working age adults. The National Numeracy Charity is an organisation founded by the government in 2012 and the wider business community to promote numeracy across society and in education. Their statistical data comes from a combination of studies and sources, notably the OECD and PISA studies and their own YouGov surveys. They claim that the number of working age adults with functional literacy skills is on the rise, whereas the proportion of adults with functional maths skills equivalent to a GCSE grade C (now grade 4) has decreased from 26% in 2003 to only 22% in 2012 (National Numeracy, 2019). This number is noticeably lower when compared with the 57% who achieved the equivalent in functional literacy skills (National Numeracy, 2019). The most recent National Numeracy report of 2019 claimed, “The cost of poor numeracy to the UK economy is £388 million per week.” (National Numeracy Trust, 2019).

The recent Ofsted research review of maths (2021) highlighted that disadvantaged pupils in England are much less likely than their advantaged peers to achieve a grade 4 at GCSE or to meet the expected standards at key stages 1 and 2 or at the end of the early years foundation stage (EYFS). This is of serious concern given that socio-economic background influences a child’s mathematics achievement by an estimated 10-20% (National Numeracy, 2019). This data is from NFER research looking at disadvantaged pupils (Wheater et al., 2016). The term ‘disadvantaged’ is very broad and well debated. The DfE uses the rather rigid and financially based measure of Free School Meals (FSM) and any child who has been in receipt of FSM in the previous six years (FSM6). These measures use income level as a proxy for poverty, which can be a very blunt instrument. The OECD uses a wider measure termed the ESCS, which considers economic, social and cultural status to determine if a child is disadvantaged. The NFER and OECD data suggests there is a gap of three years of schooling between the most and least disadvantaged children, in maths, in the UK. They also found that disadvantaged pupils who are more confident in mathematics were more likely to be higher achievers in the subject.

Williams (2008) claimed in his review that 6.8 million adults in the UK struggled with numeracy (data from the 2003 Skills for Life survey, where more than 8,000 adults across England had their maths ability assessed). The National Numeracy Project more recently claimed 4 in 5 adults in the UK have a low level of numeracy, with 17

million adults only having Primary school level maths skills. Lower mathematical skill levels are costing billions (approximately 20 billion) to both individuals and wider society (National Numeracy, 2019). Employers reported that poor maths knowledge and skills were adversely impacting upon their core business too. Less numerate individuals also earn less than their more numerate counterparts (National Numeracy, 2019). 'Good numeracy is the best protection against unemployment, low wages and poor health' (Andreas Schleicher, OECD, 2013). According to the Nuffield Foundation and the Fischer Family Foundation charity UK wide a total of 65.0% of pupils achieved grade 4/C or higher in mathematics compared to 73.2% for all subjects, in 2022, still indicating an overall societal issue with maths as a subject.

All this is of relevance to the study as the trainee teachers involved in this research may have grown up embedded in this culture of social negativity towards maths and, are also in a position of influence over the next generation and their developing perceptions, while working with families and communities that do not value mathematics highly.

2.4.Maths Anxiety

2.4.1. History of the notion of Maths Anxiety

The concept of maths anxiety first came to my attention from the work of Derek Haylock whose book 'Mathematics Explained for Primary Teachers' (Haylock & Manning, 2018, 2024) is a key tome in primary trainee teacher maths education. Haylock highlights the language of fear and raw emotionality exhibited by some trainee primary teachers when being taught how to teach maths, which echoes my own experiences. What Haylock found from his exploration of PGCE students' reactions matched the visceral and emotional reactions of the trainees in my undergraduate maths training sessions. This triggered my desire to explore and explicate what was occurring behind these emotional outbursts.

This section explores the phenomena of maths anxiety and examines links to teacher identity, as some of the initial reactions and language used by the trainees in this study do echo the language of the anxious. However, the very term 'maths anxiety' is controversial with its existence as a separate term queried, on the

grounds that it can be conflated with test anxiety and that the methods of identifying it tend to be self-auditing measures rather than an external process.

Maths anxiety is a description of the strong emotions and fearful reactions that people can exhibit when they encounter maths, such as those exhibited by my undergraduate trainee teachers described in chapter one. The notion of maths anxiety can be dated back to at least the sixteenth century (Dowker et al., 2016) so it is not a purely modern phenomena nor one just occurring in the UK but noted globally. Maths anxiety is in itself difficult to define. Definitions include:- “a feeling of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002., p181) but that definition clearly applies to those ‘doing’ maths study and applying subject knowledge (such as teenagers doing exams) and not to the act of teaching maths to others. Another widely used definition is “feelings of apprehension, tension or discomfort experienced by many individuals when performing maths or in a mathematical context” (Richardson & Suinn, 1972). This is a more appropriate definition when related to this study, as the trainee teachers who are the foci, are both learning maths and absorbing subject knowledge and then learning how to teach it to children, so applying pedagogical content knowledge. It is much more than just a dislike of the subject itself and can impact on self-esteem, motivation and may even impact on career choices at times (Gresham, 2018). The trainees’ reactions in this study did not, in my view, exemplify the extreme end of maths anxiety, such as ‘maths phobia’ which involves complete avoidance of the subject wherever possible. However, some of their reactions suggest that the subject does in some, create feelings of fear and anxiety, but the exact triggers for these emotions lacks clarity. Primary teachers have to teach a range of subjects daily, including maths and potential trainees are made aware of this, so those who are truly ‘phobic’ would not chose primary teaching as a career. Defining the precise ‘condition’ of maths anxiety is difficult as it has much in common with more generalised anxiety disorders which may have a wide range of personal, social, and emotional triggers.

Currently maths anxiety as a notion is not viewed as a medical or psychiatric issue rather more of a sociocultural or personality construct (Dowker et al., 2016). There have been studies that measured cortisol levels in response to stress in individuals taking maths tests, but none of this research has been conclusive as to pin point the

exact triggers as it is currently impossible to separate the emotions towards test taking in general and then those created when maths test taking. There is no suggestion that these could replace more usual methods of measuring maths anxiety, for example, use of self-auditing. Brain scans using MRI have also been deployed with a modicum of success (Young et al., 2012) with 7- to 9-year-old children, examining the areas of the brain activated before, during and after conducting maths tasks, but the results suggest that anticipation of the mathematics task caused more anxiety than the task itself, which again suggests that there is much more to be explored around the maths anxiety than just the maths itself. Is it the maths or the anticipation of the maths or both aspects that create the anxiety?

The first reference to a specific form of anxiety linked directly to maths, comes from the work of Dreger and Aiken (1957) who assessed over 700 students at Florida State University and differentiated between general anxiety and something they deemed 'number anxiety'. Dreger and Aiken's research indicates that people with high number anxiety gained lower grades in maths, especially compared to their overall ability in other areas. This notion of worry related to a specific subject area continued to develop over time. The work of Richardson and Suinn (1972) led to the creation of the Mathematics Anxiety Rating scale (MARS) which they applied to non-maths studying university students across a range of disciplines and suggested that 11% of university students had sufficient levels of maths anxiety that they needed counselling or support to overcome it. Their self-reporting scale has been applied, reengineered, and developed by a range of others (Plake & Parker, 1982, Hunt et al., 2011). Fennema and Sherman created their Mathematics Attitude Scales (1976) which again used a quantitative methodology using a scale; more recently Hunt and Sari (2019) evolved a scale devised for Turkish primary school teachers called the Mathematics Teaching Anxiety Scale (MTAS) and applied it more widely to the UK. Research attempting to measure and rate maths related worry and anxiety has tended to be quantitative using self-referencing and self-reported questionnaires. This self-reporting methodology makes the findings of such research dubious because, as previously highlighted, maths has complex social and public perception and image problems and a large mythological base (Cole and Sinclair 2022), so any research that uses self-reporting as method of data collection needs to

take into account the social image issues that may have permeated into the participants' frame of reference.

The very existence of 'maths anxiety' then can be perceived as controversial, and vague although it has been noted and recognised around the world and in a range of countries and cultures. According to Middleton and Spanias (1999) consideration of motivation, self-efficacy, and concepts such as learnt helplessness could also be deemed to be as types of anxiety, depending on terminology or labelling applied at the time. They were concerned that giving a label of maths anxiety could normalise the wider labelling of maths as a 'nerdy' and difficult subject thus perpetuating the wider social labels as previously discussed.

2.4.2. Maths Anxiety and children

Much of the published research around the notion of maths anxiety focuses on the experiences of children or teenagers/college students or the wider adult non-teaching population. As stated earlier, the search terms were selected to focus upon research around adults, and adults training to become teachers rather than those that centred upon children. However, the roots of maths anxiety in adults are most likely to have been laid down during their early educational experiences and as Beilock and Maloney (2015) suggest, may even stem from before formal schooling began. So, it is important to explore the research into maths anxiety with children.

Maths anxiety appears to increase as children age and become teenagers, although as with all aspects there are exceptions. Wu et al., (2012) researched young primary aged children in the USA and detected signs of maths anxiety at an early stage of education. However, the majority of studies suggest it is with age that the notion gathers strength and enjoyment of maths deteriorates, linking perhaps to higher stakes examinations and formality in the subject and potentially having absorbed the fears and attitudes from the adults around them. As Montague-Smith et al state, "We are not born with negative attitudes towards mathematics, they are learnt." (p. 3, 2017). However, how these attitudes are learned and from whom, and when and why this anxiety increases remains opaque. Blatchford (1996) stated that two thirds of 11-year-olds (year six in the UK) rated maths as a popular subject, but this had declined by the time the children reached 16. This echoes the work of Boaler

(2014) who suggests that the primary years are essential in creating and sustaining an enjoyment of maths, and that maths anxiety can often be traced back to primary years even with otherwise confident children. It should be noted that the studies that indicate a strong relationship between maths anxiety and younger children all tend to stem from the USA, which could suggest that the notion of maths anxiety may have cultural roots are not as prevalent in other nations or educational systems (Dowker et al., 2016).

Hembree's (1990) meta-analysis of over 150 different studies across the USA revealed that: - “maths anxiety seems to be a learned condition more behavioural than cognitive in nature” (p45) with participants having had negative prior experiences in school or home around maths or even just one experience that impacted upon them memorably and powerfully. Hembree also found that maths anxiety increases until the ninth or tenth grade (USA terminology for 14–16-year-olds) and then plateaus into adulthood, where it remains stable. Lutovac and Kaasila, (2011) concurred that the impact of one negative teacher can continue having an impact on attitudes extending far beyond childhood. However, again it creates the query is it the maths or the pedagogy of the teacher that has created the anxiety. The link between self-concept, and maths anxiety seems to be self-reinforcing, children who think they are weak at maths tend to become more anxious when asked to do maths echoing the earlier work of Dreger and Aiken (1957) (Ahmed et al., 2012).

Gender is also indicated as a factor in maths anxiety, with girls often having higher ratings, however as the mythology around maths ‘being a subject for males’ is still prevalent (Coles and Sinclair, 2022, Chestnut et al., 2018) it is difficult to discern if girls embed the notion of maths not being ‘for them’ from a young age and so this exacerbates the anxiety, or it is the anxiety that causes the not for me viewpoint. This is called ‘stereotype threat’ when people feel at risk of confirming a negative stereotype, for example, that girls are not good at maths. Beilock et al. (2007) found that women performed worse on maths problems if they were told that the researchers were looking into why women performed more poorly than men at maths. However, Ganley et al’s. (2013) research with 931 school children found that stereotype threat was not generally present with young children, this may be because changes in attitudes are occurring over time. Hill et al. (2016) examined

the prevalence of maths anxiety in primary and secondary school pupils and found that girls had higher anxiety levels and also higher general anxiety and that the maths anxiety increased with the age of the girls, younger girls were less anxious about maths than older ones.

Formal education in many countries has a culture of performativity manifested by high stakes summative assessments and associated pressures that children are subject to throughout their school education. This performative culture is likely to impact maths anxiety for some children.

We know that maths anxiety is prevalent in high achieving Asian societies such as South Korea who score highly on international attainment, this may be due to high pressure from within the home to be successful in examinations (Tan and Yates, 2011). Other high achieving Western European countries such as Switzerland (Lee, 2009) appear to have lower maths anxiety regardless of summative performance pressure, which again makes the discrepancies intriguing but hard to draw satisfactory conclusions.

Although the research into maths anxiety and children remains inconclusive in terms of identifying direct causes, there is too much evidence to dismiss it as irrelevant. Indeed, the term itself is hard to define and some suggest it becomes a self-fulfilling prophecy (we tell children to be worried about maths, so they are), it is important to be aware that negative attitudes do promulgate, and that trainee and early career teachers need to be reflective and aware of their own views and limit or avoid promoting this fear to the next generation that they are teaching.

2.4.3.Maths Anxiety and adults

The majority of research into maths anxiety has been conducted with children and within the wider education sector, including primary, secondary and tertiary teachers. Specific groups such as university students have been examined and many studies have also examined trainee teachers, and these are addressed in section 2.5.4 below. Fewer studies consider the general wider adult population and their attitudes, experiences and fears around maths. This gap in the research is strange as we know poor maths attainment can have a negative impact on life chances overall for the wider population (National Numeracy, 2019). The wider public represent the

families of the children and the families of the teachers however, so it is important to note what research has been conducted in this area.

An American study, Maloney et al., (2015), considered 529 children and their families and their maths homework. They found that when an anxious parent regularly helped with their first or second grade child's maths homework, this had a small but notable negative impact on the child's learning and increased their anxiety. However, if they did not help with the homework there was no impact on the child's learning. This suggests that having an anxious adult in your family, even when they are being supportive can have a negative impact on a child. Casad et al., (2015) also examined parents and children, this time teenagers and a parent, and found a link between generations and maths anxiety, especially between mothers and daughters. It is important to acknowledge (as the studies both indicated) that these studies looked at one parent only for the impact, and this was mostly the mother, which in itself could impact the research findings as gender, maths anxiety and maths mythology are complex and interlinked.

Hart and Ganley (2019) conducted an on-line survey of a 1000 adults in the USA. They found that women reported higher maths anxiety than men and those who had been to university or worked in the STEM sector (Science, Technology, Engineering, and Mathematics) reported less maths anxiety than those not in STEM or had not attended a university. However, they did find that general anxiety and test anxiety were also higher in the maths anxiety identifying groups. This study reinforces the expectations that are fairly obvious, people who enjoy maths go into careers that may involve it and that people who do not like tests, especially do not like maths tests. Although research such as this is informative it is also frustrating as we do not move any closer to the 'why' that we are really keen to understand. These studies highlight that parents with negative attitudes towards maths may have acquired these negative attitudes from their own childhood experiences and passed the legacy of maths anxiety onto their own children, negatively influencing their children's attitude towards and performance of maths in school later on.

2.4.4.Maths Anxiety and trainee teachers

As previously stated, much research into math anxiety focuses upon trainee teachers (often called pre-service teachers outside of UK) and has tended to focus on the causes of the anxiety and potential strategies to address it. Hadfield and McNeil (1994) found that older adults returning to learning felt greater maths anxiety than younger students, which they surmised linked to unfamiliarity with examinations and a greater distance between learning for exams. Understanding the concerns of mature students is relevant to this study as three from the eight participants in the study were classed as 'mature' students (over 21) and two others were over the age of 35.

Others such as Gresham (2018) used both quantitative and qualitive methods to explore the background to negative maths attitudes in trainees with a view that understanding the origin of the negativity might prevent trainees passing the same attitudes to pupils. Interviews with 20 pre-service trainees highlighted that early events within families and early schooling experiences with maths appear to be key and explain some reactions for negativity and avoidance of the subject. Situations that involved personal exposure and criticism appear memorable and invoke emotional reactions and language (Gresham 2008). Those with positive memories and experiences expressed the notion that they wanted to change the mindset of those children who didn't enjoy it. The pre-service teachers Gresham interviewed expected to find children who did not like the subject, as if this is a fact. Those who did not have good experiences and memories wanted to ensure that the children they taught had better experiences than they did, again suggesting assumptions that it is natural to not like or enjoy maths. As Geist (2010) suggests: -

> Many teachers who have math anxiety themselves inadvertently pass it on to their students. Math anxiety does not come from the mathematics itself but rather from the way math is presented in school and may have been presented to teachers when they were children. (p. 29).

Bekdemir (2010) agrees and goes further suggesting a negative cycle can form when a mathematically anxious teacher, lacking confidence, may teach in a manner that inadvertently develops maths anxiety in their own pupils, echoing the work of Hart and Ganley (2019). The situation is compounded by a trainee or newly qualified

teacher, in their very youngest years in school, who may have experienced the same negative enculturation of maths (Carey et al., 2019). Hoffman (2010) points out that what the teacher thinks mathematics is, will shape the kinds of mathematical environment they create – and thus the kind of mathematical understandings that the pupils will go on to develop.

Published research on maths anxiety in the context of UK primary teachers is limited. Jackson (2008) studied the questionnaire responses of 31 novice trainee primary teachers and discovered that 68% felt they had little confidence in teaching maths. 19% had no negative emotional or physical concerns when engaged in doing (rather than teaching) maths, 81% experienced both physical and/or emotional reactions towards the subject. A quarter were concerned about passing on their own negativity to the children and half were worried about their capacity to teach the older children. Jackson's research is illuminating but limited since the questionnaires were discrete and closed questions, so there is no opportunity to probe responses and the return rate was 62%, leading to question the motivation for return as self-selecting and unable to explore the views of those that chose not to participate.

Hunt and Sari (2019) completed larger scale research by implementing a Turkish scale called the Mathematics Teaching Anxiety Scale (MTAS). They surveyed 74 practicing primary school teachers and 53 trainee teachers. They deployed a two-factor structure; one directed towards the teacher's own knowledge and teaching skills, and one directed towards the children and their learning and covered issues such as pupils not reaching set curriculum targets. Their work was quantitative and tentative. They discovered that the pre-service trainees were more anxious than the serving teachers and that length of service was an impacting factor. The longer teachers had taught, the less anxious they were about their own skills and knowledge. The second factor focused on impact on pupils learning, and anxiety around this remained higher for both groups, experienced teacher, and trainee. This study focused on maths teaching anxiety not general maths anxiety, so not on personal academic performance in the subject. The overall "mean for the sample represented "rarely" "to sometimes" maths teaching anxious." (p440). This suggests that a distinction needs to be made between learning maths and doing maths, compared to teaching maths. When discussing maths anxiety, there may be a very personal reaction to the act of 'doing maths' for example, completing calculations

themselves and a more externalised response to the process of teaching maths to children and therefore emotions and reactions may differ between the two. This is important as the trainees in this study are looking at those two aspects: subject knowledge and the pedagogical content knowledge.

Other qualitative studies have focused on the beliefs and preconceptions of pre-service or trainee teachers towards maths and the methods of teaching maths that they had received previously themselves. Rufell et al., (1998), who researched children, PGCE secondary and Primary and Primary B.Ed. trainees and teachers and attitudes towards maths deploying small scale focus groups and diaries. They concluded that negative memories often from single incidents could embed negative views around maths, often lasting for life, and often based on a single incident at secondary school, echoing others such as Boaler. This was small scale qualitative research, with relatively small groups, so little can be generalised, but may indicate that the trainees and ECTs in this study have had similar critical incidents that trigger anxious traits.

2.4.5.Maths Anxiety and Cognitive Load Theory

Maths anxiety impacts on the working memory of the individual because their emotional reaction appears to impede their cognitive functioning (Ashcraft & Krause, 2007). When tackling a mathematical problem that requires the use of working memory, the individual has to process the anxiety first, and deploy their mental focus on dealing with the anxiety rather than the mathematical procedures and processes. These procedures cannot access working memory until the emotional anxiety subsides and space is made available for other processes. This can be particularly problematic when working with on-line or timed testing (Carey et al., 2019). Higher-level maths questions (such as algebra) depend more heavily on working memory for processing, so may show a far greater impact of maths anxiety on the individual, than lower-level retrieval type questions. For example, asking 8x7 might not cause much maths anxiety but 8700 x7 might cause far greater cognitive load as it requires many more processes to find the answer. This impact needs to be kept in mind both for the trainee teacher teaching and for the children who are learning the maths.

This is an important point, as the cognitive load upon a trainee teacher is already high (Sweller 1988, Bennett & Carre, 2002). The research of Moos and Pitton (2014)

examined 26 pre-service teachers during 14 weeks of teaching practice, split into two seven-week blocks. A self-reporting questionnaire was adopted, and semi structured interviews were deployed. The research findings showed a lack of automaticity in the trainee teacher's actions compared to experienced teachers which meant that classroom management and behaviour, coupled with the need to recall planning and meeting the needs of individuals, led to what Sweller, (1994) deems the "Split attention effect". This suggests the trainee's working memory is overwhelmed with demands emanating from so many differing directions and pulls on attention that teaching performance is negatively impacted. If any aspect of maths anxiety is already causing a high cognitive load on a trainee teacher, adding in the extra weight of classroom management, planning, teacher exposition and effective modelling will apply more pressure than usual to the trainee when they are teaching maths lessons and needs to be kept in mind by ITE providers and the school mentors who support trainees in placement.

Although the proliferation of research discussion around exactly what maths anxiety is ever refining and evolving concept, there is no doubt that something around maths can create fear. Be that poor past pedagogy, high stakes examinations or social mythology there is 'something' that for some people, creates a negativity and can place a higher cognitive load on an already weighed down trainee teacher. Therefore, ITE providers, tutors, and mentors need to be aware of this and to keep it in mind when working with teachers at any stage of their careers.

The next section examines the different types of knowledge required by trainee primary teachers in order to teach maths effectively.

2.5.Subject Knowledge and Pedagogical Content Knowledge

The classic work of Shulman (1986) highlighted seven types of knowledge that a teacher requires to teach effectively. Shulman focused on three key areas specific to teachers:- subject or content knowledge (the information they are communicating), pedagogical knowledge (how to teach and keep children's attention) and pedagogical content knowledge (the specific teaching methods that suit the particular subject being taught). A trainee teacher will require all three aspects to become an effective teacher. In this study the term effective is used to mean a fully

qualified teacher who has demonstrated that they are able to pass the English Teacher Standards and therefore teach a class independently.

As discussed in the previous section, the cognitive load on trainee teachers is high, due to the many and varied demands of teaching on their brains. A trainee must understand the range of knowledge required to be effective and decide the most appropriate aspect to focus on at any given point in a lesson or sequence of lessons. This aspect of the literature review is situated within the current theoretical discourse regarding the importance of balancing content knowledge with wider pedagogy and pedagogical content knowledge. Within this discussion the notion of content/subject knowledge will be used to clarify that this is connected to the subject being taught. Within primary teaching, this could be any of twelve subjects rather than secondary (where the majority of teachers focus on one or two subjects), therefore the term content makes sense in that context, and the term subject makes more sense in a primary setting.

Since the instigation of the 2014 National Curriculum for Primary Schools, discourse around subject or content knowledge and these being the most vital aspect of any teaching appears to be in the ascendancy. Current Governmental policy, especially that developed under the leadership of Michael Gove, appears to favour the perspective that a knowledge-based curriculum is the most effective way to approach teaching for any age phase, as put forward by Willingham (2010). Muijis (2018) (the most recent head of research for Ofsted) told delegates at a meeting for the Chartered College of Teaching that; “subject knowledge CPD is becoming more important as many schools move towards a knowledge-based curriculum” (2018). The Ofsted school inspection framework (Ofsted, 2019) mentions the word knowledge 86 times compared to 33 times in the previous framework, so the political lean is firmly towards subject knowledge as essential. The work of Rowland and Ruthven (2011) argue strongly that the quality of both primary and secondary maths teaching relies on the strength of the subject knowledge that teachers have.

2.5.1. Subject Knowledge (SK)

Subject knowledge is very difficult to define with clarity, so I am adopting the definition given by the Training and Development Agency for Schools (TDA) (defunct since 2012) in 2007. Subject knowledge (SK) when applied to teaching, per se, is

explained as “The essential knowledge and understanding needed in order to teach a subject effectively.” (TDA, 2007). Although all the trainee teachers have passed a maths qualification equivalent to GCSE grade C/4, for entry on to teacher training, all the participants in this study then had to pass the maths skills test. This involved an on-line timed test of their maths computational and procedural knowledge. Originally applicants were allowed three attempts and were ‘locked out’ of training for two years if they failed. This was then altered in 2018 to allow for unlimited attempts. The maths skills test was then abandoned in 2019 along with the English skills test, in order to remove barriers to teaching as recruitment, especially for secondary ITE is very challenging. Instead, all teacher training providers now must assess competency in maths and English (spoken and written) in the interview process. Trainees in this study had all completed a skills test in mathematics prior to entry. However, in reality trainees’ actual maths subject knowledge can be very variable indeed. The knowledge and revision required to pass a test at an adult level, requires subject knowledge but this is not the same knowledge as that required to extend or support a child in their understanding of an aspect of mathematics. As Ball (1991, p. 5) stated: - “Teachers cannot help children learn things they themselves do not understand”, the trainees need a deeper knowledge of the subject and to be able to make connections between aspects. It is possible to be able to ‘do’ long division but not know how to teach long division so a child understands and can do it themselves independently (Haylock and Manning, 2018). Hence the necessity to have a definition that is broader than just “knowing” the subject for examination purposes. Charlie Stripp (Director of NCETM) stated in 2016: - “If understanding in any mathematical area is deep (not superficial) then it will mean that the learner has recognised and grasped connections between the concept in question and concepts in other areas of maths.” (Stripp, 2016). This knowledge can be seen as the ‘what’ that teachers teach, and the trainees need to understand it and to be able to see the links between each aspect, so for example knowing that fractions, decimals and percentages all belong to the same family in maths and knowing one confidently will help you understand the others. Strong subject knowledge (SK) enables greater depth teaching and more rounded responses to pupil’s questions (Brophy 1992, Davis et al., 2017).

This echoes the seminal work of Mike Askew et al., (1997), in a report for the Teacher Training Agency, the aim of which was to identify the key factors that enabled teachers to be effective teachers of primary numeracy. They defined numeracy as: - "Numeracy is the ability to process, communicate and interpret numerical information in a variety of contexts." (p. 9). This widens the discussion to maths rather than just a more traditional view of numeracy as arithmetic. The study focused upon pupils and teachers in a range of primary settings and combined consideration of test results and teacher views, knowledge and beliefs. This study found that teachers' beliefs and their knowledge of the maths, both in terms of the subject knowledge required and the pedagogic content knowledge (what to teach and how best to teach it), (p51) impacted on the progress of the pupils. The most effective teachers in Askew's study had connectionist views around teaching maths and the less effective teachers held transmission or discovery views. Connectionist teachers can see the links between areas of maths and are confident in their own knowledge and in their ability to present this knowledge in an effective manner and probe the children's existing knowledge. Whereas transmitter teachers just tell the children how to do the maths rather than probing their knowledge or prior learning and discovery teachers who want the children to find out for themselves with little guidance or structure which is a very haphazard strategy. "The mathematical and pedagogical purposes behind particular classroom practices are as important as the practices themselves in determining effectiveness" (p5). Askew suggests that the rationale behind behaviours is as important as the behaviour itself, this research is seeking to explore the thinking behind the participants actions and perspectives.

2.5.2. Pedagogical Content Knowledge (PCK)

Askew's work supports the notion that teachers require subject/content knowledge, but they also require a deep knowledge of what Shulman deemed 'Pedagogical Content Knowledge' (PCK) (1986,1999 and Geddis, 1993). Shulman (1986,1999) is considered the key proponent of the argument towards a subject specific pedagogy, and this work has been adapted and refined by Loewenberg-Ball, Thames, and Phelps (2008). PCK is a "conceptual map of how to teach a subject; knowledge of instructional strategies and representations; knowledge of students' understanding and potential misunderstandings; and knowledge of the curriculum and curricular materials" (Villegas-Reimers, 2003., p39). Subject knowledge (SK) is the knowledge

that teachers need to communicate to pupils, but PCK is the way that knowledge is communicated, it is the way teachers bridge the gap between knowing something yourself and enabling someone else to know it. Children have to learn their times tables, that is the subject knowledge they need to know, but the how it is taught to them in order for them to know, understand and apply it further is the choice of the teacher and the PCK. PCK may vary from subject to subject, so again the cognitive load this places upon the primary teacher with so many subjects to master, is immense. Maths, it has been suggested, has complex PCK that intertwines with subject/content knowledge (Ma, 1999, 2020). Chick et al., (2006) research focused upon primary teachers explaining how to teach subtraction and the need to understand regrouping or exchanging and how then to explore and explain this to children. This required not only a strong grasp of the procedure for written decomposition methods but also a good understanding of how to model and support children who could not understand the procedure. This type of teaching draws on the PCK strongly. In Chick's study some of the teachers struggled to be able to explain the issue and did not know what to do to help the children understand it. This is a small study of 14 Australian Primary teachers, utilising questionnaires and follow up interviews. It is useful in confirming that trainee teachers will need to have knowledge and confidence in both PCK and subject/content knowledge and be able to draw on both, at speed, in the classroom. In primary teaching terms subject/content knowledge is the 'what' that is taught, and pedagogical content knowledge (PCK) is the 'how' it is taught (Haylock, 2019) and both are necessary. As Desforge and Cockburn stated in 1987 (p2):" The problem of mathematics education is that it is a many headed monster". For trainee teachers especially, who are unused to all the different facets, there is a great deal to process and to consider in every maths lesson.

Pedagogical Knowledge (PK) can be defined as "An understanding of the teaching skills and strategies needed to teach all pupils effectively" (TDA, 2007). PK is the vast array of generic teaching knowledge required to teach any subject in a primary school. Everything from classroom and behaviour management strategies to teacher exposition and how to structure a lesson, all come under the notional umbrella of pedagogical knowledge. There is much blurring between the notion of PK and PCK however as it can be challenging to decide which PCK is subject specific and narrow

and which aspects are effective across a range of subjects. The importance of identifying misconceptions for example, is central to effective PCK in mathematics, (Coe et al., 2014, Hansen et al., 2014) but it can be argued misconceptions in any subject area are vital and need to be identified and rectified as soon as possible to prevent them from becoming entrenched. In this study the focus is on PCK and SK in maths rather than wider pedagogy, as wider pedagogy covers all primary subjects and teaching generally, and this study narrows down to focus upon maths teaching specifically.

Feldon (2007) states “Cognitive overload occurs when the total processing demands of external stimuli and internal cognitions exceed available attentional resources” (p. 123). Thus, when trainee teachers are attempting to support behaviour challenges, classroom management and processing a teaching plan, then need to model effectively and answer and apply PCK and SK at the same time, they can become overwhelmed cognitively. This overload has clear implications for the novice teacher and the way initial teacher training is structured and supported. This study will explore the trainees’ views of PCK and SK over time and question which they deem to be the most useful and appropriate strategy.

In the current (and previous) National Curriculum, the maths programme of study dictates ‘what’ should be taught (DfE, 2013) (SK) but the ‘how’ (PCK) is very much suggested to be an individual school or academy chain choice. However, the performativity and surveillance cultures (Ball, 2003) and (Galič, Timan & Koops, 2017) galvanised by the inspection routines of Ofsted and their regular subject reviews are viewed as very much encouraging schools to teach in a narrow and specific type of way, focused on ‘Mastery Maths’ and knowledge acquisition, revisiting and retention. The trainees’ and ECTs perspectives of this will be explored and developed over the chronology of the study, to see if they feel a level of curriculum control and performativity has impacted upon them.

2.6. Self-Efficacy

Another aspect raised in similar studies is that of trainee teachers’ personal confidence or self-efficacy. Confidence can be defined as: - “a feeling of self-assurance arising from an appreciation of one's own abilities or qualities.” (Oxford Languages, 2022), in other words, an awareness of your own strengths and being

reassured by that awareness. Confidence links to the strength of a belief whereas self-efficacy refers to confidence in dealing with situations without becoming overpowered and overwhelmed by them, an indication of resilience as well as confidence. Self-efficacy is strongly linked to the work of Albert Bandura (1977) who was a Canadian American psychologist. His work on social cognitive theory led to the development of the notion of self-efficacy. Self-efficacy can be defined in many ways, but as Bandura's work is most widely acknowledged and accepted within the education domain, it is the one applied here as most appropriate in this context. The definition is from his 1977 work, "self-efficacy is the conviction that one can successfully execute the behaviour required to produce the outcome one desires" (p. 193). Bandura suggested that efficacy is part of the way people can exercise control over their existences, especially when encountering new and unfamiliar challenges. They are able to be proactive and reflective, having strong self-efficacy enables a trainee to approach training in a positive way and accept feedback and move forward, they would be: - "partial architects of their own destinies" (Bandura, 1997, p. 8).

Self-efficacy has been investigated by a range of studies evaluating trainee teachers and their belief in their ability to teach subjects including maths effectively. The notion of self-efficacy connects to the competency discussion previously mentioned as self-efficacy is related to the self-perception of competence rather than actual levels of competence in an area, it reveals the link between thoughts and actions. Competence is a difficult area to discuss as there are no formal measures of it in teaching bar the Teacher Standards as previously discussed. Over estimation or under estimation of personal competency may have consequences and impact on the overall self-efficacy. The work of Tschannen-Moran and Hoy (2001), is key as they devised a method of measuring teacher efficacy, prior to this there had been a range of different mechanisms applied such as Gibson and Dembo (1984) but as situations can differ and generalisations are not desirable, it was difficult to devise a measurement system that could be effective. Their work showed that strong self-efficacy beliefs are good predictors of teacher effectiveness and learning outcomes in maths. Developing the notion that trainee primary teachers who have high levels of self-efficacy in maths are more likely to engage in effective teaching practices, persist in the face of challenges, and adapt to changing classroom conditions.

The work of Hall and Ponton (2005) suggested that first year university students who enrolled on higher level maths courses had higher maths self-efficacy than those who enrolled on the lower-level courses. This may have a connection to this study as the trainees are focused on 3-7 years education. It could be suggested that this choice was linked to the level of subject knowledge required, and a potential assumption that the younger the children, the easier the course content would be, (Ball,1988) so the maths would not be as challenging in terms of subject knowledge. This maths 'myth' remains prevalent in wider society, that younger children require less knowledge to teach them.

Bates et al., (2011) examined 89 early childhood pre-service teachers in the USA. In a quantitative study they utilised scales for measuring self-efficacy and beliefs, plus maths knowledge testing. They measured the trainees own self efficacy in being able to do maths (mathematical self-efficacy) and compared it to their mathematical teaching self-efficacy. They discovered that although the students with high maths self-efficacy also tended to have higher teaching self-efficacy, (they know they can teach maths) but they do not know if this teaching will be effective for their classes, as often they lack the necessary experience to be able to assess their own impact as teachers. They lack the pedagogical content knowledge (PCK) to know if their teaching has been effective or not. Bates et al., (2011) concluded that trainee teachers need to be able to do maths, and not only observe and copy other teachers teaching maths but also know how to assess the impact that teaching has on the children. Again, proving to be a very demanding cognitive load for the trainee.

The research of Macnab and Payne, (2003) looked at first and final year B.Ed. trainees in Scotland, a relatively small sample of 25 from across the country. They found that attitudes towards maths from prior experiences at primary school were mainly positive and that it was at secondary school where the most negative experiences had occurred. They state:-

> It would seem that the student teachers prefer and feel more secure in the more personalised, real-life contexts of the primary school, (largely replicated in their teacher education course), rather than the more subject-oriented and abstract treatment of mathematics in secondary school. (p.64).

The trainees in the study again often recounted negative experiences of ‘critical incidents’ from their previous education, especially secondary school. Suggesting that self-efficacy in maths and potential maths anxiety appear to stem from negative school experiences, especially in the teenage years.

Bjerke and Solomon, in their 2020 small scale Norwegian study of pre-service trainee teachers over 3 years, argued that all sources of self-efficacy in teaching mathematics should pay more attention to the role that "understanding why" plays in mathematics. They suggested that it is essential to the experience of mastering maths teaching (Bjerke & Solomon, 2020). This was a small study using a qualitative approach tracking trainee’s attitudes. Similar to Bates et al., the notion that trainees need to be able to do maths and to understand the ‘why’ as well as the ’what’ in order to teach it effectively is a continual thread. The study also tracked attitudes over time, and similar issues to Dunning-Kruger (2011) and the Conscious Competence Matrix (Howell, 1982) emerged. Analysis of trainees’ attitudes towards their training and the value that they placed on maths subject and pedagogical content knowledge (SK and PCK) changed over time. The participants valued university taught input far more by the end of the study, than they had at the start. Muijs and Reynolds (2002) undertook a larger scale quantitative study focused on 103 primary school teachers in the UK, they echoed previous findings, with teacher knowledge of effective teaching strategies, such as PCK being the strongest factor in pupil achievement, with teacher beliefs and personal subject knowledge being influential but not essential. They also found that low self-efficacy towards maths as a subject often stemmed from negative prior experiences, reinforcing previous findings. They did not find any strong links between SK and teaching quality but did recognise that SK impacted upon the teachers own self efficacy views. However, they acknowledged that the SK aspect was self-assessed and perhaps not so accurate as they may over estimate their knowledge.

Considering all of the above studies, it can be suggested that self-efficacy towards maths as a subject stems from prior experiences or incidents, often from secondary schooling. Subject knowledge self-efficacy is not the same as self-efficacy towards the teaching of maths. There is considerable overlap between the notion of strong self-efficacy or self-belief in maths with the theory linking subject knowledge to pedagogical content knowledge in maths. The intertwining of PCK/SK and self-

efficacy and maths anxiety is clear. If someone has a strong belief in their ability to teach maths and also a good grasp of how to teach it, these studies suggest they will teach it effectively. Just being good at doing maths or just thinking you know how to teach maths does not necessarily predict that you will be an effective teacher:- knowledge, skills and personal attributes and prior experience all have a contribution to make.

2.7. Developments in understanding Early Years maths

As the participants in the study were all going to become Primary teachers with a focus on 3-7 years it is relevant to examine more recent research into maths teaching within the early years. For the parameters of this study, Early Years refers to 3-7 years rather than from birth.

The importance of children developing an early sense of number has come to prominence in recent years, with a realisation that children who are behind in maths from a young age tend to remain behind throughout their educational journey (Aubrey et al., 2006) and this has ramifications for their adult lives. Very young children can be supported in solidifying their understanding of number using play-based methods. The work of back and Sayers (2013) from Hungary and Sood and Jitendra from the USA (2007) found common threads in the knowledge that young children need to develop a strong understanding of the foundations of number in order to build upon these concepts in their later maths education.

In the UK, the work of Carruthers and Worthington (2011) developed the understanding of the importance of mark making with young children and mathematics. Their studies considered the simple marks children made while engaging in play and explored how this linked to understanding of number conservation and counting. Their work made teachers reflect on the way children of this age demonstrate understanding and the need to understand their mark making as a representation of mathematical thinking rather than needing to see formal notation as the key sign of conceptualising and understanding. This began a change in understanding what early maths might actually look like in the early years of school and a desire to understand more fully the concepts being developed.

The dilemma of valuing play based learning whilst needing to insert mathematical language and concepts has been debated over the last few years as studies such as

‘Bold Beginnings’ (Ofsted, 2017) encouraged a more formal ‘instructional’ approach to teaching young children, rather than a loose play-based approach. This increase in formality of teaching in early years has led to a need to support early years practitioners in nursery settings and early years teachers in schools with their own confidence and knowledge in maths. As discussed previously in section 2.5, educator beliefs are important as they tend to influence emotional positivity or negativity towards maths as a subject and the pedagogy and approaches taken to teach it (Lee and Ginsburg, 2009 and MacDonald and Murphy, 2019). Schuler’s research (2008) focused on the decisions that educators had to make around maths teaching, did they include direct instructional practices or have a free play environment that linked to maths where relevant, such as counting the children who were present and sharing snacks equitably which has been the trend over recent years or more overt formal lessons instructing the children using maths practical resources?

The work of Kate Tucker (2014) and Helen Williams (2022) in the UK has very much encouraged the use of play and exploration of the physical and spatial prior to teaching and using a play-based methodology that may be viewed as more age and developmentally appropriate within EYFS continuous provision to develop children’s mathematical understanding. This contrasts from the more formal foci of the DfE and Ofsted and their desire for a sequenced and tightly planned curriculum. The use of what Skene et al., (2022) terms ‘guided play’ in their meta-analysis study, with the adult being very clear about what is being learned and the children having choice and agency and the adult being flexible with their guidance for the children, if all of these intersect, you have what Williams (2022) terms “a powerful vehicle for early mathematical learning”. This is a ‘half way house’ between direct instruction and free play but requires an educator with strong maths understanding to design the structures and purpose around the play/maths intersect, which requires a strong level of subject and PCK and confidence as previously discussed.

This need for development in practitioner knowledge has led to the formation of supported CPD in England through the national maths hubs and their parent body, the NCETM. Courses such as ‘Mastery in Number’ are designed for the 3-7 age phases to develop staff knowledge and skills understanding how to develop these essential early number skills. These courses have been designed with the support of

renowned early maths expert Sue Gifford who has written key guidance on early years maths in England such as the 2021 EEF report on 'Improving maths in the Early Years and Key Stage One' (EEF, 2021).

As stated previously this drive to explore effective PCK in early maths is a global one, with Australia and their Evidence for Learning organisation having recently published their own investigation that echoes the English EEF report from 2021 and coming to similar recommendations around integrating maths into the child's day, improving educator knowledge, using manipulative resources to scaffold understanding ensuring sequenced learning and using targeted support (EfL, 2023). Other studies such as Clements and Sarama (2020) in the USA echo the need for developing the skills of teachers via CPD to extend their understanding of how children learn at these vital early stages. This exploration of early maths sense and understanding is a global issue with countries such as Norway having a Kindergarten framework (0-5 years) that encourages children to "find pleasure in mathematics" and staff shall "encourage the children to be curious, find pleasure in mathematics and take an interest in mathematical relationships" (Norwegian Directorate for Education and Training, 2017, p 53–54 in Birkeland et al., 2020).

Within this developing discussion of appropriate practice and pedagogy it is clear that within early years education, maths is no longer the poor relation compared to language and literacy but a central thread with an urgency in understanding how mathematical knowledge is constructed and developed. This is then coupled with a need for the educators to be equalled skilled in developing that learning. It is within this developing and extension of knowledge, understanding and support that the participants in this have trained and become ECTs.

2.8.Curriculum Control

Another thread of similar studies examines trainee attitudes towards the teaching methods and strategies that they deploy and those they would wish to deploy. Brown et al., (1999) in a large qualitative study explored the notion that trainees (on a four-year BEd course in England) could not teach maths in the way that they would wish. They were constrained by placement schools, mentor expectations, the spectre of Ofsted expectations and restrictions from the use of commercial schemes.

Alternatively, Basit (2003) interviewed 30 final year trainee teachers who had been in training during the evolution of the then new National Numeracy Strategy (NNS) (DfEE, 1999) which altered substantially the way primary schools in England taught maths. It was the first wholesale top-down policy initiative dictating how maths should be taught in English Primary schools. Basit stated that the trainees found it a helpful and supportive structure for them to deploy in an area that they lacked confidence in. The trainees had been trained by their university to teach the NNS and consequently felt empowered and scaffolded by having an explicit structure to refer to.

There have been no studies focused upon trainee teachers and their views of constraint and the more recent 'mastery' maths strategies as yet. These new strategies have emerged from recent government innovations connecting a change in primary maths teaching PCK to use of Singapore and Shanghai teaching methodologies, via maths 'hubs'. It would be valuable to consider if this very structured type of PCK strategy makes novice teachers more or less secure in their teaching knowledge and understanding.

2.9.Conclusion

This literature review has examined the most relevant studies involving trainee and novice teachers, reviewing and contextualising the evidence. The public perception of maths has been surveyed and explained. Maths anxiety as a problematic concept has been explored and the research around maths anxiety in children, adults and trainee teachers has been developed, the current situation of early years maths has been explored as have the links to self-efficacy and the complex inter-linked relationship between PCK and SK. In the next chapter the background to the theoretical framework based on Howell's 1982 Conscious Competence matrix is explored. The application of this theoretical framework to the wider study will be clearly explained. By combining the insights gathered from the literature review with the theoretical underpinnings, this study aims to contribute to the wider knowledge base of both trainee teacher development and to maths teacher ITE programmes.

Chapter Three

3.Theoretical Framework

3.1.Introduction

This chapter explores the rationale, relevance, and background for the deployment of Howell's (1982) Conscious Competence Matrix to the study. Key terms are defined and clarified. The Matrix itself is explained and explored and the application of this theory to the wider study then developed.

It was whilst investigating IPA and psychology in the wider domains that I encountered the Conscious Competence Matrix, it is derived from a psychological background and has been widely applied to a variety of professions in their training stages, especially those in medical, engineering and human resource fields.

3.2.Background to the Conscious Competence Matrix (CCM)

The notion that we do not know what we are not aware of, is not new, and there have been multiple ways to exemplify and explicate the idea. From Donald Rumsfeld (the ex-United States Secretary of State for Defence) who famously stated in 2002;

> There are known knowns, things we know that we know; and there are known unknowns, things that we know we don't know. But there are also unknown unknowns, things we do not know we don't know. (Rumsfeld, 2011).

He was using the expression relating to war with Iraq and threats that the USA were aware of, threats that they knew would exist at some point, and that there would also be threats that as, yet the USA were not aware of in any capacity. He later used the example of the 9/11 terrorist attacks as an example of unknown unknowns. Rumsfeld acknowledged in his 2011 book, that this idea had been explored with him previously by scientists at NASA reflecting on misjudgements made regarding nuclear weapons and the potential threat of attacks.

Conscious Competence as a concept can be traced further back to the work of two American psychologists, Luft, and Ingham, who developed a concept termed Johari's window (Luft & Ingham, 1961). Johari's window is a graphical representation for

examining human relationships that uses the notion of known and unknown, and linked it to the variety of ways humans relate to each other, revealing some aspects, hiding others and being blind to yet others. The focus is on developing self-awareness. This model is deployed widely today in modern business psychology and even in the realms of cyber security, as a way of explaining informational blind spots (Renaud et al., 2021).

The concept of unknowns and knowns also links to the Dunning-Kruger effect (Kruger & Dunning, 1999). The Dunning-Kruger effect is the argument that through a cognitive bias, people's own ignorance is often invisible to themselves. Dunning-Kruger suggest that people in the early stages of training in social and educational domains have no concept of how inexpert they are at specific or new tasks and over inflate assumptions of their own skill level. Their research tested four groups of young adult participants in three different areas, humour, logical reasoning, and grammar. The results matched the prediction that less competent individuals will overestimate their own ability and their performance and are less able to recognise competence in others too. Kruger and Dunning (1999) stated, "Not only do they reach mistaken conclusions and make regrettable mistakes, but their incompetence robs them of the metacognitive ability to realise it" (p. 1121). The effect is not universal and depends on the domain and the need for a minimum threshold of knowledge in the domain by the participant. This theory has been explored and the research replicated widely in business, politics, aviation and amongst the medical community when considering the training and development of a wide range of medical professionals. Articles such as 'How can I know what I don't know?' (Eva et al., 2004) and 'Why the unskilled are unaware' (Ehrlinger et al., 2008) have proliferated to explore this concept and application to early-stage practitioners. Others have suggested that high achievers often underestimate their skills in a similar manner (Amin-Hanjani & Haglund, 2022) a study that focused upon female neurosurgeons and their self-perceptions. The unknown knowns are central to examining the views of early-stage practitioners and their understanding of themselves. As Rand et al., (2017., p 1774) stated: "one of the prerequisites of voluntary self-improvement is actually recognising the need for improvement".

Although Dunning-Kruger's work has been widely applied to the medical training field and within psychology, it has recently begun to enter the teacher education sphere.

Connections between the Dunning-Kruger effect have been applied to the notion of metacognition, which stems from educational psychology. Metacognition is associated with the work of John Flavell (1979). It can be defined as “thinking about thinking or learning to learn” but the reality is more nuanced and complex and involves reflecting on cognitive experiences, (Livingston, 2003). For example, knowing that a quiet space is more helpful for reading, or that making notes and revision helps with exam preparation, is metacognition in action. In education in England, the notion of teaching children ‘how’ to learn as opposed to just ‘what’ to learn has gained traction. Reports from government backed research charity groups such as the Education Endowment Foundation (EEF) and their highly influential report on metacognition in 2021 (Education Endowment Foundation, 2021) have become essential reading for all teachers and educationists .

The growth of interest in cognitive psychology and its application to teaching pedagogy has developed hugely over the last ten years. Developments in understanding of the brain via neuroscience and concepts that previously were only deemed applicable in the psychological or medical world have entered the education knowledge domain. The rise in cognitive load theory as a driver in all aspects of teaching (Sweller, 1988), is an example of this. The concept of cognitive load theory is that new skills and knowledge involve a great deal of brain processing, so teachers need to break down tasks into smaller parts and with repetition they will become second nature to pupils and occupy less working memory space. Cognitive load theory and the memory load also applies to anyone learning new knowledge or skills, so directly applies to trainee teachers who are having to learn many new things in a very short timeframe. Both cognitive load and metacognition connect closely with the notion of the Conscious Competence Matrix (CCM) (Howell, 1982).

3.3.The Conscious Competence Matrix (CCM) history

The authorship and origins of the Conscious Competence Matrix are opaque, and somewhat confused (Telang et al., 2017). The first traceable source that describes the model is within a Christian teaching periodical called ‘The Gospel Guardian’, within an article by a Martin M Broadwell (1969). Broadwell used it as a journey through a teacher’s learning development and reflection. Several business training and staff development organisations, notably Gordon Training International and Noel

Burch (Gordon Training International, 2012) have also developed and defined the theory since the 1970s, applying it to business training and performance management systems. Additionally, it has also been adapted into a triangular format and attributed to Maslow, confusing it with the hierarchy of needs model, but there is no documentary evidence to confirm this link. The main source for the most frequently used version (and the one applied in this study) of the Conscious Competence model or Matrix harks back to W.S. Howell (1982) and his book, 'The Empathetic Communicator'. This is the most developed and explicative version and therefore the one that I am using in this study.

The Conscious Competence Matrix creates a descriptive theoretical framework for considering self-awareness when learning a new skill, gaining new knowledge, or taking on a new behaviour (Rogers et al., 2013). It has gained traction and popularity within the business domain as a measure of competency in skills and has been applied to an array of performance management tools. The range of 'grey' literature around the concept is huge, notably blogs and business personal and performance management webpages. However, it has been utilised in the academic medical sphere, notably around training and staff development.

The term 'conscious' in this situation means "an organism's awareness of something either internal or external to itself." (APA Dictionary of Psychology, 2023). In humans it is our ability to be self-aware and to be able to communicate this.

Competence is a much more complex word to define, and at times troubling, with many varying perceptions. Competence is a minimum measure of proficiency for some in the business field, almost derisory, as a statement of the most basic level of aptitude. The dictionary definition is simply: - "An important skill that is needed to do a job." (Cambridge Dictionary, 2023).

In terms of teaching in England, the measure or baseline for teacher competency is assessed as meeting the Teacher Standards (Department for Education, 2011). There are eight of these and a second part, that is linked to professional conduct. Every trainee teacher is assessed at the end of their training against these standards, having built up an evidence base during their ITE course. If they are deemed to have been successful, they are conferred the title of Qualified Teacher Status or QTS by the DfE (Department for Education). However, once a teacher has

achieved QTS they then have to complete two further years as an Early Career Teacher (ECT) being observed, going through further training, and assessed against the Teacher Standards again, in greater depth. The description from the standards document states: - “They must be used by schools to assess the extent to which early career teachers can demonstrate their competence at the end of their induction period” (Department for Education, 2011). At the end of the two years a teacher is then deemed as being fully qualified. A teacher who fails to meet the Teacher Standards is forbidden to teach in state-maintained schools in England. Apart from formal assessment against the Teacher Standards there is no other measure of competency applied externally. Ongoing competency as a qualified teacher is assessed through performance management systems within the school or the academy chain that the school belongs to. To reach the upper pay spines for promotion, teachers are again compared to the Teacher Standards and expected to go above and beyond these but there are no other formal metrics applied. This leaves a gap in the discussion around teacher competency with no other language

Other professional bodies such as Chartered Engineers or Accountants and the Civil Service have more structured competency frameworks that are applied to give external verification and clear metrics for career progression but in England teaching only has the Teacher Standards. The Teacher Standards though are a performance benchmark, a pass/fail bar rather than a graded scale of competency levels and described by the DfE as: - “the minimum requirements for teachers’ practice and conduct.” (DfE, 2011). The accompanying guidance on how to apply the Teacher Standards states: - “headteachers and other appraisers should use their professional judgement and common sense to assess teachers to a level that is consistent with what should reasonably be expected of that teacher, given their role and level of experience.” (DfE, 2021). So, the judgement of competency in teaching is a best fit to localised common sense rather than against a progression-based set of metrics. Hence the interest in this study for considering other careers and their structures for developing skills, knowledge and understanding.

“Competence is the ability to integrate and apply contextually appropriate knowledge, skills and psychosocial factors (for example, beliefs, attitudes, values and motivations) to consistently perform successfully within a specified domain.” (Vitello & Greatorex, 2022). This definition from two educators, fulfils the need to

broaden competence as a term, beyond simple task fulfilling or as a tick box exercise to the wider and more complex and far more nuanced act of teaching. Teaching requires knowledge, skills and very, many tiny and complex pedagogical decisions to be viewed as being effective. Therefore, Vitello and Greatorex's view is the most relevant definition for application in this educational study.

The CCM has been applied most frequently to the medical training domain, often using quantitative assessment type scoring to judge the position of the participant on the Matrix in relation to a particular skill. Within the counselling and medical training community it is "… the predominant model used within the healthcare professions and clinical environments…" (Lane & Roberts., 2022 p 3). Lane and Roberts also completed an IPA study in 2020 applying the CCM to medical interns reflecting on medical errors (2020).

There are some instances of the Conscious Competence Matrix (CCM) being applied to education, Black (2015) applied the Matrix to help evaluate higher education leadership and refine models as did Clegg and McAuley in 2005, with their focus on middle management in higher education. Refugio et al., in 2019 focused upon secondary school maths teachers in a quantitative study exploring progress in a knowledge enhancement programme. That study applied the CCM to the participants based on a scored quantitative model, an external viewpoint, as opposed to this research which seeks to see if the participants own perspectives and descriptions of themselves anchor into the model structure. Castle and Buckler (2021), suggest the Matrix is helpful when working with learners to help them consider the level they are currently at and externalise their thinking more clearly.

The Matrix itself, in the original and most frequently described version (Broadwell, 1969, Houldsworth, 2018), suggests a four stage learning process that is an iterative process when learning something new and unfamiliar. The Matrix considers two aspects: self-awareness or consciousness, and aptitude towards the new knowledge or skill. Conscious interpretation, according to Howell (1982), is analytical and often evaluative, and the unconscious view of any setting is holistic. Howell does add a fifth stage which will be explored and explicated further below.

3.4.Structure of the CCM (Howell,1982, pp 29- 32)

Stage 1: - Unconscious Incompetence

The individual is unaware of the requirements, knowledge and skills needed and is unaware of their own incompetence. This stage links back to the Dunning-Kruger Effect as described previously. The person is incompetent, and unconscious of this. They may make mistakes and be unaware and indeed may present as overly confident, as they have not understood the complexity of the task and the effort required. An ‘ignorance is bliss’ standpoint.

Stage 2: - Conscious Incompetence

The individual is now aware of the requirements, knowledge and skills required and is aware of the shortfall in their own knowledge base. The person now knows that they do not know what is required sufficiently to be skilful and recognises that they have a great deal to learn to gain the necessary skills. However, improvement at this stage should be considered as trial and error, unhelpful or unproductive actions are abandoned. Success is more linked to chance and coping strategies rather than developing insight and knowing which tool is appropriate for the task. Greater insight is required to improve in a systematic manner.

Stage 3: - Conscious Competence

The individual now comprehends the knowledge and skills required to complete the tasks. They are, however, very conscious of the steps in learning that they have taken to be able to execute the skill and are conscious of new or further learning that they require to progress and develop beyond the basic grasp. They are conscious and aware and must consciously think through each of the steps when completing the skill but are competent at completing this automatically. They know the range of tools required but automaticity is not yet achieved. This stage is analytic and self-aware. Howell states: - “The third level adds understanding. Understanding is knowing what you do and why it works or does not work.” (1982, p30).

Stage 4: - Unconscious Competence

The individual no longer must think consciously about completing the original new skill or task, it has become embedded. Automaticity has occurred, and they can complete it unconsciously, without having to focus on each step. This is the goal of the Matrix, to mesh the new understanding so that it becomes embedded and achieves automaticity, echoing the notion within cognitive load theory. Reaching this point lightens the cognitive load as the person with automaticity must expend less effort and has a lighter mental load when performing the same activity (Feldon, 2007). The teacher at this point can operate without thinking about many aspects of the role that previously they had to expend energy and thought on. Broadwell (1969) suggested that it is this stage of actions becoming naturalised that can lead to the myth that teaching has innate attributes and reminds his readers that great teachers are not born but a product of effort and work.

Figure 1

The Classic Conscious Competence Matrix Diagram

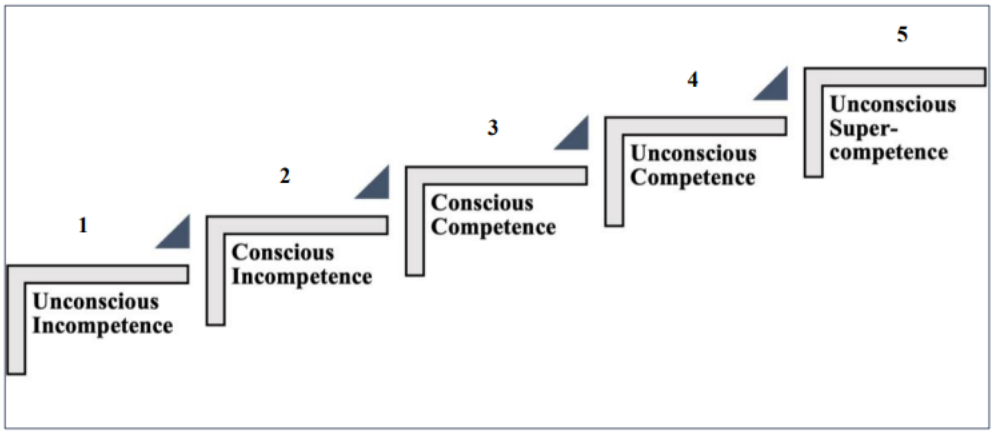
(https://kineticpr.co.uk/i-dont-yet-know-what-i-dont-know/ 2023)

The illustration above signifies the flow from one state to another using the CCM. Illustrations of ladders, cycles and triangles proliferate within the grey literature around the concept of the CC Matrix. The figure above was selected for clarity of the process and making it clear that it is not a single linear process but may cycle round in an iterative form, whenever a new skill or new learning is required. This idea of a continuous and fluid cycling of understanding and growth is important to this study, as the nature of teaching is such, that every time something new is encountered, regression to a previous stage may occur, for example, a teacher changing age phases or moving schools or taking on new responsibilities will lead to regression and progression. This is key to the development of my metaphor as this notion of cycling round, moving forward at times and retreat back at others is explored more fully later on.

Extensions and modifications have been applied, especially within the medical training community, and an inclusion of a fifth stage has been debated. Howell in his book 'The Empathetic Communicator' (1982) deems this further stage as "Unconscious Super Competence", an unwieldy term. This stage is described by Howell as rare and as "peak performance" (p32). He applies this stage to musicians and athletes who have practised so much that the act becomes effortless, stating: - "Here the total resources of the human being achieve harmonious integration" (1982, p. 32). Ruona and Gilley (2009) applied the CCM to human resources, they suggested that anyone achieving the fifth level could explain and articulate themselves to others. This notion has implications for the teacher who mentors and supports trainee teachers. Utilising their fifth level, they should make the implicit, explicit and recognise and be able to explain to trainees what the unconsciously competent teacher is doing and how they can apply those skills and knowledge specifically to their own practice. However, the step notion again does not take into account the fluid and cyclical nature of teaching so as an image it is problematic when describing teacher development, which is not neat and regular steps but far more organic and iterative.

Figure 2

Howell's Five Levels of Competence



This figure shows Howell's interpretation of the five stages of conscious competence.

(Adapted from The Empathic Communicator by W.S. Howell, 1982, copyright 1982 by Wadsworth.)

The Conscious Competence Matrix is deployed in this research as a lens through which to analyse the data to understand and chart participants' journey from novice trainees to qualified Primary maths teachers. The notion of the fifth level of Competency is debated and discussed as a suggestion for further application to mentors and those who support trainees in development. The figure above explaining the matrix in a stepped manner will also be discussed in later sections of the thesis, as the idea of the CCM being portrayed as a very even set of steps is problematic and as such is debated and re-envisioned as a cyclical and iterative process rather than a stepped and linear motion.

This chapter has explored the background to the CCM and made explicit links to wider theories such as Dunning-Kruger and metacognition. It has explained the four stages of the CCM and introduced the potential fifth stage to be explored further in the study. The CCM will be applied to the study to answer the following research questions: -

How useful is the Conscious Competence Matrix (Howell, 1982) for understanding the development of trainees' self-evaluation of their teaching competency: drawing on the experience of primary maths trainees.

What are the implications for ITE and ECT programmes in supporting Primary trainee teachers and Early Career Teachers in light of the CCM.

The next chapter considers the philosophy and methodology underpinning the research and examines the methodological tools and processes deployed in the study. The reasoning and rationale for the use of RTA and IPA is explained and the ethics and the background to the notion of insider/outsider research is explored. By explaining the decision-making process behind the selection of these methods, a deeper comprehension of the validity, reliability and transferability of the subsequent findings is developed.

Chapter Four

4. Methodology

4.1.Introduction

This chapter addresses the central research aims and questions and the background to their development. The philosophical, ontological and epistemological stance that situates the research within a phenomenological case study are presented. The research was longitudinal and tracked eight trainee teachers personal journey over four years. Their attitudes towards mathematics as a subject and teaching mathematics were explored by deploying a range of different research tools in order to distance the researcher from the participants. The rationale for applying both a Reflexive Thematic Analysis (RTA) application (Braun and Clarke, 2006, 2019, 2021) and Interpretative Phenomenological Analysis approach (IPA) (Smith et al., 2009, 2022) to this data is presented and explored and the limitations and challenges investigated. The research analysis methods are described and clarified. Explanations and a rationale for exploring the lived and unique experiences of trainee and Early Career Teachers (ECTs) using these approaches is explored, proving to be both beneficial and revealing.

Insider/Outsider research as a notion and researcher identity and the necessity for reflexivity is explored along with the wider ethical issues and safeguards that were applied to ameliorate any potential issues. This derives from a personal desire as the researcher and the main maths tutor to distance myself from their narratives and lived experiences and yet still be able to observe and interpret their stories. The full suite of data collection methods is explored and the processes of analysis for each stance is elaborated upon.

This research takes a qualitative, interpretive stance. The qualitative approach taken aims to ‘drill down’ (Thomas, 2011, 2013) into the personal reflections and experiences of the research participants. A naturalistic approach was taken, where I as an insider in the world of ITE acknowledged my own bias and standpoints, and where I recognise my own positionality and situated knowledge from the outset (Mason, 2002b).

The research took a diachronic local case study approach (Thomas, 2011). The focus of the case-study was initially, pre Covid-19, a cohort of 26 undergraduate Primary ITE trainees at a northern English University, this was then reduced to a self-selecting purposive sampled group of eight. The undergraduate course focused on the knowledge and skills required to teach children between 3 and 7 years old. The course took three years to complete, and students graduate with a degree and as fully qualified primary school teachers. The study spanned the three years of the degree course and the first year of their full practice, where the research group were then known as Early Career Teachers (ECTs). The research spanned four years in total.

Thomas (2011, p 13) states, 'There can be no assumption that the case is anyway representative of a wider whole.' Whilst the case in this study is not generalisable due to being a small-scale project, it is typical of its type in England in terms of undergraduate teacher training courses. All providers of ITE are regulated by the Department for Education (DfE) and inspected by the Office for Standards in Education, Children's Services and Skills (Ofsted). The content of courses across England is broadly similar, with a split between the 'what' and the 'how' of teaching, underpinned by the Core Content Framework (CCF) (DfE, 2019). Providers of ITE publicise the module overviews, but the complete curriculum sequencing varies from provider to provider.

RTA and IPA are both defined and explored as to their evolution and development as the methodological framework for this study. The rationale for using both methods is considered with a focus on the lived experiences of the trainee teacher and a desire to hear them speak through their experiences. They describe their personal journey from trainee to qualified and practicing teacher, without potential 'contamination' from my acknowledged stance as their tutor, assessor and then colleague.

4.2.Research Aims and Questions

This research aims to capture and explore the lived experiences of the trainees and their emotional, personal and social response to maths, both from a subject knowledge view and from a pedagogic and teaching point of view (what we teach and how we teach it perspectives). Their experiences over time and during their teaching practices and eventually as qualified primary class teachers are discussed and their personal narratives explored. The notion of the Conscious Competence Matrix (Howell, 1982) is explored and developed as a potential framework for application to trainee teachers, ECTS and for teacher training providers and mentors to utilise within school settings.

The knowledge gained from these lived experiences and viewpoints is intended to help develop and evolve the maths ITE curriculum, in order to effectively support trainee teachers and early career teachers, both in initial training and later in the workplace.

Title:-Learning to Love Maths. A qualitative investigation mapping Early Primary ITE undergraduates' evolving perspectives on Mathematics and Maths teaching.

4.2.1.Aims

1. To analyse and interpret primary ITE trainees' perceptions towards Maths as a subject, during their training and into their first year of practice.

2. To analyse and interpret primary ITE trainees' perceptions towards Maths teaching during their training and into their first year of practice.

3. To evaluate and develop Howell's (1982) Conscious Competence Matrix for application to initial teacher education.

4.2.2.Research questions

To achieve these aims the following questions will be answered: -

1. How do undergraduate Primary ITE trainees' perceptions towards maths and teaching maths change over the duration of their training and into their first year of teaching?

2.How useful is the Conscious Competence Matrix (Howell, 1982) for understanding the development of trainees' self-evaluation of their teaching competency: drawing on the experience of primary maths trainees.

3. What are the implications for ITE and ECT programmes in supporting Primary trainee teachers and Early Career Teachers in light of the CCM.

4.3.Research Design

4.3.1.Philosophical Position

Reality and the way we as humans perceive it and then explore it has been a subject of debate over many years within research communities, with paradigms, paradigm shifts and even ‘wars’ (Hammersley,1992, Ling & Ling, 2016). Although the stratification of research philosophies into two strands is an oversimplification, considering the extremes is a useful approach to situate my research and justify my choice of paradigm (Kivunja & Kuyini, 2017).

Positivism is the main underlying philosophy of the medical and scientific research communities. Positivists look for empirical data, measurable and quantifiable, testing for cause and effect, with the intent to generalise findings and create laws. Observed phenomena are considered to identify causal relationships and validity is probed. Hypothesises are created with the intent to prove or disprove, absolutes are sought and encouraged (Flick, 2018). Historically, Auguste Comte (1798-1857) is identified as the first philosopher to use the term and identify its key facets (Mill, 2022), and in more recent times, Karl Popper (1902-1994) and Thomas Kuhn (1962) have debated the nature of science and how theories and ‘truths’ develop and are refuted and subject to change.

Interpretivism does not accept the concept of an overarching ‘truth’ to be unearthed, rather that there are multiple ‘truths’, depending on the understanding and the viewpoint of the actors involved. Approaches are deployed in attempts to view the social world through the eyes of the participant rather than from an outsider’s perspective. People make sense of the world in their own terms (Cohen et al., 2018). Terms such as generalisability and nomothetic are not applicable in interpretivism. Laws are not sought, or even desired, instead the idiographic (idios from the Greek,

belonging to the individual) is the focus, embedding a desire to seek all that is unique or distinctive about a context or situation (Arthur et al., 2017).

Ontology considers reality and the perception of that reality, Byrne (2017) gives an etymological definition, “Ontology comes from the Greek ‘ontos’ which means being and ‘logos’ meaning study… Your ‘Ontology’ is how you answer the question: ’What is reality?’”. Crotty (1998) puts it more succinctly as “the study of being”. This links to the second notion, that of epistemology. If ontology has the focus of what is reality, then epistemology considers what can be learned from that reality. Epistemology again stems from the Greek, “’Episteme’ which means knowledge and ‘logos’ meaning study. It is the study of knowledge. Your epistemology is your answer to the question, ‘How can I know reality?’” (Byrne, 2017).

In the context of the study, the focus of the ontology is the reality of the participants journey from total novice to ECT, and the epistemology unites the two methodologies of RTA and IPA to develop the ‘Polyhedron of intelligibility’ (Foucault, 1981), to explore the perceptions and viewpoints of the participants, their attitudes towards maths and maths teaching, and the application of the Conscious Competence matrix to their development. This entails considering the participants from many different perspectives and allowing them to reflect on their own growth, change and development over a specified time.

Alongside these terms lies the notion of axiology (Cohen et al., 2018, Kivunja & Kuyini, 2017) which considers the personal values and beliefs that we adhere to, and the ethical stance taken. All these terms help explain and determine the research aims and questions. The nature of being in terms of the development of a trainee teacher and their understanding of the subject of maths and themselves as a teacher of the subject is the focus of the research, this is examined and explored within my personal axiology. My axiology stems from the desire to be ‘truthful’ to the participants stories and avoid personal influence over their narrative from a power-based perspective.

4.3.2.Case Study

This study is a diachronic local case study, considering changes over a period (Thomas, 2023). The time period spanned just over four years, (Sept 2018-May 2022) from the very beginning of the trainee teachers on their undergraduate degree

course until completion and covering their first Early Career Teacher (ECT) year experiences.

Thomas (2011., p 3) defines a case study as “what is of interest is the uniqueness of the thing and the thing in its completeness.” Further describing it as a “wrapper” or a container. The 'case' within this research centres on the participants' emotions, reactions, and feelings around their personal lived experiences of primary maths and maths teaching, regardless of their age, prior experiences, and lives. It is not, however, being deployed as a theoretical framework. Thomas (2023) states; - “The case that is the subject of the inquiry will normally illuminate and explicate some broader theoretical theme” (p. 312). This is then the common ‘casing,’ (Thomas, 2011), that the participants were all members of the same degree course and being educated together, they have specific situated local knowledge in their belonging to each other and to the course over three years (Yin, 2009). Thomas even suggests that IPA is “best thought of as a specialised branch of case study” (2023., p. 160), so case study as a ‘wrapping’ for an IPA study is a desirable and logical concept. The study includes a group of people all undergoing the same phenomenon (the case) and exploring their own narratives in an idiographic manner (the RTA and IPA methods).

This case study will examine the narrative that undergraduate trainee teachers often enter their training with a negative view of maths as a subject, tend to have fewer concerns around teaching it, gradually develop confidence and grow into effective primary teachers of maths. This research seeks to explore the participant’s personal journeys, deploying both RTA and IPA as data analysis methods to develop the ‘Polyhedron of intelligibility’ (Foucault, 1981), revealing and developing as many viewpoints as possible. This entails considering the participants from many different perspectives and allowing them to reflect on their own growth, change and development over a specified time. Methods are repeated purposively to gauge change and development of perspectives, and to present the most rounded views possible considering relationships and processes. Repetition of methods enhances perceived validity as it reduces the range of variables (Boehm, 1994).

4.4.What is Phenomenology?

Phenomenology can be defined as “a philosophical approach to the study of experience” (Smith et al., 2022, p. 7). Mason (2018) suggests that the world and consciousness, real and lived experiences and the participants perceptions are interconnected and that the researcher needs to explore these perceptions. This study therefore considers the lived experience of the trainee teachers and the phenomena that is their personal journey from initial novice through to qualified and practicing teacher. Phenomenology fits within the interpretative genre as the intention is to explore the phenomenon and then interpret the stories revealed by the participants (Arthur et al., 2017). Indeed, the term phenomenon derives from phaenesthai, a Greek word meaning to “flare up” or “appear,” and its construct comes from phaino, a Greek word meaning to “bring to light, to place in brightness …” (Moustakas, 1994, p. 26). This seems very appropriate, the notion of bringing to light things that were previously in the dark. The research intent was to reveal the personal and hidden stories of the participants and ‘shed light’ on the phenomenon of their personal narratives.

The ‘father’ of the phenomenological movement was Edmund Husserl (1859 – 1938) although it is suggested that he built upon previous work by Bretano (Smith et al., 2009). Transcendental phenomenology was developed and understood by Husserl to ask researchers to consider all the assumptions/preconceptions around a phenomenon, such as culture, history or context and ‘bracket’ them off. Literally, putting these assumptions on one side and going beyond, transcending, to be able to see the phenomenon as it is, through “unclouded glasses” (Moustakas, 1994). The aim is to “uncover essences of phenomena that have not previously been conceptualised” (Lopez & Willis, 2004, p 734). In recent times this notion of transcendental phenomenology has been queried as to whether it is even possible to do this, and if humans can ever bracket off fully, so partial bracketing is now more commonly articulated, (Smith et al., 2022). This notion is echoed in the study as, although my positionality is recognised and influence ameliorated by the two methods deployed to distance myself, it is also clear that my position as an ITE tutor and ex teacher will always be present and needs to be recognised.

Heidegger (1889-1976) was initially a student of Husserl but diverted away from the transcendental phenomenology ‘being-question’ espoused by Husserl. Instead,

Heidegger questioned the possibility of anyone being able to stand outside the lived experience (Smith et al., 2009). Instead, in his work 'Being and Time' (1967) he explored the notion of 'Dasein' (translates to there-being) and argues that we are amid a world of people, objects, language and cultures and that we cannot bracket that off, we are immersed and engaged in 'intersubjectivity'. Relatedness to the wider world is, according to Heidegger, enmeshed in us, we cannot remove ourselves entirely from the outer world, but are embedded in a short and limited existence (Larkin et al., 2006). This echoes my own positionality.

Merleau-Ponty writing in 1962, focused on the situated viewpoint, that views of and on others come from our own embodied position in the world. We can look on and empathise with others but never share the exact same experience as we are different entities, different bodies, even if we are looking at the same thing, our perceptions will inevitably differ as we are separate beings (Smith et al., 2022).

Husserl's work situates phenomenology in a firmly conceptual and theoretical context of experience and perception but with the observer firmly behind the looking glass, describing but disconnected, an observer. Heidegger and Merleau-Ponty extended this and situated each person as embedded in a world of objects, culture and language and the observer as also being in that world, moving to an interpretation, description and a recognition that we do not exist in isolation (Smith et al., 2022). IPA draws on these later views and rather than a transcendental approach (Lopez & Willis, 2004) the ambition is to not ignore presumptions nor bracket and remove them. Instead, IPA recognises and embraces preconceptions and endeavours to deploy them in supporting and understanding the participant from a range of angles. "The goal is to make sense of the participants making sense" (Miller et al., 2018., p 242). Which is same as the ambition for this study.

4.5.IPA (Interpretative Phenomenological Analysis)

IPA is qualitative methodology from the psychology domain, it developed as a reaction to and a departure from the quantitative data focus that had previously dominated psychological research. The pioneers of the approach are Smith, Flowers and Larkin whose work is viewed as seminal (2009). IPA is founded upon three philosophical strands of knowledge: phenomenology, hermeneutics and idiography (Smith et al.,2009) woven together. The history of phenomenology and the

theoretical origins of IPA were discussed in the previous section, hermeneutics and idiography will be explored and developed in this section.

Originally, the IPA approach focused on research in the psychological and medical or counselling areas but in recent years has begun to be viewed as a useful tool across social sciences and especially within education (Smith et al., 2022). Smith describes the psychological aspect as having a “small p as well as a big P” (2022, p. 4) allowing the widening of IPA application across a range of domains including education and increasing relevance to studies such as this one.

IPA is situated within the phenomenological domain, but rather than considering the philosophical perspective on the lived experience which can be removed and distant, it is a live and dynamic activity examining the subjective and often individual experiences of participants (Smith et al., 2009). Part of the struggle within IPA has been the exploration establishing the most effective manner to have a structured and practical approach to the collection and analysis of data (Moran, 2000). Deploying semi-structured interviews, this issue can be addressed. Semi structured interviews have been viewed as the “exemplary” instrument of data collection at the centre of the IPA structure, but in recent times the IPA suite has developed outwards and other methods such as focus groups have been deployed effectively (Smith et al., 2022). However, semi structured interviews do ensure that “detailed and reflective, first-person accounts” are generated. Participants’ personal perspectives and their voices are recognised (Larkin & Thompson, 2012, chapter 8). IPA places these unique lived experiences under the lens to examine in intense detail how the participants experience and view their experiences, and these perspectives are then reconsidered through the interpretative lens of the researcher (Willig, 2008). Since the intent of this study is to reflect upon the reflections of the participants, thinking back over their experiences, IPA is the most effective way to explore these reflections. IPA allows the voice of the participants to be central while the ‘treble hermeneutic’ allows for the lens of interpretation to be applied.

4.5.1.Hermeneutics

Hermeneutics is the second strand required to understand IPA. Hermeneutics can be defined simply as “interpretation” from the Greek (originally from the Greek god Hermes, who translated messages to communicate to the humans) (Zimmermann,

2015) and began use primarily in the study of theology. The term interpretation suggests that we only require hermeneutics when situations are complex and need interpretation, so Zimmerman refines the definition further: - “Hermeneutics is the art of understanding and making oneself understood” (2015, p. 2). The works of Heidegger and Gadamer (1900-2002) reflect a hermeneutic phenomenology, where interpretation is inevitable and necessary to reach beneath the surface (Lopez & Willis 2004). The idea that the interpretation is a ‘” dialogue between the past and the present” (Smith et al., 2009. p.27) and that meaning is made in light of the moment at which it is made, suggest that the context of the interpretation process is as important as the interpretation itself.

The notion of the hermeneutic circle is a helpful way of considering the application of IPA as a process (Larkin et al., 2006, Zimmermann, 2015). In IPA the analysis process is iterative, an on-going development cycle, moving backward and forward, focusing in and out as well as step by step in a process. Consideration of the different views and perspectives and chronology all form the hermeneutic cycle, as does the researcher’s relentless probing relationship with the written accounts of the interview. “Thickening our understanding of the research process” is how the hermeneutic circle gives insight and depth to descriptions and relationships (Smith et al., 2022, p 23).

IPA is often described as a double hermeneutic cycle, in that the researcher is trying to make sense and interpret the participant who is trying to make sense of the phenomenon themselves, reflecting upon a reflection (Willig, 2013). However, this study is different in that it deploys a ‘treble hermeneutic’. A ‘treble hermeneutic’ in this case is the participants reflecting on their own past recollections and reflections (all the RTA based research completed earlier in their journey) and then an extra step of the researcher reflecting upon those comments and thoughts and reinterpreting that initial interpretation by the participant. The previous data was shared with the participants at the beginning of their IPA interview, and they had time to comment and reflect on their own experiences and critical incidents and opinions if they wished. I then reflected and interpreted those recollections within the IPA structure, considering the added impact that time and historical distance has given the participants and their viewpoints. Smith et al., (2022) makes the point that: “Temporality and change are important aspects of experience” (p.127). This is an

important aspect as the time period of the study allowed for reflection and perspective to change and at points blur and soften what could be initially, a sharp and painful personal experience.

While the notion of viewing the world from the point of view of the participant is vital for IPA, it is also vital to remember the researcher is attempting to consider the participant closely by looking from their perspective and at the same time, at, the participant's perspective.

Ricoeur's hermeneutics of suspicion and empathy (1970, in Willig, 2013) suggests that interpretation can take two forms. Empathetic interpretation focuses on what is there rather than what might be hidden. An empathetic study aims to report what is revealed by the participants only and does not seek to make underlying theoretical connections or seek to impose structure. The interpretation aims to join the dots but not make any larger claims about the shapes that the joined dots create. This does not mean that empathetic hermeneutics just describe, but rather that the meaning is implicit from within the data rather than having a label or theory imposed on it from the outside. The hermeneutics of suspicion stems from Ricoeur's focus on Freud and psychoanalysis, and the notion that apparently trivial slips of the tongue can indicate deeper hidden or underlying motives and links to theory. Interrogating from a suspicion viewpoint is to deploy a theoretical structure and to consider all evidence from an external perspective, like a detective searching for clues.

However, the work of Schmidt (2016) suggests that interpretive hermeneutics cannot be either suspicious or empathetic but in reality, deploys both, as the interpreter brings their own viewpoint and perception to the role, and it is vital that this is acknowledged. The 'hermeneutic circle' suggest that the process of interpretation has to consider the parts as well as the whole, as all aspects are dependent on each other, similar to words making sense in a sentence, each having a whole and a part. In reality the interpreter is careful to acknowledge their own viewpoint, be empathetic to the 'truth' of the participant and search for implicit meaning beyond (Harper & Thompson, 2011). Smith et al., (2009) suggests that IPA occupies this middle ground and even terms this "hermeneutics of questioning" (p.36). Where the researcher seeks to look through the lens of the participant and question and view the participant from the outside as well. IPA strongly adheres to the notion that the interpretation always stems from the text and returns to the participant.

This study considers both viewpoints and aims for this middle ground occupied by IPA. The participant's experiences are initially explored via the RTA analysis, looking closely at initial reactions, emotions and prior experiences of maths and thoughts about teaching maths as a novice. Then the IPA interviews had the participants considering and reflecting on those earlier experiences and moving them into an historical reflection phase. They, therefore, were interpreting their own past reactions and reflecting on their early experiences with maths and maths teaching. Finally, the IPA interviews also took the participants forward in their journey from graduation to becoming ECTs and explored their views on maths and maths teaching as a class teacher. Some of the participants even looked further forward and considered the notion of becoming a maths subject leader one day.

4.5.2.Idiographic Approach

The third and final strand of the IPA underpinning structure is idiography. Idiography is focused on the specific and the tangible. It stems from the Greek word "idios", which means "pertaining to self; one's own, private or separate", (Pagnini et al., 2012), referring to the aspects of human experiences that are unique and specific to us as individuals. Psychology, in contrast seeks to be 'nomothetic' which is more positivistic in approach, aiming to create laws and generalised claims about the phenomenon as experienced by a group of people, or the 'case' (Miller et al., 2018).

Idiography has been defined in the context of IPA research as having "a concern for individuality and a commitment to a rigorous finely textured analysis of contingent, unique, and often subjective phenomena" (Noon, 2018, p.76; Moses and Knutsen, 2012). The idiographic approach allows the researcher to examine closely how the individual makes sense of the phenomenon, it is detailed and particular and requires systematic analysis. In idiographic studies, each case or person needs to be analysed in depth prior to drawing any (tentative) generalisations (Pietkiewicz & Smith, 2014). After each case is considered then cross case analysis is conducted and potential themes or strands of commonality may develop (Noon, 2018). The research utilises the IPA processes that consider each case in turn and then considers across cases in a structured manner.

IPA uses small purposively selected samples and data sets, and the study is situated in a small purposively sampled case with people all undergoing the same

educational process, an undergraduate teaching degree, so it forms the same ‘case or container’ fitting into the IPA idiographic approach. Thus, ensuring that the study matches the overarching concept of an IPA idiographic style.

The next section will consider the role and rationale for use of RTA as the main research tool in the preliminary stages of the research, while the participants were still trainee teachers.

4.6.RTA

The original research design pre-Covid 19 was to utilise Reflexive Thematic Analysis (RTA) as the data analysis tool for all the data collected during the 3 years of their ITE degree. When Covid prevented the original research design, as I was unable to access schools and mentors, IPA was then adopted for the semi-structured interviews that took place after the trainees had become qualified teachers. By this point the participants were qualified and this ameliorated many of my concerns around having personal insider/outsider roles and power-based relationships with the participants.

The central concept of RTA is that themes are extracted from the data through a continual process of reflection, analysis and coding. Unlike other thematic analysis methods that focus solely on identifying themes in the data, RTA encourages researchers to consider how their own preconceptions and biases may be influencing their interpretation of the data, to acknowledge this and accept it as part of the process. RTA is known to be the seminal work of Braun and Clarke (2006, 2021) but it is important to note that (as IPA has) RTA has developed and evolved in the intervening time period and this study will be applying the most recent iteration (Braun and Clarke, 2021).

Thematic analysis is a qualitative method that focuses on the situated and contextualised meaning created by participants and is firmly positioned within the interpretive realm (Braun & Clarke, 2021). There are no specific rules around data set size nor any specific requirements to be inductive or deductive or deploying both of these notions. This lack of apparent rules or structure has led to various critiques suggesting inconsistency or a lack of coherence (Nowell et al., 2017) recommending that a trustworthiness criterion may need to be applied, such as that devised by Lincoln & Guba (1986).

However, it can be suggested that the questions applied to the validity of thematic analysis are based on a ‘positivism creep’. This is where the underlying values of a positivist philosophy such as the search for an objective truth or the need to control bias, the general unhappiness with the ‘messy’ aspect of qualitative research or the need to ‘control’ the data are erroneously applied (Kincheloe & Tobin, 2015). This was an issue that I had to grapple with, within this study, allowing myself to sit with what Braun and Clarke term ‘uncertainty and discomfort’ over my ‘teacher lust’ (Mason & Johnston-Wilder, 2004) which desired tidiness, control and no ambiguity or loose ends when encoding and interpreting the data sets. However, if subjectivity is central to the RTA process, then reflexivity, acknowledging who the researcher is and what they stand for are enmeshed and enshrined into the analysis process. This was important to me, as I wished to be authentic as possible.

The notion of reflexivity became so important that Braun and Clarke in 2019, reframed their version of thematic analysis to reflexive thematic analysis (RTA). This was to clarify and reinforce the need to embed reflexivity within the process. The idea of reflexivity challenges the view of knowledge production as independent of the researcher producing it and of knowledge as the pure objective. It means turning the researcher lens back onto yourself to recognise and take responsibility for your own situatedness within the research and the effect that it may have on the setting and people being studied, questions being asked, data being collected, and its interpretation (Berger, 2015). Instead of removing myself from the data, reflexivity is an acknowledgement of my values, and an awareness of assumptions made. You do not have to consider yourself a ‘neutral conduit of information’ (Braun & Clarke, 2021, p 15). As previously discussed, my insider/outsider identity lends itself to a reflexive methodology and indeed highlights the need for honesty around my own opinions and perspectives, ‘and the importance of making the familiar strange’ (Sikes, 2003). Using an RTA approach to the university-based research data ensured my positionality was always within the scope of the wider lens.

4.7.Limitations of IPA

IPA has been critiqued on a range of levels, the main ones being a lack of standardisation, (Giorgi, 2010, Chamberlain, 2011) and a lack of rigor within the interpretation aspect. The more recent work by Smith et al., (2022) has attempted to

address this by clarifying the IPA structure and methodology to allow for both flexibility but also embedding an “heuristic framework for analysis” (p. 76). This framework is an open set of guidelines rather than a strict ‘recipe’, (Pietkiewicz & Smith, 2014) to avoid what Smith (2022) terms “methodolatory” or the glorification of the method overall. This research adopts the IPA method for the section of the study that deploys semi structured interviews and is appropriate for the stage of development of the participants as they were now qualified teachers and therefore no longer ‘my’ students. At this point the participants had all qualified and graduated and were therefore more akin to colleagues than trainees, so interviewing them no longer carried issues of insider research nor of any power or influence issues. Other methods (RTA) are utilised at distinct stages of the research process that particularly allowed for the positionality of myself as the researcher.

Tuffour (2017) and Willig (2008) suggest that the reliance of IPA on language as the key tool of communication and data gathering is of concern. Language can clearly be limiting, especially if applying IPA methods to those with limited dialogical capacity, such as young children, those with medical or verbal capacity issues or who have a different first language. In terms of this study, all the participants were at undergraduate level and training to teach so the ability to converse, be reflective and discursive is entirely within expectations and norms. In this study, the participants are also commenting on their own thoughts, feelings and reactions from previous data sets, so they have the opportunity to re-express or clarify these thoughts as well as exploring new ones. As I have been a teacher, I am privy to the ‘insider’ language nuance and the meaning making that the participants may utilise and explore in their discussions (Smith et al., 2022).

Another criticism of IPA addresses the perceived tension between the notion of idiographic research and the search for commonality within themes. Noon (2018) deems this as “uncomfortable dualism”, questioning if participants have the space and time to explore their own views and if the research itself allows the space for the individual viewpoint as well as the collective themes to emerge. In the study this is addressed within the sample of eight individuals, the IPA analysis of their semi-structured interviews encouraged consideration of individual views, before seeking commonalities and themes which unite the participants, and decisions were taken around how many viewpoints constitute a clear theme (Noon, 2018). Generic themes

are addressed as tentative and relevant to THE case rather than generalised across all cases (Goodall, 2014).

Whether or not IPA can accurately capture the full richness of experiences and then probe beyond the experience to the underlying 'why' around their occurrence is queried (Chamberlain 2011, Willig 2008). This, however, may be beyond the remit of an interpretative phenomenological perspective and may require another framework such as critical interpretation instead to consider the wider social, cultural and environmental issues that shape the participants wider views. That is beyond the scope of this research study. This case, although appropriately situated in the wider world of the participant (the 'macro' of their experience as a trainee teacher) firmly focuses on the participants and their experiences and perceptions of the phenomena of their own journey over time that is central to the research aims (the 'micro' of their world).

4.8.Pilot Study

A pilot study was devised and conducted in Summer 2018 to test that the premise of the research aims and questions was sound, and to test the efficacy of some of the creative methods of data collection. Participants for the pilot were 17 final year undergraduate Primary ITE trainees. This was a convenient and 'known', (Thomas 2013) selected sample that mirrors the genuine sample for this research with the exception that the pilot participants had completed their programme of study and experienced all the taught maths input. Participants for the research-proper were first year undergraduates tracked within the research from the start of their course. Selecting final year students for the pilot was necessary, so that they could participate in reflection exercises that formed part of the methods of data collection. The pilot group were cognisant about the purpose of the research and informed consent was sought and given as per BERA (British Educational Research Association) guidelines (2018). Creative methods of data collection were trialled during the pilot study. Participants were given access to playdough and asked to construct two sculptures; one to express their relationship with maths at the beginning of the course and a second to sum up their relationship with it at the end of the course. Next, participants conducted short, peer to peer interviews which they self-recorded onto I-pads. During the interviews participants explained and explored

their sculptures to each other. I was not present in the room when the interviews took place to diminish the 'insider/power dynamic' arising from my role as tutor (Haylock, 2018) and to diminish the potential contamination and lessening the credibility of the data.

Soon after the data collection was completed the recordings were transcribed and explored. My first response to the data, during step one of the analysis, was that the purpose and aims of the research were credible and that the research had potential to make a valuable and important contribution to the field of study. As a researcher and tutor I was drawn and moved by the student-participants' emotional reflections on their learning journeys, which were stimulated by their mutual discussions of their playdough sculptures. Rather than just gesturing to their sculptures, some participants used them actively as a prop to animate their story and bring it to life. This demonstrated that the visual and creative methods used enabled the trainees to express their viewpoints in several ways (Mannay, 2015) and confirmed their capacity to yield rich, valid and personal data.

The extract below is one typical example from the pilot-study to illustrate the capability of data collected in this manner to yield rich data. In the extract, the participant's strength of feeling and recollection of their transition from being, a "bit frightened and scared" to "me now, not frightened", is clearly observed. Concepts outlined in the literature review above were present in participants' descriptions of their experiences, which verified the purpose of the research.

Transcription of C4 trainee-pilot study

> This one is me at the beginning of the course, and I'm sat behind a wall, that is maths, bit frightened and scared, I don't know what to do so I'm sort of hiding behind the wall. This is me at the end of the course [figure now sat on a wall] I'm now sat on the wall, not conquered the wall, not got over it, I'm just sat resting on it, I feel like I know a lot more now than I did about just how to teach maths I feel more comfortable teaching maths from all the support we've been given, I still find doing maths tricky. I feel like I know a lot more now because of the structure of it. I find it now easier to teach than English. This were me at the start of the course, frightened of maths and me now, not frightened.

It was the description of a rich lived experience, reflective observation and, the clear division between their emotional reaction to maths as a subject compared to that of teaching maths that confirmed and shaped my initial thoughts. It was this journey that the trainee went on, in order to develop themselves, that I wished to explore and develop further in the full study.

4.9.Insider/Outsider Research Design

As part of the research design, I needed to be aware of the concept of insider research, where the researcher takes a magnifying glass to a group in which they are a member, but also must consider their own position and subsequent reflection. “Insider research is that which is conducted within a social group, organization or culture of which the researcher is also a member”, as defined by Greene (p.1, 2014). This contrasts with outsider research, which is a more positivistic term, with the outside researcher looking onto the situation from an external and uninvolved view, bracketing assumptions and putting them aside (Arthur et al., 2017).

As the lead maths tutor for all the Primary QTS undergraduates I was on the ‘inside’ of their learning, development, and assessment journey. I had completed similar teacher training myself and was clearly on the ‘inside’ in terms of the language and the ability to ‘blend in’ with terminology but on the ‘outside’ as I was not part of the undergraduate group itself. Positionality will bend and flex around the cultural values and norms of both parties, and my position was fluid as I both belonged and did not belong (Merriam et al., 2001). I had been a primary school teacher for 14 years, so this again makes me a partial insider as I had been one, although I am no longer. I am still a Vice Chair of governors at a primary school so again, insider in terms of terminology, language and focus but an outsider as not an actual teacher. Researchers, notably Chavez (2015) have postulated that the notion of insider v outsider is a false dichotomy and that a continuum is of more value than an either/or (Breen, 2007) and I would concur with that as I see it that I occupied the ‘space between’ and moved in a fluid manner between different roles during the research project (Dwyer & Buckle, 2009). I was, at times an insider, at times an outsider, this suggests being a member does not constitute sameness and not being a member does not constitute total difference.

The work of Rufell et al., (1998) examined the attitudes of primary aged children, trainee primary teachers (both PGCE and BEd) and in service teachers towards mathematics. Their thoughts highlight the potential issues around how we collect this type of personal data: -

> The results in this study support a view that the fact of probing, and the context of that probing, can produce responses which may say more about the context and nature of the probing than about the person being probed. (Rufell at al.,1998 p.14).

This was how the creative methods and the removal of myself as a direct influence as far as possible evolved, from the desire to remove my influence (however benign) from the participants narration.

4.10.Ethics:Power and Influence

The situation was further complicated by my power situation in relation to the trainee teachers. I was acutely aware of the power differential between myself and the participants (Berger, 2015). I was leading a module and part of the team that would be assessing and grading them on their assignments and teaching practice. Ultimately, it could be my decision if they passed or failed the course and became a qualified teacher or not. I therefore planned the research design and tools to mitigate my influence and negate my participation and even my physical presence as much as possible during the data gathering. The RTA evidence, from the word clouds, peer to peer interviews, sculptures, written reflections and journey maps did not involve me at all. Apart from an explanation of what to do I did not get involved and even left the room to avoid my presence being a factor. I needed to be assured that my influence would not ‘taint’ the participant responses and lead them to feel restrained, constrained or judged in any way. Nor did I wish to add to their mental loads or stress with extra work or requirements beyond that of the normal course metrics.

As Giddings states: “We do not enter a research project as a neutral vessel, rather we take with us our values, politics, gender, ethnicity etc. We also take our assumptions, categories feelings and previous experiences” (in Arthur et al., 2017 p72). This has sharpened my focus on my role, precariously balanced in the position of ‘insider/outsider’ research. I acknowledge that I bring into my research my

baggage from my previous occupation as a teacher and therefore, a would-be colleague and as the tutor and assessor of my participants, leaving me as not an insider with them, but not exactly an outsider either. I cannot claim any significant distance or objectivity (Ross, 2017) and had to consider a reflective and reflexive stance, constantly checking and rechecking myself. My choice of research instruments therefore needed to extricate 'me' as a tutor and ensure that the trainees were as free as possible to speak their own 'truth' and not be influenced by my presence as far as possible (Mercer, 2007). I therefore had to be reflexive and reflective around my data collection, and to consider methods that removed myself as tutor/maths lecturer from their thought processes as much as possible.

4.10.1.Ethics:-Research Instrument Rationale

Trainee teachers often need to re-structure their existing mental schemas as they learn and develop in practice (Skemp, 1976) and their perceptions of maths are often the indirect outcome of their experiences of learning mathematics over a number of years, often with some strong emotional reactions (as noted in the introduction) (Chap-Sam & Ernest, 2000). Maths is not always an easy topic for trainees or indeed teachers to discuss openly, especially in front of a tutor; social perceptions of maths as a 'difficult subject' are deeply rooted in this country (Williams, 2008).

Therefore, the use of "Arts based research is often particularly useful for investigating topics associated with high levels of emotion" (Kara 2015, p 24) so 'hands on' playdough was a good entry point for what may be an emotive or difficult topic, based on their prior experiences of the subject. This enabled the pilot participants to speak to each other and to utilise an alternative media to illustrate their perceptions beyond that accessible with purely words.

As a primary teacher and an academic, holding dual identity, I decided to deploy a familiar primary classroom resource, playdough, for my vehicle of choice for the pilot and then for the initial stages of the research itself. For the pilot final year BA primary teaching degree students were asked to construct a sculpture which reflected their initial reactions towards maths as a subject itself and maths teaching from memories of the start of the course (see section on the pilot study). They then constructed another sculpture, which reflected their views at the end of their training. Peer to peer video interviews were completed where they discussed their two

sculptures and their journey, talking directly to each other and manipulating their sculptures to enhance and explore their personal narratives around their history with maths. All of this did not involve me directly as the tutor and allowed them the freedom to speak openly and honestly.

To avoid 'contaminating' their views or making them feel uncomfortable, by discussing and reflecting in front of me as a tutor (Breen 2007, Ross 2017) I therefore carefully absented myself from the room during the peer-to-peer recordings. I reflected that my 'teacher' tendency to participate and comment was not required for their authenticity to be paramount. The trainees had given their permission and knew that I would be part of the audience for their models so I was not completely removed from the overall process, but they could be reflective to whatever extent they chose.

The peer-to-peer videos were then transcribed and thematically coded using an RTA process and the sculptures photographed. The students engaged with enthusiasm and were happy to discuss their relationship with maths and several of them used their play dough models as props to 'tell' their stories to each other and to physically act them out. This process was effective for the pilot, the trainees' feedback was that the process was easy and 'natural' which encouraged me to deploy the same methods in the actual research.

4.10.2.Sampling and Participants

The 26 trainees who comprised the original participant sample were a range of ages, ethnicities, and gender. The gender split was 23/3 female to male, typical of the primary teaching community where over 80% of Primary teachers are female (ONS 2020). The ages ranged from 18 to late 30s, with the majority being at the younger end of the span. All participants had achieved GCSE (General Certificate of Secondary Education) Maths Grade C/4 and above and had passed the (maths) Skills Test, both of which were entry requirements to the undergraduate QTS course at that point in time. As Creswell (2013) states "It is essential that all participants have (similar lived) experience of the phenomenon being studied" (p. 155). All of the participants had received the same teaching in university on the subject of maths and had the same length and age phases in their teaching practices (although Covid 19 had impacted upon my ability to observe them directly, they had all been able to

complete 3 full teaching practices). However, each of their teaching practice experiences would be unique to them, as would their experiences in education, teaching and maths prior to course entry.

When the research developed into an IPA based study from a creative and thematic interpretative study utilising only RTA methods, due to the impact of Covid 19, the initial participant sample was purposively reduced. All the participants were self-selecting from the original main body representing a range of age, ethnicity and gender from within the original 26. Eight participants volunteered for in-depth interviews at the end of their first ECT year, reflecting on their personal maths journey as trainees and reflecting on maths teaching as early career teachers. It is their data that will be explored in greater depth using the IPA methodology.

The data collected from earlier in the study had been analysed using a Reflexive Thematic Analysis approach (RTA) as championed by Braun and Clarke (2021). I drew on the other creative methods evidence base that the trainees had explored at intervals during their training to enable reflection and to act as prompts to the participants, to their thoughts and emotions at specific points in their training journey.

The sample was purposive and intentional, as stated in Cohen, Mannion and Morrison (2017) and for the IPA research aspect, self-selecting (Smith et al., 2022). The participants all volunteered to be interviewed at a time and place of their own choice. The notion of self-control and choice over the setting and timing of the interviews was important in my personal ethics and morality. This was a purposive decision, ensuring the participants were relaxed, in a setting and time of their own choice and able to be as reflective and reflexive as possible (Mason, 2018). Smith (2009) suggests that a homogeneous small sample is most appropriate for an IPA based study. Noon (2018) suggests that between 4-10 participants is the most effective for an IPA study, so eight participants fell into a suitable median grouping.

4.10.3.Ethical Approval, Confidentiality and Anonymity

All the participants gave signed permission for their data to be used in this research. They all read and signed the standard University consent forms and understood their rights to confidentiality, anonymity, and their right to withdraw (examples in Appendix 1). The early thematic and creative research methods had been carefully designed so that no additional workload was generated for trainees by their

participation in the study beyond the standard course requirements, as this would have been unethical (Mason, 2018). At the proposal stage, ethical approval was submitted and granted (2017) and again after Covid 19, the original ethical approval was discussed, and changes agreed with my supervisor due to changes in the methodology.

The semi structured interviews were again, voluntary, with all participants verbally reaffirming their participation permissions. The interviews were conducted virtually online via Teams at a time of the participants choosing, at the convenience of the participant. I was cognisant that the participants are all qualified teachers with full days in the classroom, therefore allowing them the freedom to select the time and situation was important for their wellbeing. The nature of the online interview was to allow ease of timings and that attending university would have been difficult and a burden and I was conscious that I did not wish to add to their 'work' by being involved in the research. Critics of online interviews suggest that nuance and relationships are harder to develop online (Cohen et al., 2017) but I knew these participants very well after teaching them for the previous three years and being their personal academic tutor in that time. Therefore, the relationship was pre-existing and well-formed, and I had taught the participants online during Covid so knew that I could communicate in a relaxed and open manner with them and them with me. Therefore, the advantages of online participation in terms of their convenience outweighed potential negatives and risk.

The participants reaffirmed their consent again verbally at the start of the online interview process. There was no sense of power or influence 'contaminating' these interviews as the participants had all qualified and were relaxed enough to talk to me openly as an equal colleague not as a tutor in a position of power any longer. They were informed that the interviews would be recorded and transcribed and that all identifying factors would be removed. They were also informed that the recording would be destroyed once the research was complete. The semi structured interviews were recorded and transcribed and stored securely in accordance with the BERA guidance (2018) and the University data protection policy which covers GDPR (General Data Protection Regulation) and internal and external regulations which follow the nationally approved guidelines (University of Huddersfield, 2019). The research had gained ethical approval from the University's ethics committee when

the initial proposal was submitted. All data concerning the participants and interviews were stored in accordance with current university policy and securely password protected under an initial letter, then their pseudonym.

All the participants had their names removed from the data sets and replaced with a name that was gender neutral to assure anonymity. There are always few males attending Primary ITE courses, so a gender-neutral naming system was devised as the most secure way to ensure that their data remained confidential and fully anonymous. I used the replacement names from the start of data analysis and then throughout the coding process. This name applied to the participants for both the RTA and the IPA data sets to ensure clarity and parity. Due to the iterative nature of both RTA and IPA the participants now exist in my head as their pseudonyms and are fully rounded 'people'.

Participant wellbeing and safety was paramount, and it was important that all participants felt comfortable and able to be open and authentic in the processes as the personal 'truth' shared was at the heart of both the RTA and IPA philosophies. The semi structured interviews had a guide for me to use and (Appendix 4) allowed for the participants to 'take charge' and alter the direction of conversation if they wished or stop it at any point. As stated in the BERA (2018) guidelines: - "In advance of data collection, researchers have a responsibility to think through their duty of care in order to recognise potential risks, and to prepare for and be in a position to minimise and manage any distress or discomfort that may arise". (Section 34). The initial IPA interview was also reflected upon, and the semi structured questions revisited, notes were taken in terms of my conduct to make alterations to ensure the participants voices were the predominant ones, in line with IPA conventions (Smith et al., 2022). Notes of reflection were added in during the coding process too, in order to indicate any specific thoughts or reflections during the re-reading of the interviews.

In order to not be 'selfish' by just 'taking' from my participants (Denscombe, 2021) and not offering anything in return for their contribution and efforts, a personal commitment was made at the start of the research process to all participants. Denscombe (2021) argues that research should strive to contribute back to participants and should never be "frivolous, selfish or malicious in its aims" (p.221) and should avoid having any detrimental impact on any participant. All the

participants will receive a single sided summary of this research disseminated via email after the thesis and viva process is completed. There is also an open offer for them to read the entire submission, on request, upon full completion.

4.11.Validity, Replication and Transferability

Validity is a difficult notion within the qualitative sphere as it tends to be a positivistic term and intensely debated (Creswell 2013, Cohen et al., 2017) In this study validity is defined as "assessing the extent to which the design and methodological approach used in a study is fit for purpose" (Smith et al., 2022 p 147). Every aspect of this study has focused on ensuring that my influence as a tutor was removed or limited and that the voice of the participants was heard. All decisions around data collection and analysis were embedded in what Braun and Clarke (2021) deem 'ethical thinking' to minimise the potential of harm to the participants and to ensure the power dynamics were limited or acknowledged. To strengthen the validity verbatim quotations are utilised to ensure that the voice of the participant is embedded throughout the process.

Steps in data analysis are explicit and replicable and samples from the process are illustrated in the appendices (Appendices 2 and 3) and the findings chapters. The intention was that this study has internal validity and that although two different types of methodologies are deployed the rationale and style of both ensures they overlap and are complimentary to each other. My supervisor has had sight of all aspects of the data collection from the schedule through to coding and theming, to add additional transparency to the process (Yardley, 2000).

Generalisability is another contentious term, especially in the small-scale qualitative realm. Braun and Clarke (2021) suggest that RTA studies can be 'softly generalisable' and may well be relevant and add value beyond the scope of the original study. IPA studies are firmly idiographic, and I prefer the term 'echoing' when considering application beyond the original sample, as Smith et al., (2022) states, "The specifics are unique, but they are hung on what is shared and communal" (p 32). The research question regarding the application to the Conscious Competence Matrix (Howell, 1982) seeks to apply a theoretical framework to the entire case and to decide if it has relevance and application across the sample and tentatively, beyond. As a term, I prefer the notion of 'transferability' rather than 'generalisability'

when applied to both RTA and IPA research, which is the term preferred by the psychology community too (Maxwell, 2021).

The research was insider/outsider research conducted upon my own trainee teachers, so this could be classified as close to practice research. In order to avoid some of the potential issues indicated by the BERA “Close-To-Practice” report (Wyse et al., 2018) various safeguards were undertaken. The methodologies utilised are clarified and exemplified with an explicit account of the analysis process. The sample size of eight is within the ideal norms for IPA and RTA methods. Terms have been clearly defined and a theoretical lens has been applied.

4.12.Rationale for the research tools

Thomas (2011) states that “case studies are a scrap book or portfolio of sources or information”. The data collection methods encapsulate this notion and aim to deliver a ‘Polyhedron of intelligibility’ (Foucault, 1981), considering a variety of angles and viewpoints and aiming to create a three-dimensional picture with a range of rich data sets. To capture different reactions at different points in time in trainee development, snapshots were taken in a variety of ways along the chronological timeline. The first data collection point was at the very first university maths taught session and the final ones were the IPA interviews that occurred in the final term of their first ECT year. The range of methods was designed to collect an array of rich data and ‘thick description’ (Geertz, 1975) to document each participants’ developmental journey from raw new entrant to early career teacher of Primary maths

4.12.1.Methods of data collection

A wide variety of data was collected over the time period and was split into phases for ease of clarity and description.

Table 1-Phases and timetable of data collection

PHASE?	WHEN?	METHOD	DATA / JUSTIFICATION	ANALYSIS
Phase 1 Sept 2018	Start of term-1st ever maths teaching session September 2018	Word Clouds – using pens and sugar paper- feelings/emotions about maths and one around teaching maths. Sitting in table groups.	Trainee initial reactions to maths to use as a baseline; this is the starting place to measure changes in attitude if they occur. Initial reactions.	Largest word in the cloud is the one that was most repeated. Instant snapshot
	2nd maths session	Peer to peer short self-recorded discussion explaining their feelings about mathematics. Using the sculptures which they modelled in play dough.	Approx. 2-3 mins discussion in pairs. Audio recorded then transcribed. To gain an overview of personal perceptions. Photos to be taken of these initial models to compare with at the end of the research period.	Reflexive Thematic Analysis
The purpose of Phase 1 was to understand the participant responses to maths and teaching maths as a group and as individuals. Aimed to know the starting place in order to track changes (if any) over time.				
Phase 2 2019	After first practice June 2019	Word cloud – repetition reaction to 'Maths' Word cloud – reaction to 'teaching maths'	Development point – noting reactions to maths and to maths teaching To notice change (if any) in students' relationship with maths so far.	Largest word in the word cloud is the one repeated the most often Instant snapshot
	Same session	Trainees wrote a short 300-word reflection of their maths teaching experience in Year 1 and reflect on their development so far as a teacher of maths.	Development point- student's own views of their maths knowledge, teaching and journey so far. Aim to recognise any changes from their own perspective.	Reflexive Thematic Analysis
Phase 2 purpose-had doing maths and learning more about effective maths teaching altered their views-of what and why?				

Phase 3 2020	After 2nd full teaching practice September 2020	Word cloud – reaction to 'Maths' Word cloud – reaction to 'teaching maths'	Development point -reactions to maths and to maths teaching Purpose to notice change (if any) in students' relationship with maths/teaching over the full 2 academic years	Largest word in the word cloud is the one repeated the most often. Instant snapshot
	After 2nd full teaching practice – and before final practice - September 2020	Peer to peer discussion explaining their feelings about maths initially and then at this point, they then modelled in play dough and had a photo of their original model for comparison. Constructed Journey maps of their teaching in maths and key 'critical moments' mapped out over the previous 2 years	Approximately 2-3 minutes discussion in pairs. Audio recorded and then transcribed. To gain an 'honest' overview of their emotional state now as opposed to at the start of the course. Attempt to discuss the subject knowledge/teaching pedagogy discourse comparing both sculptures. Use the journey map to explore their highlights and lowlights of maths teaching and what they are thinking around their final practice and beyond.	Reflexive Thematic Analysis. Reflexive Thematic Analysis
Phase 3- Could they reflect on their views towards maths and maths teaching development and articulate their development?				
Phase 4	In final term of their Early Career Teacher 1st Year May 2022	IPA semi structured interviews utilised the evidence base from other phases, to remind and used as a basis for further probing and discussion.	Longer length interviews reflecting back on their journey in maths from day one of training and up until current, using the previous evidence as prompts. With a	IPA

			view to their future in maths and in teaching. IPA as the focus was on the idiographic.	
Phase 4 – Were the participants able to reflect on their own previous constructs/reactions and articulate their views towards maths and maths teaching now, as a qualified classroom teacher?				

The first research tool deployed was the construction of word clouds or 'wordles'- a visual representation of a collection of words. The size and predominance of certain words relate to the frequency of their use and repetition within the word set (McNaught & Lam, 2014). The larger the word in the overall image, the more frequently that word was deployed by the participants. No claim is made in terms of their reliability as a research tool, however the value of them as a 'snapshot' of the participants and as a method of demonstrating an 'instance' in time, is the rationale for their deployment. The words were gathered on large sheets of paper, while the participants sat in groups and were asked two questions. They were asked to write down their instant reactions to the word 'maths' in one section and then to write down their reaction to the phrase 'teaching maths' in the other. Time was then given to complete the tasks and all participants were asked to contribute at least one word to each section or phrase. These sheets were collected, and words then typed into lists and inserted into a word cloud generator programme. The largest words in the word clouds are the ones repeated most frequently.

Word clouds were generated at three specific points in the training programme. The first one was completed at the start of the maths course, before any teaching or input was given (to avoid any sense of 'tutor contamination'). The second after their first teaching practice, with the intent to observe if the combination of teaching maths themselves and having taught input at university had made any change in their reactions. Covid 19 then interrupted as there were no face-to-face teaching sessions from March 2020 until September 2020 so no data collection could be done directly after their second practice. The final word cloud was gathered prior to the trainee's final teaching practice and at the very end of all the taught input for maths. I had no verbal input bar the instructions for completing the word collections, but these are normal practice in taught sessions, for retrieval practice and to gather initial thoughts.

These were pure ‘snapshots’ to capture emotion and reaction in the moment and to ensure that there was depth to my questions and a real ‘case to answer’.

The next tool was deployed twice, once at the very start of the trainee’s maths input and once at the very end of the subject teaching before their final teaching practice. This method is the one that was deployed and described in the pilot section. The participants were given play dough and iPads and asked to create dough models that captured their feelings around maths and then record their explanations on the iPads sharing with a partner and swapping over, recording each other. These mini peer to peer interviews were recorded whilst I absented myself from the room, in order to not ‘contaminate’ or influence the interviews as previously explored. In the second version the trainee had a photograph of their original sculpture and then created a new one and compared the two and discussed what (if anything) had changed. These short interviews were transcribed and coded utilising the RTA approach. These were very effective, as the participants used the sculptures to, at times, animate their views and even linked their first and final sculptures to tell a narrative around their journey. This depth of thought and adaptions were far beyond my initial expectations.

The third tool deployed was a short reflection written by the trainees after their first teaching practice, reflecting on their feelings/emotions around teaching maths for the first time and what they had learned so far, these were short (approximately 300 words). Reflecting on progress is something that is commonplace practice to trainee teachers, they do this verbally whilst on practice and at punctuations during the course, so this was not additional workload. From the early work of John Dewy (1910), Schon (1984) to the work of Goodman (1984) and Ottesen (2007), the value and development of reflective practice within trainee teachers has been well documented. Learning to explain and explore thought processes and decisions is essential, so this exercise built on previous experiences in other subject areas. These reflections were anonymised, and coded and themed using the RTA process.

I have included the relevant eight reflections within the data for RTA, however this dataset was the least successful. Many of the main class group tended to describe a lesson that either went well or badly for them on first practice and not really reflect on their own learning. The eight sampled participants reflections did contribute more rounded data and highlighted some of the wider themes and very relevant content

(refer to findings chapters five and six for details). Upon further reflection, I noted that the trainees were still very early in the course, in their personal development and professional identity development as trainee teachers. They were not familiar enough with how to reflect or process reflections using a structure with confidence. This was a case of “knowns and unknowns” for some of them.

The fourth data collection tool was based upon the work of John Mason and Sue Johnston Wilder (2004) and their work involving ‘critical incidents’ in maths teaching. These are key incidents that changed views and behaviours for maths teachers. I felt this was relevant to this study as several trainees had indicated that there had been incidents on their teaching practices or in their past lives that had impacted upon their attitudes and beliefs around maths. I am combining this with visual mapping (Manney, 2015) and used a chronological journey ‘map’ as a tool of elicitation. The trainees utilised the chronology line to map their journey on the maths aspect of the course and highlighted their personal ‘critical incidents’ from their teacher training placements, be they positive or negative. The maps were effective, as they encouraged the trainees to make links to the sculptures and iPad peer to peer videos to explore their own reactions and to revisit aspects of their past. The sections on the map were very short sentences and phrases, which they then may have chosen to elaborate upon in their short sculpture interviews. These ‘maps’ were also utilised as prompts for thoughts and reflections in the later IPA interviews, in order to ‘jog’ the memory of the participants and to see if these critical incidents remained as ‘critical’ after 18 months had passed by in their teaching journey.

The framework of the semi structured interviews (phase 4 of the data collection) stemmed from the creative images of the playdough models created, and transcripts of their peer-to-peer interviews from all the previous phases. These were used as prompts to remind and encourage discussion with the participants around the participant’s own journey map from novice trainee to qualified teacher, encouraging them to reflect and expand upon their own thoughts and their own journey. The previous data set for each participant was considered prior to the semi structured interview and presented to each participant. The RTA data was not fully analysed at this point. The eight online interviews lasted from 45 minutes to 1 hour and followed a flexible semi-structured design. Each one began and ended with a generic ‘catch up’ to find out how each participant was and to confirm they were happy to still

participate and be recorded. I revisited the right to anonymity and their right to withdrawal was also reinforced (BERA 2018). This was important as it had been some time since I had spoken to them and wished to confirm that they were able to talk freely and were happy to discuss teaching in relation to maths. I also felt it was efficacious to 'warm up' each participant by reminding them of their sculptures and showing them their maths journey map to encourage reflection.

4.13.Process of Analysis-RTA

There were two types of analyses deployed in this study. The first was RTA (Reflexive Thematic Analysis) and all the data gathered in the first three phases during their undergraduate programme was analysed utilising this strategy. The second was IPA (Interpretative Phenomenological Analysis) utilised in their final interviews when they were ECTs. Both strategies have similarities to each other and have a similar structure and procedures.

The RTA data consisted of two playdough sculptures as images created by the participant, two short transcriptions of peer-to-peer interviews with other trainees at the start and end of the taught programme, one written reflection and one journey map of critical incidents. All the eight participants data sets were considered utilising Braun and Clarke's (2021) structured system of analysis but being flexible and iterative, in order to return to the original data set each time, see below for further explanation of each stage of the process.

Stage 1 involved careful reading and re-reading of each individual data set, noting my own reactions, and asking myself questions about my reactions and the transcriptions.

Stage 2 was the creation of initial codes, using comments boxes and colours on screen or post it notes on paper (see Appendix 3 for examples from participant Gerry). I was mindful of the research questions considering maths as a subject, teaching maths and the notion of unconscious competency. However, I was keen to consider other issues that the participants valued, and that perhaps I had not considered.

Stage 3 was the grouping of codes and deciding on overarching themes. This was an iterative process and was returned to and reflected upon several times, over an extended period.

Stage 4 was reviewing of themes as a whole; some were regrouped, and others split and some aspects that were not mentioned by multiple participants (four or more) were classed as outliers in this aspect of the study. As the RTA was only one of two methods deployed, any outlying notions that occurred in few data sets were retained to see if they occurred in the IPA data sets and were therefore deemed to be important to that trainee's story. One of these occurred and is developed within the IPA data set.

Stage 5 was the defining and naming of themes. This process was iterative, a continuous and reflexive process referring back to the research questions at regular intervals. These names and their associated explanations are detailed in Table 2, below.

Stage 6 was the writing up process and looking at the contribution of the RTA to the participant journey.

Table 2

The RTA Themes

Theme	**Explanation of theme**
Theme 1 Prior Experiences	Reaction to the word maths, trainees previous experiences of maths as a subject
Theme 2 Pedagogical Content Knowledge (PCK)	Knowing the pedagogy of how to teach maths (as opposed to subject knowledge)
Theme 3 Competency Awareness	Links to the Conscious Competence Matrix
Theme 4 Scaffolding	An incident where someone or something supported or scaffolded the trainee to improve teaching/maths knowledge
Theme 5	Something happened that instigated the

Critical incident/ personal responsibility	trainee taking greater responsibility for personal maths knowledge/a turning point

4.13.1.Process of Analysis-IPA

The semi structured interviews that were conducted with the participants as fully qualified teachers (and therefore not trainees, as any potential power dynamics were now reduced even further) so I utilised the IPA approach (Smith et al., 2022). IPA has a specific and systematic process of data analysis, whilst keeping to the notion of the hermeneutic reflective cycle, with the lived experience of the individual at the centre.

Data analysis in IPA is an iterative, fluid and dynamic process, with the data being revisited many times to be considered from as many angles as possible, with many checks and reflexivity being applied. The step-by-step data analysis process is described below. Smith et al., have changed the language and description of the process between their 2009 book to their 2022 book. I decided to adopt the most recent version for this analysis process as the updated version explored the data analysis in a more systematic way which I felt really enabled me to treat each interview in the same rigorous manner, again to allow the idiographic nature of the research to stand out . Educational use of IPA is still quite new and unusual so using the most up to date version also seemed the most appropriate. The steps below are the ones that each IPA interview analysis followed.

Step 1: - Reading and re-reading each case and actively engaging with the data.

Step 2: - Exploratory noting, staying close to the explicit meaning, so no interpretation at this stage, considering your own reaction to statements and points. Noting specifically emotive language and personal reactions to the transcriptions.

Step 3: - Construction of experiential statements. This is the beginning of interpretation developing from the exploratory notes. Some statements may appear many times, at other points they may be unique.

Step 4: Connections between and across experiential statements. This involves clustering statements together and forming personal experiential themes from the experiential statements.

Step 5: - Naming the personal experiential themes (PETs) and organising these into a table of PETs for each participant, referring back to the research questions and aimed to help formulate PETs.

Step 6: -Repeat steps 1-5 for each participant.

Step 7: - Considering all the participant PETs and looking for commonalities that suggest overarching themes which are termed Group Experiential Themes (GETs). This is a dynamic and iterative process and not all PETs may become GETs (again as in the RTA over half the participants needed to have discussed the theme for it to become a GET). PETs may remain and stand alone as unique experiences relevant to that one participant.

This data was analysed into PET and then GET themes, and because of the interweaving of the RTA aspect into the IPA interviews, they formed the ‘treble hermeneutic’ connections between the RTA themes and the IPA themes were explored and then linked back to the research questions.

4.14.Conclusion

This chapter has addressed the philosophical, ontological, epistemological and contextual basis for this research study. The research questions and aims have been presented and the rationale for these discussed. The ethics, morality and treatment of participants and data have been explained. The types of research tools and the two main approaches to the data analysis have been discussed and their underpinning philosophies explored and explained. Limitations and the need for constant reflexivity and personal reflection have been investigated and developed.

The research design is rooted in a qualitative, interpretivist and phenomenological perspective. In the context of this study, it is embedded in the qualitative dimension, it is the exploration of the lived reality of the case study group that is of specific interest and bears close and detailed examination and discussion.

The next chapters will address the findings of the various data collections in chronological order. This begins with the word clouds gathered on the trainees first day learning maths at university, moving on to the RTA evidence utilising Braun and Clarke's (2021) methodology and ending with the IPA semi structured interviews taken with the participants as Early Career Teachers (ECTs). The entire process of gathering data spans a four year period, from initial word cloud data in September 2018 when they were new undergraduates to May 2022 when they were completing their first year as ECTs.

Chapter Five

5.Findings-RTA Research

5.1. Introduction

The previous chapter discussed the rationale behind and the organisation of the data sets. Findings from the data are now presented in this and the following chapter. It is important to note that the findings chapters are purely to develop and explain the findings, discussion and links to literature are developed in the discussion chapter. This chapter presents the findings from data collected when the participants were trainee teachers, over the course of three years. The subsequent chapter presents findings from when the participants were ECTs. There are two finding chapters because of the different research methodologies deployed and to indicate the different stages that the participants were on in their journey. In this chapter, the word clouds are presented first, followed by the RTA data sets, these are presented chronologically in the order that the data was collected.

5.2. Data Sets

5.2.1. Word Clouds

The first data set collected in phase 1 were the word clouds. This initial data set considered the views of the entire undergraduate cohort (26 trainees) and asked the very new trainee teachers to jot down the first things that came into their head when the word ‘maths’ was mentioned, so the focus was on maths, the subject itself. This data collection occurred during their very first day of maths training at university. Next, they were asked to write down their thoughts around ‘teaching maths’ to ascertain if there was any difference in their thoughts. The tables below list all the words written by the trainees, used in each collection and then arranges the words into a word cloud, where the largest word is the one most repeated/most common in the data set. This creates a very visual and stark graphic of their initial thoughts collated and ordered. Tufte (a pioneer of data visualisation) stated as one of his principles for clarity in data visualisation: - “Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in

the smallest space." (Tufte, 2001). A word cloud enacts this and allows a snapshot of the cohort's initial impressions and reactions with stark clarity.

There are two separate themes addressed by the word clouds, and these are arranged so that each theme is explored in turn, with all three data collections in chronological collection order. The tables below list the words collected and then the word cloud these words then represent.

5.2.2. Word Clouds-Attitudes towards maths as a subject

Table 3

Words associated with 'maths' From data collection 1 September 2018
Scary
Average meh
Fairly easy one answer
Liked it
Bad memories
Bad teacher in high school
Go to bed instead
When it involves letters too hard
Scared
Anxious x 100
Confusing (x3)
Cry
Lack confidence
Hate
Hard
Struggle (x2)
Marmite
Confused
Challenged (x2)
Interesting
Numbers (x3)
Stay in bed
Fractions
Argh
Tables shapes 2d/3d
Stress/ed (x4)
Fun
Easy
Simple
Panic
Hard (x 8)
Sad

Figure 3 Word cloud of words associated with the word 'maths'

Data Collection 1

September 2018

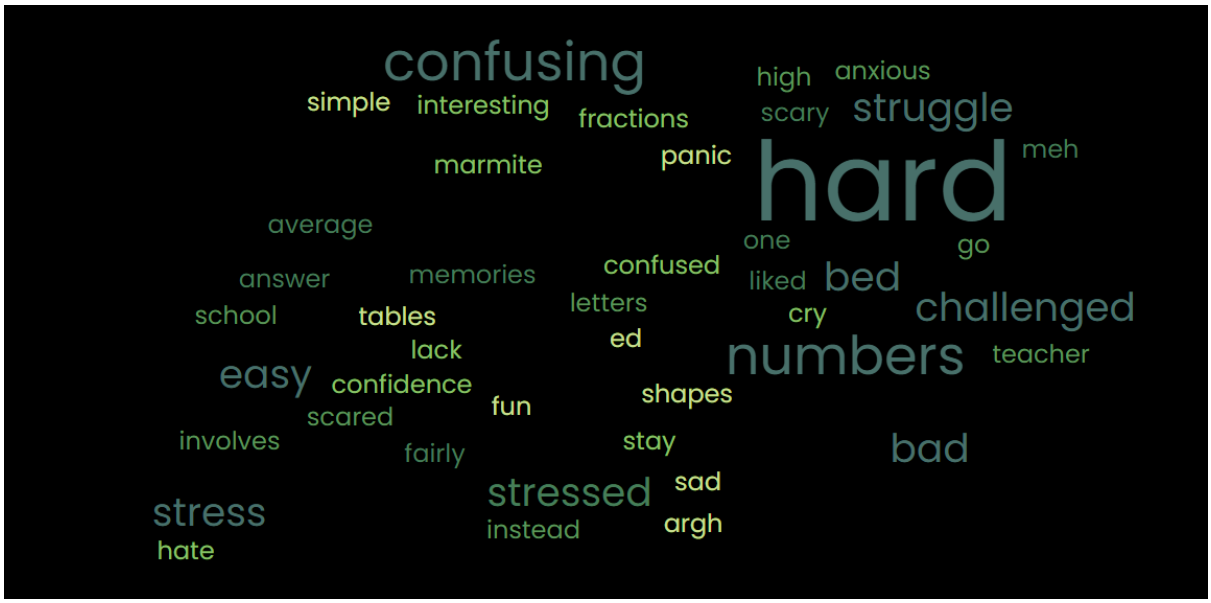


Table 4

Words associated with 'maths' From data collection 2 After first full teaching practice June 2019
Subject knowledge
Confused (x4)
Hate (x3)
Poor
Bad
Stressful (x3)
Logical
Number
Times table knowledge
High + anxiety
order
Enjoyable
cry
Confident (x2)
ok
Been working on it
Panic
Marmite
Improving

Figure 4 Word cloud of words associated with the word ‘maths’

Data Collection 2

June 2019

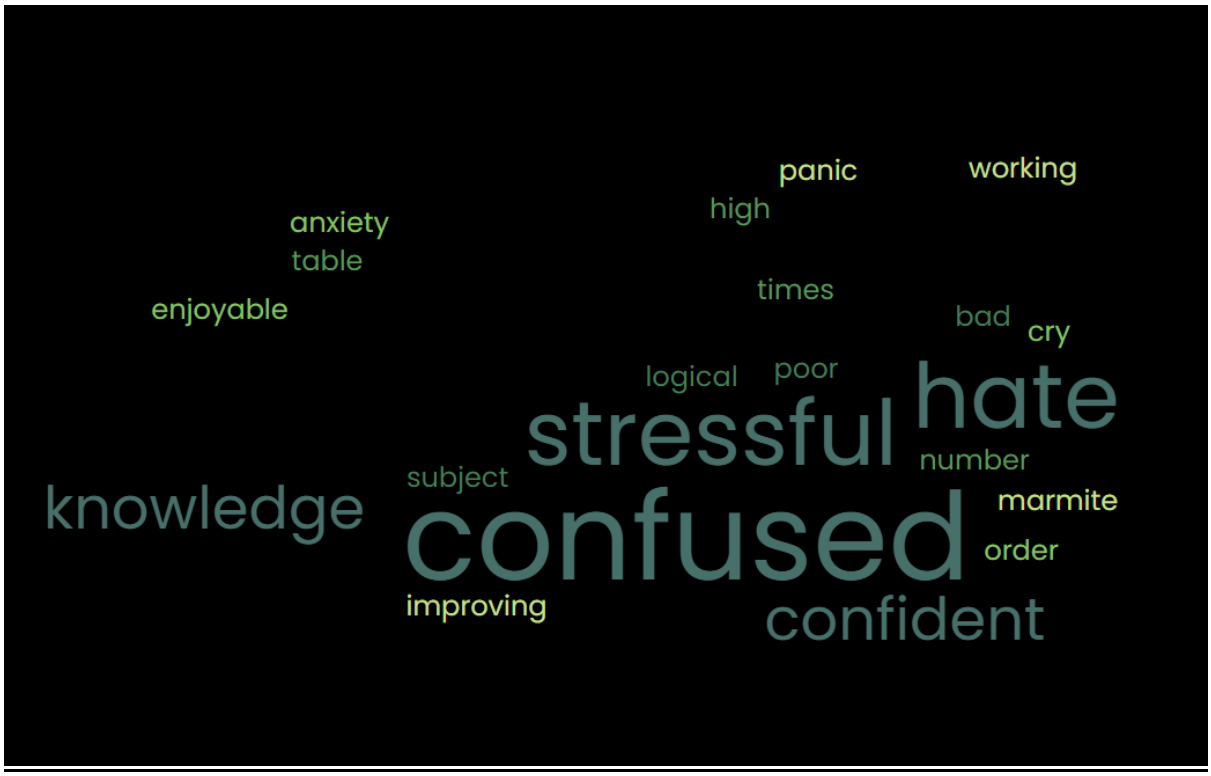


Table 5

Words associated with ‘maths’ From data collection 3 After second full teaching practice and prior to third and final September 2020
Improved as used school strategies on myself
Own research has helped
Confidence grown massively
Reasonable knowledge
Can do maths now
Subject knowledge muddled can impact on teaching
Hate
Not my favourite
Actually, understand what maths is now- not numbers but patterns.
Grown in subject knowledge
More enjoyable now

Figure 5 Word Cloud of words associated with the word ‘maths’
Data Collection 3
September 2020

These word clouds confirmed my original notion that there was a phenomenon to explore and investigate when considering trainee teachers’ attitudes towards maths and teaching maths. The very first cloud (figure 3 and table 3), looking at maths as a subject from September 2018 has words such as: -‘hard’, ‘struggle’, and ‘stress’ as frequent repetitions. There are some terms such as -‘easy’, ‘fun’ and ‘interesting’ that suggest that anxiety or dislike is not universal across the cohort, but the negative and emotional terms are strongly present, at this point it is their own school experiences that they are recalling from the recent past. Certain maths topics also presented themselves in the first word cloud such as ‘times tables’ and ‘fractions’ that are often areas that trainees find both difficult to learn and to teach.

The second cloud (figure 4 and table 4) data was gathered just after the trainees first full teaching practice in June 2019. They had been teaching maths to either whole classes of children or groups for whole weeks while on their first practice. They would also have been observed and received feedback on their maths teaching by their class mentor in school. Their teaching at this stage is a very supported and scaffolded process, with mentors guiding a great deal. They have also received the equivalent of five days of training in maths at the university, both linking to subject knowledge (SK) and pedagogical content knowledge (PCK) and had to audit their own maths knowledge.

The emotive and highly charged words such as ‘hate’, ‘stressed and confused’ remain in the data from the second collection regarding feelings around maths. New vocabulary such as ‘improving’ and ‘working on it’ have been introduced, reflecting the developing recognition that they need to work on their maths skills and knowledge. The more positive words such as ‘enjoyable’ and ‘confident’ remain and have grown in number. It was interesting to observe more teaching specific terminology such as ‘subject knowledge’ was being deployed for the first time. This suggests that the maths teaching in university, combined with observations in school and the terminology associated with the curriculum, was starting to permeate into the trainee’s vocabulary and into their understanding of the subject.

The third and final word cloud collection (figure 5 and table 5) was conducted after the trainees second practice and just before their third and final practice in September 2020. It would have been advantageous to have had another round of data collection after their second teaching practice but unfortunately Covid 19 restrictions prevented face to face teaching in university in the summer of 2020. This data collection was conducted at the first point of face-to-face teaching in maths in their third year and this was still under movement and mask restrictions.

It is clear, that this third and final collection of words to do with maths as a subject is quite different from the previous ones. The maths cloud contained more phrases, fewer individual words, although “hate” and “not my favourite” remain to demonstrate a continuation of emotional dislike and negative feelings toward the subject. The remaining phrases are no longer one-word reactions but much more complex and often full phrases. This reflects a potentially closer grasp of the relationship between subject knowledge (SK) and pedagogical content knowledge (PCK), for example: - “Subject knowledge muddled- can impact on teaching”. Some sense of enjoyment has also entered the lexicon and clearly not only from those who originally deployed the term: - “more enjoyable now”, “Can do maths now” for example. A sense of personal responsibility for self-development is also present for the first time, “Improved as used school strategies on myself” and “Own research has helped”.

5.2.3.Word Clouds-Attitudes towards teaching maths to children

The next section will focus on the second strand of the word clouds, from data gathered at the same time periods as the first ones. This focuses on the trainees' reactions to the thought and reality of teaching maths to a class of children.

Table 6

Words associated with 'teaching maths'. From data collection 1 September 2018
Not ready
Scared
Ok
Scary prefer to teach than learn
Excited
Simple
Logical
More confident
Panic
Rules
Interactive
Fun
Early years easy
Lower numbers
Straight forward
Less scary
Practical
Hands on
Okay in Key Stage One
Smaller numbers
Less complicated

Figure 6 Word Cloud of words associated with 'teaching maths'.
Data Collection 1
September 2018

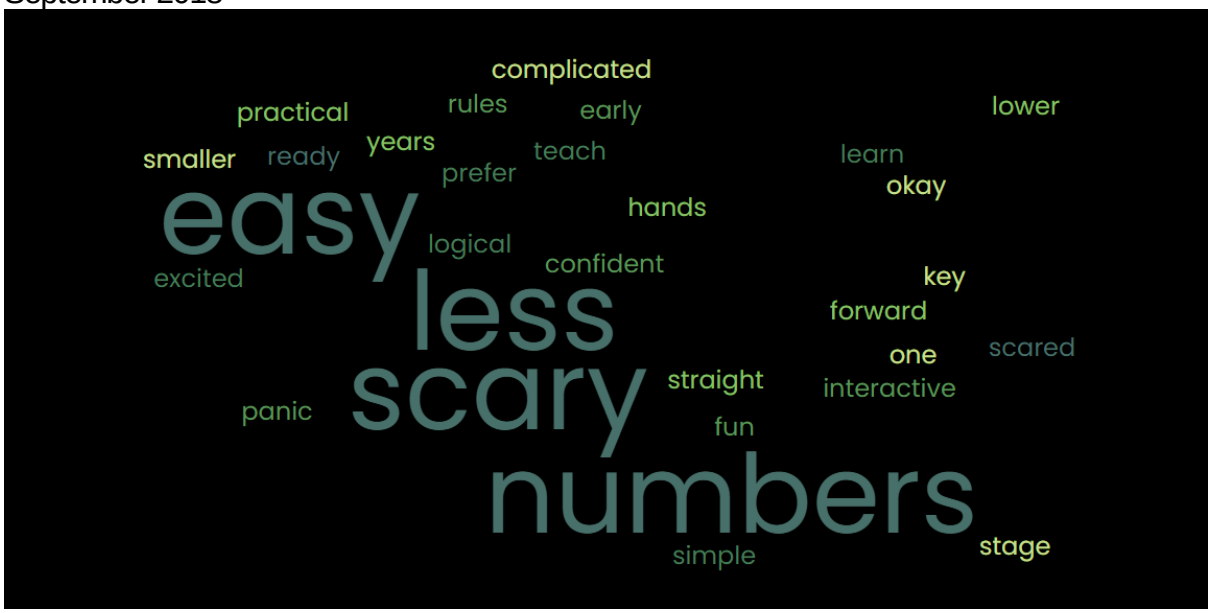


Table 7

Words associated with 'teaching maths' From data collection 2 After first full teaching practice June 2019
Confident (x4)
Key stage one better
Practical
Easy depending on topic
Scary
Excited (x3)
Anxious
Hands on (x3)
Daunting
Interesting
Fun
Time and money challenging
Y6 scary
Highers scary – lowers ok
KS2+enjoyable
Scared (x3)
Responsibility
Interactive
Early +years+easier

Figure 7 Word cloud of words associated with ‘teaching maths’

Data collection 2

June 2019

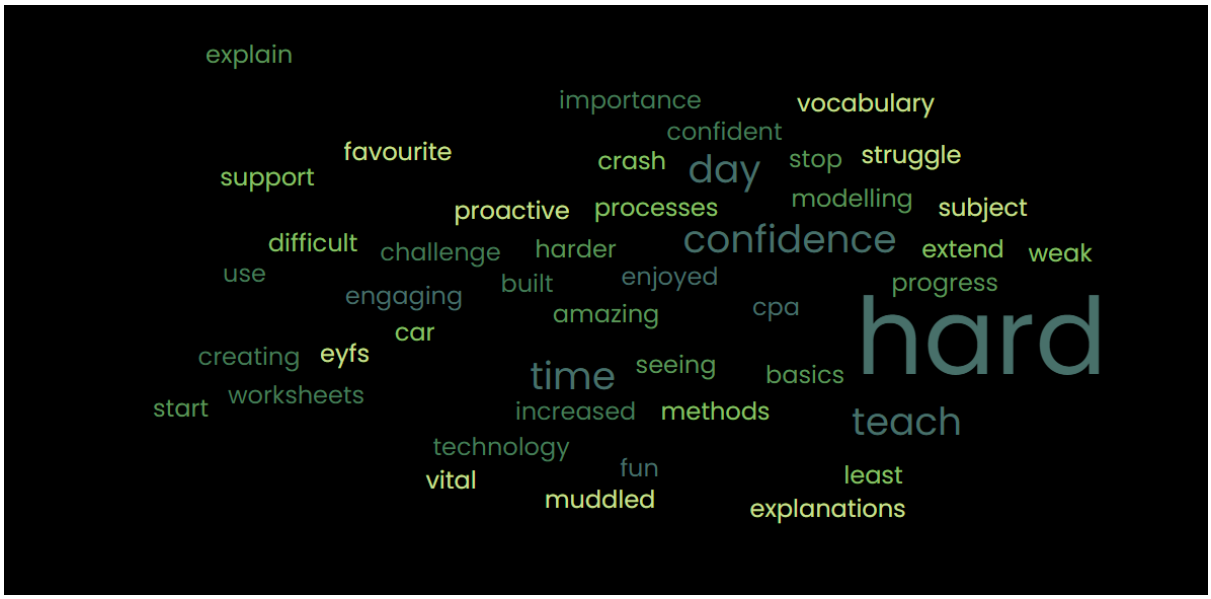
Table 8

Words associated with ‘teaching maths’ From data collection 3 After second teaching practice and prior to third and final September 2020
CPA
Enjoyed
Fun
Engaging
Confidence increased
Creating worksheets, a challenge
Confident with use of technology
Built my confidence
Importance of modelling
Seeing day to day progress amazing
Harder+basics
Start+stop hard
Hard to explain
Difficult to extend+support weak
Car+crash
Time hard to teach (x2)
Methods and processes can be hard
Least favourite subject in EYFS hard
Proactive
Struggle+muddled explanations
Vocabulary vital

Figure 8 Word cloud of words associated with ‘teaching maths’.

Data Collection 3

September 2020



The first word cloud (figure 6 and table 6) relating to the cohorts’ perceptions of teaching maths, and it is immediately clear that this provoked a different reaction to the one focusing on the subject of maths. The word “less” was a repeated word in phrases such as “less scary” and “less complicated”, suggesting it is less difficult to teach maths than it is to ‘do’ maths. Other words such as “practical, fun and confident” suggest that the cohort, (remembering their focus is on teaching 3-7 years) felt happier with the notion of teaching younger children, and the quote from one trainee: - “Scary-prefer to teach than learn”. This strongly suggests that at this initial stage, the trainees were nervous, but engaged with the notion that teaching young children maths would be more enjoyable and easier than learning the subject, themselves. The concept of unconscious incompetence can be introduced here, with the trainees assuming that teaching young children ‘easy’ maths is much more straightforward to do, than learning maths is, for them. It needs to be noted however, that at this point on the course, no school teaching practice had occurred, so for many of the cohort their only experience of primary school maths came from their own prior experiences, seven or more years ago. Most have very little wider experience to draw on bar their own.

The second ‘teaching maths’ data (figure 7 and table 7) was collected at the end of the first year, after a full assessed teaching practice. The teaching maths comments, and vocabulary were similar to the first data set on this theme, with words deployed such as ‘confident, excited, hands on’ but also ‘daunting’ and some more technical phrases such as ‘time and money challenging’ demonstrating a greater grasp of the curriculum and better understanding of the way primary maths is taught. The myth that Key Stage Two maths (teaching children aged 7-11) is harder or more difficult than teaching Key Stage One appears for the first time and that more able children are harder to teach is also stated. Again, suggesting unconscious incompetence due to lack of experience. The word ‘responsibility’ also appears, perhaps the first experience of a performativity culture has been awakened while on teaching practice.

The third ‘teaching maths’ collection word cloud (figure 8 and table 8) demonstrates a large change of perspective, in the first two data collections around teaching maths, the dominant terms were confidence and excitement at the prospect of teaching maths to a class. The difference in word choice is stark. The word ‘hard’ dominates and more technical and education infused technical terminology is deployed. ‘Hard’ however seems to have replaced ‘Scary’, which suggests a challenge that can be overcome, rather than something that is totally overwhelming, perhaps experience has enabled the trainees to recognise they are more capable and do not need to be scared any longer. Words such as “fun, engaging and confidence increased” suggest that some have experienced success in their teaching practices in maths and these positive experiences have increased their positivity. Others such as “car crash” suggest that negative experiences in lessons and lesson observations have occurred and a recognition that earlier assumptions were wrong, such as “Least favourite subject- in EYFS hard” and “harder basics”. Clearly it is not possible to draw any specific conclusions from these words, but it is possible to see the change in the cohort and the growing sophistication in their understanding. They appear to have moved beyond an attitude of: - ‘young children- how hard can it be’ naïve unconscious incompetency viewpoint to one of knowledge and personal growth. Phrases such as “importance of modelling”, “vocabulary vital” and ‘CPA’ (concrete, pictorial and abstract, these are three key strategies used to

teach maths currently) acknowledge a growing understanding of effective and necessary pedagogical content knowledge approaches in maths and beyond.

5.2.4.Word Clouds-Summary

The final word clouds reflect a cohort having gone through two full teaching practices despite Covid-19. Change in their views is stark and transparent but the rationale and thoughts behind these developments is not something that this type of data set can reveal. These clouds are purely a 'snapshot' of key moments in the trainee timeline, illustrating shifts in mood, tone and language, which may be indicative of wider changes but must be treated accordingly (photographs of sample papers from the word cloud collections are in Appendix 2).

However, the language deployed especially in regard to the final 'teaching maths' cloud, (figure 8 and table 8) suggests a fundamental shift in mindset has occurred in many of the participants and indicating a distinct movement from unconscious incompetence through conscious incompetence and on further into the start of conscious competence.

5.3.RTA findings

This section presents the findings from the multiple data sets conducted during the three years of the degree course. These are from the eight participants, described as trainee teachers at this point in time. These data sets were analysed using Reflexive Thematic Analysis or RTA (Braun and Clarke, 2021). The rationale for this decision and sampling strategy has been explored within the methodology chapter.

The eight trainee participants were a mixture of gender, ethnicity, and age selected to fairly represent the wider cohort. In order to preserve anonymity, gender neutral pseudonyms have been assigned because a small number of males were present in the group meaning that gendered pseudonyms could have made them personally identifiable. Gender neutrality of pseudonyms has become a much more commonplace strategy within qualitative research recently (Allen & Wiles, 2016). This seemed appropriate with this size of group and in a situation where I had made a great deal of effort to situate myself outside of the research, I had no desire to name

them in a conventional manner. Age phases of the participants have been indicated to demonstrate the spread across the wider case.

Table 9

Table of participants, their allocated pseudonyms and their age phases

Participant Name (Gender neutral anonymised names)	Participant Age Phase (at the start of the study)
All part of the BA Primary 3-7 focused cohort Enrolled - September 2018 Graduated - July 2021 ECT years-September 2021 to July 2023	
Harper	35+
Gerry	35+
Indigo	25+
Piper	18+
Sam	18+
Viv	21+
Riley	18+
Umber	21+

The data that was analysed applying RTA, consisted of several data sets.

i) are images of models created with playdough- they created these twice, the first set on the very first day doing maths on the course, the second on the last data collection, before final teaching practice, they compared both structures.

ii) Two transcribed, peer to peer video interviews in which students interviewed each other in pairs about their playdough models and opinions about maths, and which were audio-recorded on I-pads. The first interview took place at the very start of the course (same day as the initial word cloud) and second just prior to their final teaching practice in year 3.

iii) a short, written reflection after their first teaching practice.

iv) a journey map highlighting the trainees' own views of the highs, lows and 'critical incidents' on their journey to become a primary teacher of maths.

Table 10

The RTA Themes

Theme	Explanation of theme
Theme 1 Prior Experiences	Reaction to the word maths, trainees previous experiences of maths as a subject
Theme 2 Pedagogical Content Knowledge (PCK)	Knowing the pedagogy of how to teach maths (as opposed to the subject knowledge)
Theme 3 Competency Awareness	Links to the Conscious Competence Matrix
Theme 4 Scaffolding	An incident where someone or something supported or scaffolded the trainee to improve teaching/maths knowledge
Theme 5 Critical incident/ personal responsibility	Something happened that instigated the trainee taking greater responsibility for personal maths knowledge/a turning point

Table 11

Timetable of Data Collection

Phase	**Date**
Phase 1 RTA Word clouds First sculpture and peer to peer interviews	September 2018
Phase 2 RTA Word clouds Written reflection	June 2019
Phase 3 RTA	September 2020

Word clouds Second sculpture and peer to peer interviews Journey maps	
Phase 4 IPA Semi-structured interviews	May 2022

Due to the volume of data collected, one exemplar of the RTA data set, for one trainee (Piper), is shown below. This is to illuminate the data set analysis process, in line with my personal axiology around transparency and clarity and honouring the participants. It also explicates and situates the range of data deployed in the RTA section of the data collection.

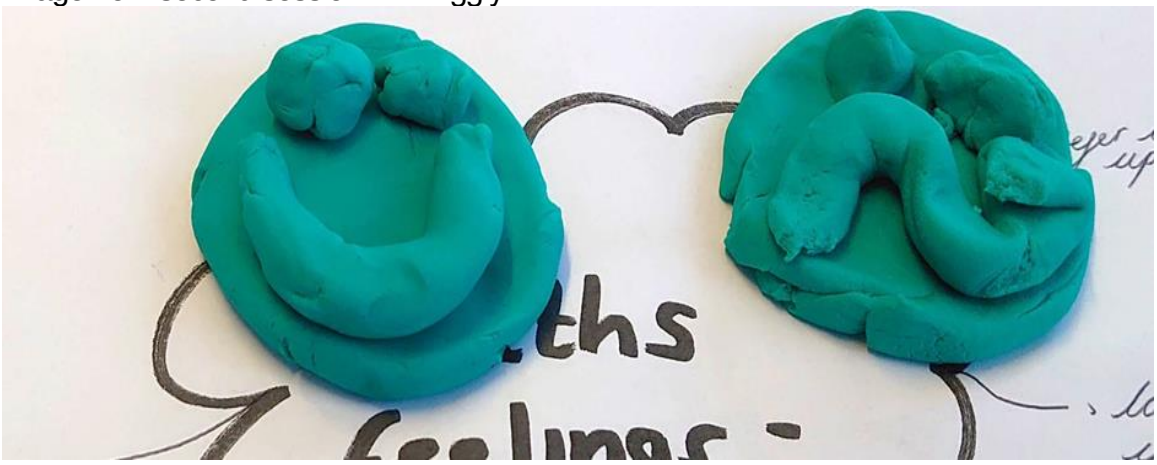
Table 12

Participant Piper
RTA Theme 1- Prior Experiences
Evidence source (direct quotations in italics) Peer to peer video 1 *My initial reaction is a happy face as I enjoyed learning maths, especially at primary school, and it was enjoyable, and I want to do the same as a teacher myself.* Reflection *Getting an A at GCSE meant it felt like I knew most of the subject knowledge well.* Journey Map *Interesting, exciting, confident like it*
RTA Theme 2-Pedagogical Content Knowledge
Evidence source (direct quotations in italics) Peer to peer video 1 *I hope I can be confident and good at teaching it and the children and myself both enjoy it.* Peer to peer video 2 *In EYFS I think maths is broken down into simple steps and it is the first time they have encountered things I find it quite hard to break things down into easy to explain steps as I am quite good at maths myself. Whereas in Years 1 and 2 teaching them maths like through PowerPoint, because like they have already got some knowledge and prior knowledge, I feel like I am better at teaching year 1 or 2 than I am to Reception.*
RTA Theme 3: - Competency awareness
Evidence source (direct quotations in italics) Peer to peer video 2 (reflecting on their own prior reflections from the first video and sculpture 1) *With the first sculpture had a smiley face, because I felt quite confident then about*

maths and was confident teaching maths at the start and then now, I have made one with a 'wiggly' face as sometimes I am alright with understanding teaching maths and how to explain it sometimes, I am not.
RTA Theme 4: -Scaffolding
Evidence source (direct quotations in italics) Journey map *Used my PD time in Y1 placement to observe maths as I was struggling – this helped me greatly to see others teach…*
RTA Theme 5-no evidence

Figure 9:-Sculptures created by Piper as a reaction to the word 'maths'

Description of the two sculptures: - Image from first session: - a smiley face
Image from second session: - a 'wiggly' face



5.4.Sculptures

Below are photographs of the playdough sculptures created by the participants, in reaction to the word 'maths'. The first sculpture was constructed on the first day of course, the second prior to their final teaching practice in the third year of the degree course, after they had seen photos of their original sculptures. The sculptures are included here to add depth and colour to the unique journey of each participant, their own words are then used in the RTA data to explicate the images and the thoughts behind them.

Figure 10- Gerry-Image from first session: - Letter d

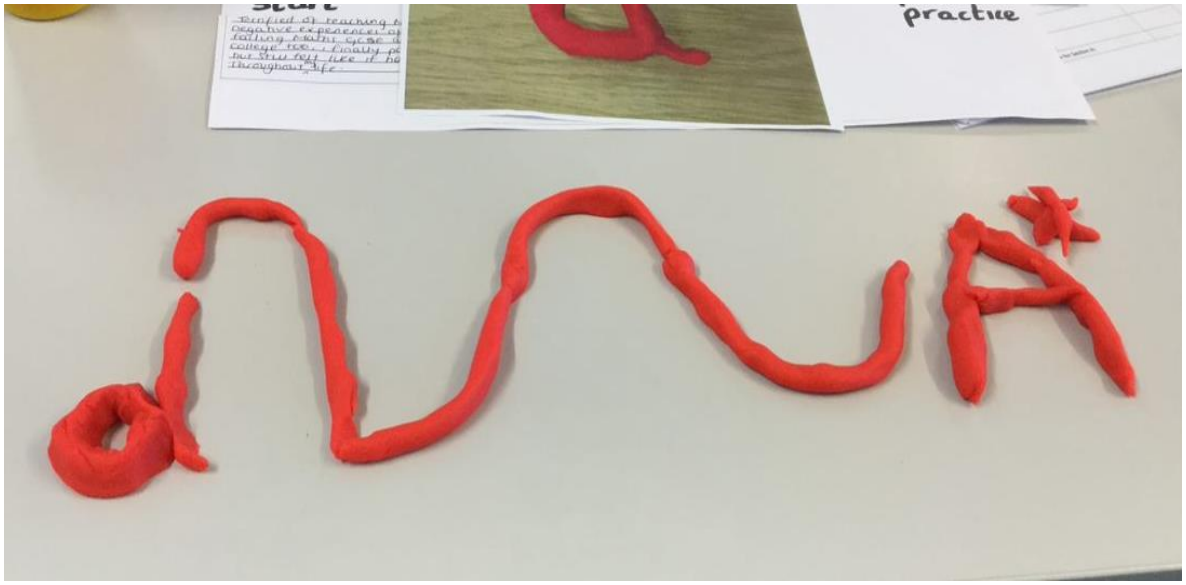


Figure 11 Gerry- Image from final session: -from d to A*

Figure 12- Sam - Image from first session: - negative face

Figure 13- Sam-Image from final session: -smiley face and thumbs up

Figure 14-Harper- Image from first session:-Ladder

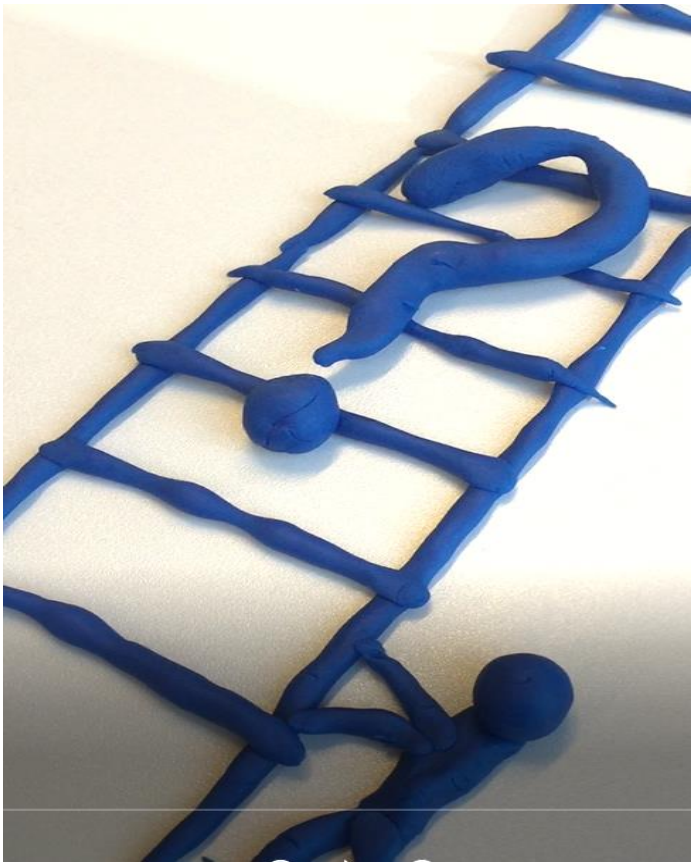


Figure 15 Harper-Image from final session: -ladder climbing figure and a ? mark

Figure 16 Riley--image from first session:-smiley face

Figure 17 Riley-Image from final session: - smiley face and upward arrow

Figure 18-Umber- Image from first session: - unsettled face

Figure 19 -Umber-Image from final session: -smiley/confident face

Figure 20 Viv- Image from first session: -thumbs up

Figure 21 Viv- Image from final session: -arrow indicating onwards and upwards

Figure 22 Indigo-Image from first session: -a wall of bricks and blue cement

Figure 23 Indigo:-Image from final session:-house made from the bricks, with extension into a garden.

5.5.Analysis of RTA themes

5.5.1.Theme 1- Prior Experiences

This theme explores the trainees' prior experiences in maths, often connecting back to their own school experiences and their emotional reactions to the word maths and the subject itself. It positions the trainees at the start of their training journey, reflecting back on the maths that they have experienced in the past.

Of all the 8 participants, only Viv did not comment about prior experiences, either in the home or school around maths and did not talk about subject knowledge either in the past as a child or as a trainee teacher. The remaining participants were keen to discuss their personal mathematical past, several using very emotive words about their prior experiences, terms such as "dislike/struggle/confused/hated maths" (Sam-journey map) or "I hated it" (Harper-peer to peer video 1) or as something that had been difficult or unpleasant, "Maths has always been something I struggled with" (Gerry-reflection). Much of the dislike appeared to stem from prior experiences in school, often secondary school. Gerry created their entire initial sculpture around their GCSE maths result, as it had such a strong emotional impact upon them:

> So, my symbol is the letter d, because this is the grade that I got when I did my maths GCSE at sixteen years old, I was very upset and disappointed at this grade, and it has stuck with me ever since. This has led to me losing all my confidence and enjoyment of maths from that time onwards….

Umber had a negative experience at Secondary school too and it clearly impacted upon them especially in terms of personal confidence: -

> I had a bad experience with a maths teacher while I was at high school, ever since them I have been put off maths, it really damaged my confidence quite a lot and made me worried… (Peer to peer video 1)

This connects back to the notion of maths anxiety which several of the trainees alluded to, based on their past but did not actually mention it as their lived reality. Instead, the notion of the impact of negative prior experiences and not wishing to promulgate this to the children in class was a thread across several trainees, such as Gerry, who stated: - "as a teacher I aim to make maths fun and enjoyable and that is what I believe I lacked myself as a child." (Peer to peer video 2)

Not all the participants had poor prior experiences however, several explained they had enjoyed maths and one had chosen to study it to AS level. Riley explained that they: - “feel quite confident with maths and I enjoy the subject because I did further maths at school, so I have a bit more subject knowledge of it. It wasn’t new to me.” (Peer to peer video 1). Piper in the peer-to-peer video 1 explained that: - “my initial reaction is a happy face as I enjoyed learning maths, especially at primary school, and it was enjoyable, and I want to do the same as a teacher myself.” Piper also used words such as “interesting, exciting and confident” in their journey map at the end of the course, so had maintained their enthusiasm for the subject itself across the three years. Prior experience and knowledge, be it a positive or negative one exhibited a large influence on the way the participants felt about the subject and even impacted on their desire to teach it and the ways that they wished to teach it. The desire and need to make maths lessons an enjoyable experience, (possibly as opposed to the lessons they had experienced) and this being important was mooted by several of the participants at differing points.

Subject knowledge being an important aspect of their future career, was another aspect that several trainees connected back to. Piper, who had obtained an A at GCSE felt that their personal subject knowledge had given them a strong underpinning. Riley who had taken Further Maths to AS level (Advanced Subsidiary Level) stated: - “because I did further maths at school, I have a bit more subject knowledge of it” (peer to peer video 1) This gave them a sense of personal confidence in the subject right from the start. For the participants who had struggled with the subject, such as Harper, a very honest and reflective approach was observed, “I know that I need to brush up on my subject knowledge” (reflection) and in their reflection Indigo similarly admitted “I have a way to go to develop my subject knowledge”. At the early stages of the course, not all participants knew or understood the terminology of phrases such as subject knowledge, so care needed to be taken to ensure clarity in my interpretation regarding what subject knowledge was. As time progressed their grasp and understanding of educational terminology strengthened and extended, as the word clouds demonstrated.

This theme has considered the prior experience of the participants, their reactions to the word maths and the relevance of subject knowledge to them.

5.5.2.Theme 2- Pedagogical Content Knowledge (PCK)

This theme relates to the trainees' perceptions around the process of teaching maths to young children and the pedagogical content knowledge (PCK) that they would require to do this effectively.

Several of the trainees focused upon the notion of "explaining" maths to children and recognising that this might be a difficult aspect for a novice. As Sam stated: - "It is the explaining it to the children that is my worry" (peer to peer video 1) and Harper explained in their reflection that they were: - "…worried about being able to explain things to children in a way that they can grasp". Riley (even with strong subject knowledge) stated that in the first peer to peer video: - "I am just a bit nervous to teach it as I feel it might be difficult to get it across to older children, I am not sure I know how to explain things well yet." Riley was perhaps thinking that teaching the younger children would be easier to do, as the concepts were 'easier', indicating an adherence to a myth around the subject, an unconscious incompetency, this is a topic that will be explored more fully later.

However, others focused much more on wanting to make the experience of learning maths enjoyable for the children. Gerry stated in the second peer to peer video: - "as a teacher I aim to make maths fun and enjoyable and that is what I believe I lacked myself as a child." Umber reflected that they needed to "have to get into the swing of it – need to get the children actively involved – actions- chanting out loud etc", Umber wanted the children engaged in the learning, clearly unsure as to how or with what but recognised that a classroom learning experience was collaborative not a solo performance. Piper, at the very beginning of their journey in the first peer to peer video, stated that: - "I hope I can be confident and good at teaching it and the children and myself both enjoy it."

The notion of enjoyment for the children, as part of the teaching and learning experience as well as the teacher, resonated with several of the trainees.

Even at an early stage of development, some of the trainees noted that teaching maths to others and 'doing' maths themselves was not the same thing, so began to separate subject knowledge (SK) as an entity from pedagogical content knowledge (PCK). Umber stated: - "However, remembering it (the maths) and teaching it are two very different things." This was in a reflection after their first experiences in a

school. Piper made it clear that they had changed their perspective after their first full teaching practice. In the initial peer to peer video and sculpture session they stated: - “I hope I can be confident and good at teaching it and the children and myself both enjoy it.” However, after placement 1 in their reflection, they then reasoned: - “However teaching children maths I think, is very hard.” Again, hinting at a movement away from unconscious incompetence. Gerry, after their first teaching practice expressed: - “At the start I had no idea how to teach maths or what approach to take …”. However, after first placement they began to understand that subject knowledge and pedagogical content knowledge were linked as they needed to understand the content in order to teach it and reflected in the journey map that; - “I finally understand maths now and the importance of teaching it well.” Indigo also recognised that there was a connection between subject knowledge and pedagogical subject knowledge: - “I can use my knowledge of maths and use the activities and experience that I have learnt in the past to go forward with this.” Indigo’s background was from a private childcare nursery perspective so felt that they could build on from the experiences they had previously.

The trainees had a complex relationship with pedagogical content knowledge, at the very start they knew they wanted to give their pupils a positive and enjoyable experience of being taught maths, often better than that they recalled receiving. However, what that might look like or how to communicate that was a mystery, with naïve assumptions made, especially early on in their training journey.

5.5.3.Theme 3-Competency Awareness

This theme explores the notion that some of the trainees held at the start of the course, that teaching 3–7-year-olds maths would be quite easy, as the maths subject knowledge requirements for that age phase is quite straight forward. The theme title links back to the theoretical framework discussed in Chapter 2. This literature suggests that people embarking on a new learning experience tend towards over confidence in their own skills and knowledge and do not know what they do not know. The movement from unconscious incompetence to conscious incompetence and then to conscious competence can be traced through the trainees' comments.

Indigo had been a nursery practitioner previously and so had thought this prior experience of teaching maths to very young children would be sufficient to support their initial development. However: -

> "As the lessons progressed, I became more worried about teaching maths in Key Stage 1 especially due to the number of different things that needed to be taught through the year and how the lessons were structured and delivered to a class. It wasn't as easy as I had thought..." (Indigo)

This was written in a reflection after spending time in a school observing, supporting and then teaching some maths lessons during the first year of the course. The key phrase 'It wasn't as easy as I had thought" confirms that Indigo in the early stages of the course had been in an unconscious incompetence state, very unaware of their own ignorance and then quickly became aware of the things they did not know, so moving into the second and third aspects of the CCM.

Piper had obtained high GCSE results in maths and suggested at the start of the course that they felt comfortable about the subject and the prospect of teaching maths was not daunting (words such as 'interesting', 'exciting' and 'confident' were utilised and they created a smiley face as their initial sculpture). However, in their final sculpture for the second peer to peer interviews, the image was significantly different: -

> With the first sculpture I had a smiley face because I felt quite confident about maths and was confident teaching maths and then now, I have made one with a 'wiggly' face as sometimes I am alright with understanding teaching maths and how to explain it sometimes, I am not… (Piper)

The recognition that the process of teaching maths to make it accessible to children is more complex than just knowing maths yourself through subject knowledge is evident. This clearly reflects the CCM journey, and this is echoed again in the IPA interview data sets.

Piper also reflected that they had assumed teaching the younger children would be 'easier' and that in fact, they had found much harder than anticipated.

> In EYFS I think maths is broken down into simple steps and it is the first time they have encountered things. I find it quite hard to break things down into easy to explain steps as I am quite good at maths myself. Whereas in Years 1

> and 2 teaching them maths like through PowerPoint, because like they have already got some knowledge and prior knowledge, I feel like I am better at teaching year 1 or 2 than I am to Reception. (Peer to peer video 2).

The notion that it is more difficult to break down the pedagogical content knowledge to teach children who have no prior knowledge at all than it is to teach building on the input of others, is one that reoccurred with several of the trainees. Riley was similar to Piper, had studied AS level maths and had made similar assumptions around how difficult the teaching aspect would be: - “Coming into university I felt confident with maths. After placement in Y1 I felt much less confident, I had a few lessons that didn’t go well, and I found it more difficult to teach maths than I had thought.” Riley was clear that they had not really understood enough early on in their training and that their initial over confidence was misplaced. In their journey map, they stated “but my confidence is real now and after all my training I now know what I want and understand how to teach maths and how to break it down.” The suggestion of ‘real’ confidence as opposed to the unconscious over confidence from the total novice, ignorant of what they do not know, is evident here.

Viv was another initially superficially confident trainee who had been personally successful in maths and appeared to be confident, but admitted in their journey map towards the end of the course that they had a steep learning curve after their first block placement. They stated: - “Deflated after Y1 block placement still enjoyed maths but felt that I wasn’t good enough at teaching it, I thought it was going to be easier than it was, picked myself up and grew more determined to finish the journey that I’d started.” This also resonates with another comment from Viv who initially early on in the degree, felt that: -

> I enjoy maths, I found it fairly easy, especially where there is only one correct answer whereas in other places you might have more of an opening question like in English, where it is like grammar and there are loads of different ways to do grammar, whereas maths it is like just that is it, that is the answer. (Journey map).

Maths has tended to accumulate myths around it (Boaler, 2009, Ernest, 1996) suggesting that is somehow different to other subjects and this is what leads it to be perceived as more difficult or less difficult for some. At these initial stages Viv had

been seduced by this maths myth, potentially from both naivety and unconscious incompetence. Many of the trainees exhibited unconscious incompetence at the start of their journey.

5.5.4.Theme 4-Scaffolding

This theme relates to the type and sources of external support and guidance that several of the trainees commented upon, during their maths training journey. The range of support mechanisms were wide and are explored in turn.

All trainees receive in school mentoring support, often by their class teacher or another senior teacher within the school. The mentors conduct lesson observations, hold coaching sessions and are a general in class guide and support to trainees.

Viv stated in their journey map that: - “Year 2 placement-very supportive mentor - figured out what worked for me and the children ...” It is interesting that Viv comments on the mentor considering what worked for both the children and the trainee and viewed the teaching aspect as impacting upon both groups not just that of the trainee needing development. Sam, in their map, saw their mentor as an inspirational figure and someone to emulate: - “Y2 placement mentor – Loved her style, and made maths really practical, short inputs and interesting. The input can be made practical and interesting and fun for the children.” Riley was similar “Mentor was supportive, gave me ideas and links to resources etc” (journey map). Piper stated on their journey map: -Used my PD time in Y1 placement to observe maths as was struggling – this helped me greatly to see others”. They found observing other teachers and noting down the strategies that they deployed helpful and scaffolding for their own teaching.

However, other trainees took inspiration and guidance from different sources (hence the title for this theme- a ‘more knowledgeable other’, this phrase stems from the sociocultural work of Lev Vygotsky (1980). He developed the notion that knowledge can be created when supported and scaffolded by more capable peers or, by ideas and resources that are better informed and able to support and extend personal understanding.

Riley found resources such as books and online subject resources supportive: - “White Rose scheme (a well-known published maths scheme) in Y2 helped with

planning and understanding of delivery in maths “and “subject knowledge was developed further using the Derek Haylock book” (both from their journey map). Derek Haylock is the author of a book about effective maths teaching for trainees and it is the book recommended to improve all trainee’s subject and pedagogical content knowledge (Haylock & Manning, 2018). Umber too felt that knowing where to find resources and what type of resources to use had helped them develop: -. “I know how to access resources much better now, all of this enables me to teach it much better, so I am feeling much more confident...” (peer to peer video 2). Indigo recognised that input from both the mentor around what to do and how to do it and then where to find resources had aided them. They commented: - “I am now extending that knowledge, of both my subject and my teaching knowledge, thanks to the mentors and the resources that I am now aware of.” (Peer to peer video 2).

Finally, several trainees linked their growth in understanding back to university teaching sessions. Viv commented in their reflection that they had applied the university input on CPA methods into their own teaching and planning: - “Learning concepts such as using concrete, pictorial and abstract (CPA) teaching has boosted my confidence and I am starting to gain a better insight into how children learn.” Umber stated in their reflection that: - “My subject knowledge has developed immensely during maths lectures- bringing it back to me.” Gerry in their reflection noted similar movement in their understanding: - “Gained lots of subject knowledge during lectures”. They could then apply this improved understanding to their own teaching.

The trainees clearly utilised a wide range of scaffolding and support mechanisms to develop and improve their teaching skills and their maths knowledge, both subject knowledge and pedagogical subject knowledge. Covid 19 meant that the range of maths resources available to the trainees online and often for free expanded hugely and many of the trainees took advantage of this to develop themselves.

5.5.5.Theme 5-Critical Incidents/Personal Responsibility

This theme links to the notion promulgated by mathematician John Mason (2002b) that teachers can have specific ‘critical incidents’ in their maths teaching that impact upon them and can directly lead to a change in learning or a recognition that more

learning needs to happen. For several of the trainees there were ‘critical incidents’ that happened and led them to make a change and take greater personal responsibility for their learning, to take action to address the specific need or issue that had been exposed.

An example of this is from Gerry and their journey map: - “I attended a staff training event on how to support in maths. Trainers were asking staff to join in and demonstrate the ideas using times tables. My times tables were poor, I felt so embarrassed. I realised, at the moment that I needed to practise before next placement.” This is an example of a ‘critical incident’, the participant being asked times table questions in an open forum with teachers present, led to Gerry feeling embarrassed at their lack of speed and knowledge so this encouraged them to really work hard on this area prior to starting on their next school placement. Thus, taking greater responsibility for their own mathematical development.

Covid 19 and the requirement to combine teaching online to children at home, with live classroom teaching as a trainee, provided critical incident moments for two other participants. Viv commented on their journey map that: - “During Covid I home schooled my nephews. They didn’t enjoy learning, especially maths and together we worked on developing ways to make the learning fun. Eldest went back to school excited to do maths as we had both been working on times tables and both them and I were more confident in maths.” And Harper stated in the second peer to peer video: - “Covid helped me gain confidence in learning to juggle online and face to face and I also supported in Key Stage 2 which helped me gain confidence”. Harper had previously stated that the thought of teaching maths in Key Stage 2 filled them with ‘fear’.

Sam had a critical incident when they had a poor lesson observation early in training which led them to consider in their second peer to peer video: - “I need to make sure that I use the correct vocabulary and key words, explaining everything very carefully. They need this to ensure that they can follow and understand me in order to get it right.”. Ensuring they are careful when planning and well prepared to teach in detail is an essential aspect of teacher training, Sam obviously noted this feedback and developed and extended their understanding to avoid this type of issue happening again.

5.6.Conclusion

This chapter has explained, developed and evidenced the key themes raised by RTA analysis of the data sets. These data sets were the ones developed and envisaged specifically to ameliorate my influence as tutor and assessor/insider and allow the journey of the trainee to be explicit and front and centre. The journey of brand-new primary trainees from unconsciously incompetent novice, with negative views from their own past and overtly simplified views about the value of both subject knowledge and pedagogical content knowledge has been mapped. The word clouds exemplified the move from being scared and naïve to erudite and reflective. The scaffolding by others, deployment of a range of resources and the application of 'critical incidents' which helped to move trainees forward to a position of dawning conscious competence has been explored. The next chapter will examine the data set findings elicited by semi structured interviews using the IPA methodology. This extends the narrative further with the participants' self-reflection on their trainee journey and then beyond to graduation and the gaining of QTS and a class of children of their own.

Chapter Six

6.Findings-IPA Research

6.1.Introduction

The aim of this chapter is to provide an interpretative and phenomenological narrative of the findings from the IPA semi structured interviews held with each of the eight participants. There were multiple layers of interpretation, especially as the 'triple hermeneutic' occurred. I was making sense of and interpreting the participants' historic recollections and memories of phenomena that had occurred up to four years previously and then their current experiences as a qualified class teacher. It is a cyclical process, with the reader, who must make sense of the researcher, who, in turn is making sense of the participant, who is already making sense of their phenomena (Smith et al., 2022). Again, this chapter's purpose to is explicate the findings, so no links are made to literature at this point.

6.2.IPA Analysis

The process of analysis began as per the recommendations of Smith et al., (2022) and explained in the methodology chapter. Close reading, and re-reading of each case, occurred on several different occasions after the initial transcription process. Then exploratory noting took place, and this considered my own reaction to the transcripts and the thoughts of the participants. These notes focused on language, semantics and my personal initial reactions.

Further re-reading and consolidation of ideas occurred, and re-reading of the exploratory noting led to the construction of experiential statements. These statements were more interpretive and less obviously descriptive than the exploratory notes and I began to coalesce them together and group into wider concepts and themes.

In order to be totally transparent, and in line with my personal axiology (and IPA standards) to remain close to the participant's idiographic journey, I have included one example of the IPA data process (table 13). Below is a table with Piper's

dataset, with the interview transcript in the centre, the exploratory and then experiential statements on either side. The highlighted parts of the commentary were the sections that I felt held the most powerful, relevant and informative quotations to highlight key ideas or potential themes. There are also exploratory notes that journal my personal thoughts/recollections as a researcher or aspects to alter for the subsequent interviews that occurred to me during the interview process.

Table 13

Piper's IPA Data

Dataset for Participant Piper (Piper's comment in italics)		
Experiential statements	Commentary transcript	Exploratory notes – initial thoughts and personal reflections
	Kate Aspin That's good. So, if you remember, you know way, way back in first year you made models of how you felt about maths. So just to start off with tell me a bit about how was maths for you at primary and secondary school, did you enjoy it, what was it like as an experience for you?	Nervous – I needed to be more specific in question.
"THEN" PRIOR EXPERIENCE SUGGESTING A CHANGE LATER	P *At primary school. I absolutely loved maths.* *I understood maths then.*	I understood maths 'THEN'
	Kate Aspin What made it enjoyable at primary then?	
	P *I think, just a creative way that they used. So, we did a lot, lots of practical and then we did, we applied it to the visual.*	Creativity engaged - enthused/strategies applied.
	Kate Aspin Right.	
PCK IMPORTANT TO TEACH IN AN ENJOYABLE WAY	P *And then we did problems. So, like in year six, it was about all about word problems. But it was made fun. It was just very creative, and my teachers taught it in such a fun way. I just love maths. I understood maths and yeah, I just got it.*	Maths is something you can just 'get' or not get. Worth exploring
MATHS MYTH-POTENTIAL?	Kate Aspin Good. So, what about secondary?	
	P *I think up to year nine, I was fine. I was in one of the top sets for maths, so I did enjoy it, but then….*	
EXAMS - PERFORMATIVITY-NO FUN	*Because it stopped being fun, in Y10 and 11, because we were focusing on GCSE's, it was a lot of exam papers, I think.*	Stopped being fun – is maths supposed to be fun? Exams/no fun
	Kate Aspin Yeah.	

PCK VITAL-OR GAPS	P *It was just it wasn't taught in a creative way, some of my teachers, they didn't explain things properly, so there were gaps in my learning. And that meant in year 11, when we were learning techniques and more advanced things, I was behind.* Kate Aspin Because you had gaps? P *Yeah. Yeah. Well, my misconceptions were addressed because I had a maths tutor. And then my mum was doing maths with me at home because I didn't understand it. So, because I was doing maths all the time, but in different ways, I stopped enjoying it.* Kate Aspin It just became something you had to do to get through it, to get the GCSE? P *Yeah, yeah. Exactly. And then I then I did it for A level. Don't know why I took it for A level, but I did!* Kate Aspin So did you sit that? Have you actually got a maths A level? P *I think I dropped it in the first year of 6th form so no.* Kate Aspin And what made you drop it? Did it just did it just become a chore and not enjoyable? P *It would just not enjoyable, and I didn't really understand it and I was just I found myself, just struggling with maths.* *I think I think I like things that are black and white, so I used to like maths because it was either right or it was wrong, whereas English it was all over.* *And like you had to write answer the question in a certain way, but they were like lots of different answers, whereas it was just black and white.* Kate Aspin So did you go off it when you found that it was less black and white and it was a little bit more, it could be this, it could be that could be the other, do you think? P *Yeah, I just didn't feel comfortable.* Kate Aspin And so when you started on the course at university and we did, you know, we made our sculptures you seem to be quite mixed about your feelings at the time. P *Yeah, was very up and down.* Kate Aspin	Understanding need for clarity in delivery – what does properly mean? Home life link-family support scaffolding – enjoyment seems central to P 's philosophy. AS level Probed Maths myth/misconceptions – one right way – When it stopped being like that – ran out of steam? Could have probed more here. 'What does comfortable look like- missed opportunity to probe.
FAMILY INVESTMENT IN MATHS-MATHS HAD VALUE TO PIPER'S FAMILY		
DROPPED A LEVEL - STRUGGLED WITH THAT LEVEL OF MATHS		
MATHS MYTHS-CCM		

MATHS IS CREATIVE AT PRIMARY -PRIOR EXPERIENCE LINK-BEEN SUCCESSFUL AT THIS STAGE TOO?	Was it the thought of doing maths again that put you off or was it thought of teaching maths? How? What was the difference between the two, do you think? P *I had mixed feelings because I had lots of memories going back.* *Primary School was the fun, creative side of maths, I think.* Kate Aspin Umm.	I needed to be more precise here. Drawn to primary as more creative?
INTIMIDATED BY THE THOUGHT OF PCK	P *I'd been so used to math being more advanced and quite tricky. And because I lost the passion for it, I think I was scared to teach it to primary school children, fearful it would be like it was for me towards the end.* *The maths A level was so advanced and then going back to the basics and then having to teach someone, was scary.* Kate Aspin That makes sense.	Thought that loss of passion would be contagious. Was not the maths itself but the TEACHING maths that caused fear.
SK CONFIDENCE STRONG	P *The basic method of maths in say reception seemed ok, like I can count, I can add 10 confidently. That bit didn't worry me.* Kate Aspin Yeah.	
PCK HARD WITH V YOUNGEST-CCM AND MYTHS	P *But the idea of telling teaching someone how to tackle addition and subtraction right to 10.* *I just was scared that I don't know. I wasn't scared. I was more worried that I wouldn't be able to do it and that they wouldn't understand the maths because of the methods to teach it.* Kate Aspin So you were quite confident in your subject knowledge, but what worried you then was the pedagogy. The pedagogical subject knowledge, wasn't it? You knew what to teach them, but it was the how to teach them bit that was harder? And you hadn't done any of that at that early point.	
SK v PCK	P *Yeah. I knew the maths but not the how to teach them the maths bit.* Kate Aspin So what about during the course then? Were there any kind of critical incidents or things on your placements or in lectures or things like that? What would you say sort of helped you along the road, in your	Refection:- Already worried about letting children down because of a lack of PCK knowledge at the early stages of the course.

	understanding? P *I think obviously learning about maths in uni helped, lectures and study but then applying it so in my first-year place but I think.* *There was quite a lot of lessons in that first placement.* *Maths lessons that my mentor said that were too long.* *And she said that they weren't effective.* *She told me that you did the input and then the product. There was no practical side, so they weren't applying what they've done. So, they didn't fully understand.* Kate Aspin Right. P *Well, and I think when I look back about what we learned at university, we learn about the abstract pictorial. No, actually concrete too. Yeah, the methods for pedagogy. I think that's when my understanding increased.* Kate Aspin What helped do you think? P *I don't know. Teaching maths became easier because I understood that the children had to do it practically first.* *Yeah, I think and that's what I use in my teaching now. So, we do it on the board, but then I also model it practically so they can see. Both pictorial and concrete.* *We do it so they see it on the board and then they do it practically and it's from modelled examples. I understand that is a good way for them to understand it, as I do too.* Kate Aspin What do you use? Do you use White Rose and things? P *We follow White Rose, but we follow it loosely like so it's meeting the needs of our children.* Kate Aspin That makes complete sense. P *We don't do it in their order. We don't do it structured; we just do it to fit the needs of the class.* Kate Aspin Yeah, that's makes sense. You meet the needs of your kids first that that makes perfect sense. So, looking back now then, you talked about your earlier days, and I've got your little journey map here and you talked about being in early years and then being in the year 2 on practice?	I needed to be more direct in questioning. Secure with SK but not with the PCK Role of mentor strong here- Understanding the process of teaching and supporting a trainee CPA-PCK Thought processes – linking own development and the children's learning. Probed here. Children and needs come first the scheme fits around them.
UNI LECTURES SCAFFOLDED MENTORING – DEVELOP THE PCK		
PCK- CPA		
MENTOR GUIDANCE PCK VITAL		
CPA-PCK		
MATHS SCHEME- ALLOWED SOME FLEXIBLITY		
PCK -CHILDREN'S NEEDS COME FIRST		

	P *Yeah.* Kate Aspin Which was obviously very different. P *Yeah*. Kate Aspin And then how was it on your final placement maths? How did you find it at that point? P *It just clicked. I think being in year two it was very different because it was more in yes that we did it practically. And then this whole question, but I was able to go round the year two class and I could see, and I could do many plenaries with them, so the and I did find teaching year two easier than EYFS at that point, but I liked all my placements.* Kate Aspin Oh yes, it's very structured in Y2. P *On my last placement I learned a lot, but I've kind of in my teaching now incorporated what I've learned from my class now and placements.* Kate Aspin Can you give me an example? P *Like doing the inputs on the screen, making it interactive, but then also my first-year placement where they did a lot of practical and teaching on the carpet and less of an input. So, I've kind of combined being in two different settings, two different early years classrooms. I've kind of combined what I've learned from both of them and put them into my teaching.* Kate Aspin That sounds very reasonable, P to be honest. Sounds very sensible, because I agree with you, I'm not a massive fan of it all just being on the screen, like the practical too. P *It's important for children to see maths done in different ways. So, like when we were doing it, when we were learning about the numbers to 10, we did not go straight into the abstract.* *So, we initially watched the number blocks (tv programme) so that they could see the two number blocks added together and how they could be joined.* Kate Aspin Excellent. P *Through the number blocks that they love, that's just their interest at the moment. And*	Found Y2 easier than EYFS. Knowledge and processes Better probing PCK and SK and experience Maths terminology very confident use Resources practical, able to be flexible – knows instinctively.
FOUND STRUCTURE IN Y2 COMPARED TO UNKNOWN PCK IN EYFS PULLING THREADS TOGETHER FLEXIBLE WITH PCK APPLYING KNOWLEDGE ACROSS REFLECTIVE – PCK DEVELOPING CCM		

TECHNICAL KNOWLEDGE OF PCK	*then we also learn some songs. So, I learned one on placement and if you rhyme with the children, they know them off by heart and sing when they play. And then we also did it on a 10 frame, so using different coloured counters to make the additions. But then we also used numicon as well.* Kate Aspin Do you like to use a range of resources? P *And then we use like different items, so it wasn't just always pegs on the 10 frames. Sometimes it was linked to our focus story, so if it was Jack and the Beanstalk, we did magic beans or golden eggs.*	Confident use and knowledge of supporting resources
EXAMPLES FROM PRACTICE OF APPLYING PCK AND SK – MOVE TOWARDS UNCONCIOUS COMPETENCY?	*And then with the new Reconreks and I showed them different ways. So, if they were struggling, they could use fewer and then I try to differentiate and challenge the highest.* *So I think it's important that children don't just see one way of doing it. They see lots of different options.* Kate Aspin And lots of reinforcement in lots of different ways? P *Yeah.* P *And the application as well in continuous provision, they've got access to all of the objects and all of the maths things that we use, the equipment.*	PCK growth Probing
CURIOUSITY IMPORTANT	*And it's just nice to see them using it. And sometimes they don't always get it, but the fact that they try and are curious about maths is important.* Kate Aspin Does curiosity in maths matter to you? P *Yes, they're independent learners. They like to explore.*	Curiosity matters to P. Probing question
SELF EFFICACY GROWTH	Kate Aspin So, do you, do you feel like you're putting across a confident maths teacher persona when you teach them? P Yeah. P *There are times I think, this was such good lesson. The children have learned, I think. And then there's some that I don't feel as confident with, sometimes when reflecting.* *I think, oh well, I could try this or this, but I think.* *That's part of being a teacher. You always learn, and even when you're like when you're older and you're teaching, I think.* Kate Aspin	Reflective and growth in self-efficacy -honesty Self-awareness

RECOGNITION OF NEED FOR REFLECTION AND CPD – TEACHER MATURITY CCM	But no, I think from what you've described is cracking practice. P I don't think you should doubt yourself at all. P *Oh, thank you*. P *I think in quite a lot of teachers, they get fixed on this way works. I'll do it this way. But you've got to meet the needs of your children. It might work one way with one set of children. It might not work, so you change it.*	Reflective and flexible thinking
ACKNOWLEDGES NEED FOR REFLECTION AND ADAPTATION	*P* *Maths is always evolving. You always finding new strategies and different things that might grab some children and not others. So, like, some of my children that struggle with maths and showing them the part/whole model so they struggled to add 2 numbers on a 10 frame but when they had the two circles and the whole number at the top on a part whole model, they because they could see it more clearly they could tell me independently what the sum they'd made.* *When we put a number of counters in each of the circles and then it had to add to the same number at the top, it made sense and whereas on a 10 frame they needed quite a lot of support.*	New strategies learned and applied.
FLEXIBLITY NECESSARY- EXAMPLES		
DESCRIBING TEACHING STRATEGIES	Kate Aspin Yeah 10 frames could be quite abstract, can't they? P *Yeah.* Kate Aspin So if someone said to you would you be, the maths lead, would you? P *I think eventually I would like to be a maths lead; I think.* Kate Aspin It's not put you off. P *I Well, if I was a head teacher, I'd want someone that was experienced, as it is a core subject, it is too important to be in inexperienced hands.* *I will in the future I would like to be one, but I think.* *I need that experience in teaching and maybe another subject first, being a subject leader before I take maths on.* Kate Aspin So like a foundation area first? P *Just from working quite closely with the last maths lead on my last placement, I think she did find it quite stressful and there was always lots to do. There were*	Need to probe – less description of teaching process – bigger picture. Reflective – still unsure of self Leadership potential

PERFORMATIVITY RECOGNISES TOP-DOWN PRESSURES	*things that were changing all the time, it was busy.* Kate Aspin But it's not put you off. P *No, I actually quite like it myself. I think because I'm more confident at teaching it and I had to push myself out of my comfort zone.*	Performativity culture -time and workload
	Kate Aspin What do you mean by that? You're more confident in teaching it?	Challenge self to develop.
REFLEXIVE AND RELFECTIVE PRACTICE	P *Was quite daunting, but this year I've been observed in maths twice for my observations and because I've received really positive feedback, they've said that they like the way I've used my input on the board, but also linking it practically so they can see it two different ways and the way that I do it. So, I had to give them my planning and they could see progression and the children were not just learning it one way and then moving on. They will be learning the same concept in lots of different ways and consolidating.*	Probing question
PERFORMATIVITY – OBSERVATIONS POSITIVE OUTCOMES	Kate Aspin And that went down well with the leadership?	
	P Yeah. positive feedback, I think it did increase my confidence and thinking back to where the children were in September, there was some children, well, most of my children couldn't count to 5 and now we're adding numbers to 10, they are adding different numbers. So, they're adding like nine and three, they're taking away too, and some children can share, they can write the sum too, they've just come such a long way.	Probing
SELF EFFICACY FROM THE CHILDREN'S PROGRESS – ABLE TO STAND BACK AND SEE	Kate Aspin That's excellent. P *Seeing that progress and seeing them learn, and at the end of the lessons, being able to achieve the learning objective, I think it's just increased my confidence. So, I do actually quite like teaching maths now.*	
UNDERLYING TRUTH?	Kate Aspin Excellent. So, if you're going to tell somebody, how does how does it feel to be confident in maths? P *I think.* Kate Aspin Because everybody uses that word, you say and talks about it, but I want to know a little bit more about what? What does confidence mean to you? In maths.	Suggests that at one point they did not like it. Justifying myself and clarifying

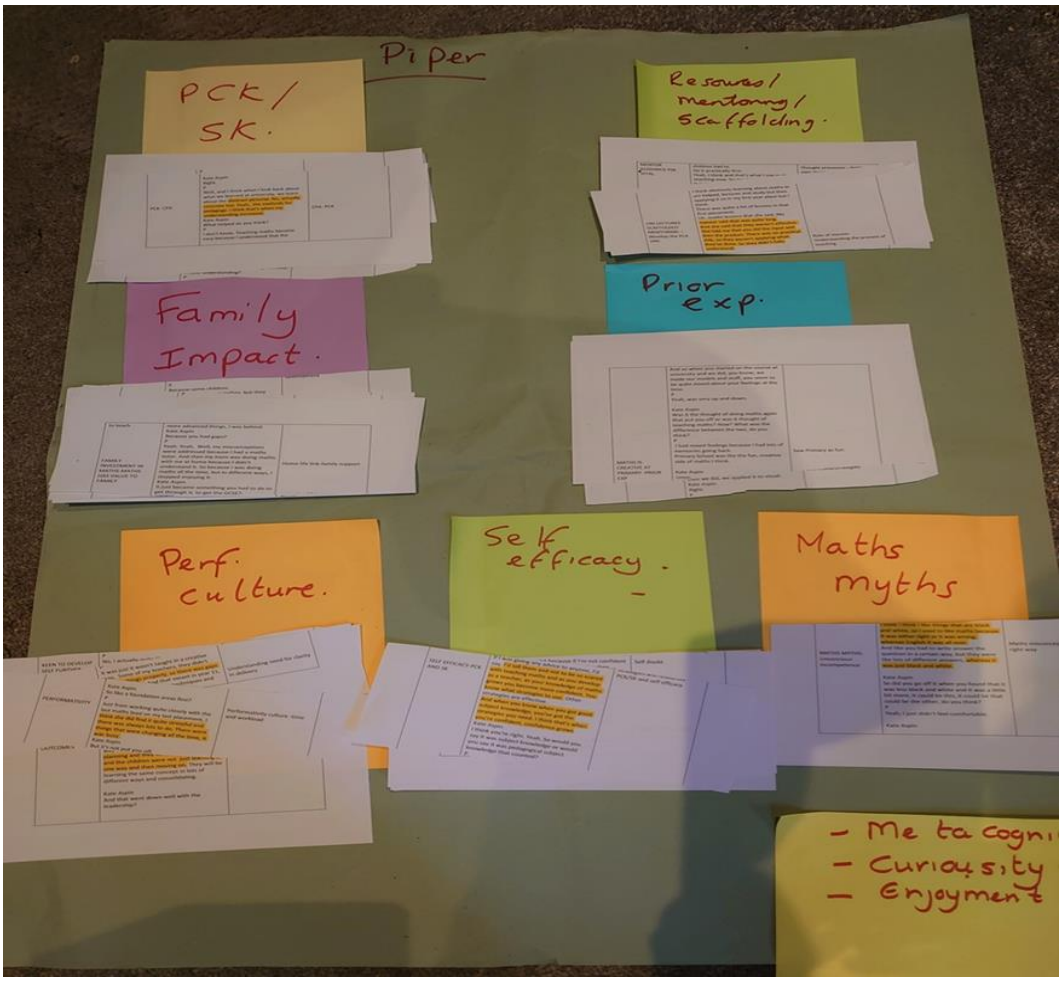
SELF REFLECTION ON SELF EFFICACY – HINTS ON PERFORMATIVITY PRESSURE AT END	P *It means a lot because if I'm not confident in it, I doubt myself and that's when….* *Some of my teaching is perhaps not the best because I'm trying to put on act, I'm trying to overdo it.* *But because I'm confident in the teaching I must know what I'm doing? I've planned it in my head the night before. How I'm going to teach it, what I'm going to use my lesson, objectives that I need, as I need to hit the lesson objectives. The children need to achieve.*	Self-doubt -and then reflection
SCAFFOLDING SUPPORT FROM TEACHING ASSISTANT	*And the strategies that work for my class and the use of the TA as well.* *She's been a massive part of it. I have quite a lot of children that struggle with understanding, so when they're in the big the whole class input, they get lost. So, the fact that they do it, with the TA, they follow in my input, but by doing it practically, these strategies work for those children, and they've come on so much, I think.* *If I was giving any advice to anyone, I'd say, I'd tell them and not to be so scared with teaching maths and as you develop as a teacher, as your knowledge of maths grows you become more confident. You know what strategies to use. Other strategies are effective.*	Other adult support important Personal growth – knowing strategies and resources. PCK/SK and self-efficacy
SELF EFFICACY-PCK AND SK	*And when you know when you got good subject knowledge, you've got the strategies you need. I think that's when you're confident, confidence grows.* Kate Aspin I think you're right. Yes. So, would you say it was subject knowledge or would you say it was pedagogical subject knowledge that counted?	Probing the SK v PCK
PCK AND SK REQUIRED	P *You mean in first year?* Kate Aspin Well, all the time in maths to become more confident. What do you need? Do you need both? P *I think you need both. It needs strong subject knowledge. You need to know what you're teaching. You need to know. You need to be teaching the children the right things in maths.* *But you also need to know how to teach, so you need to know what strategies are effective, what to do when they get stuck. So, I think it's a bit of both.* Kate Aspin I would agree. P *Yeah, I think as well with I think going off*	Need both.

IMPORTANCE OF HOME LIFE	*tangent here, but… I think homework is a massive part of maths too. And the children going home and apply what they've learned in the lessons. Some of my stronger children in maths, they've got it in the lesson and they're really confident with it, but they, like I said, they've gone home and tried it at home, or they've done something similar in choosing time they struggle. I think the children that are curious about maths and eager to learn, just have the passion for maths.* Kate Aspin That is in itself is good because we know that maths and home lives are not always great, and people don't always talk positively about maths. So that's really good. P *Yeah.*	Home life? Impact? Support? Maths myth? Born not made?
HOME LIFE/FAMILY SOCIAL IMPORTANCE OF MATHS	P *I think it's important that the parents understand as well. So, we did a maths workshop on Tuesday, and we showed the parents what we did in maths and why we did it this way and then the importance of maths games with them and there were quite a lot of parents didn't really know, they didn't have the knowledge of maths. So, they were trying to teach them like in September how to add to how to add 2 numbers together. But because they didn't have the basic knowledge of how we start to teach them it didn't work well.* Kate Aspin The children were not ready for that you mean. P *Because some children.*	Importance of parental influence and support but they need PCK as well.
NEED TO WORK WITH FAMILIES	*They add numbers together, but they don't understand the meaning of it, or I think it's really important to work with the parents as well. And so, they have an understanding of what we are trying to do.* Kate Aspin Do you find your parents are negative about maths or are they OK? P	Family support and development is an important aspect of being a teacher.
MATHS AND FAMILY-NEGATIVE ATTITUDES - RIGHT ANSWERS	*I think quite a lot of my parents. They struggle with maths. So, I always put on video of how I want the maths done for their homework, and the parents watched that and then copy it. I think some of the parents are scared to let their children explore with maths and some of the videos I get sent back are very much a do this then do that. The parents want them to focus on the answer.* Kate Aspin Brilliant that you do a video!	Some families struggle with maths and PCK strategies.

FAMILY-LACK OF PCK KNOWLEDGE CANNOT SUPPORT	P *There's quite a bit of … No, you're doing it wrong, and that's just not how the children learn, they need to experiment.* Kate Aspin Do you think that's because the parents are nervous about doing it wrong themselves and they're sticking to what they know because it's the only way they know it? P *Yeah.* P *Yeah, definitely. I think they're also because they want the best for the children and I think they think that if they get it right all the time, that's really good. But if they make mistakes, that's like a really bad and that isn't what we say these days.* P *And trying to explain to the parents that actually mistakes are good, especially in maths, because*	Maths the right and wrong myth supported by parents. Probing Maths teaching has changed. Not all about right/wrong answers
THE MYTH OF RIGHT/WRONG PARENTAL VIEW	*there's so many times you say, Oh, just have another look at it or oh is that right and they look at it again.* *They can do it, and work it out, whereas if I just went, oh no, it's this and move the counters or just told them the maths sum.*	
FAMILY MATHS – SOCIAL ASSUMPTIONS OF MATHS	*Then they're not actually learning from it, it's from them making the mistakes that they're learning!* Kate Aspin Absolutely.	
METACOGNITION	P *Asking them to have another look at it, they can see where they've gone wrong and it's creating that independence that independent learner in maths as well.* Kate Aspin Yeah, it's being brave to know that I can change an answer and it is ok. P *Yeah*. P	Metacognition
STRONG PCK STRATEGIES	*Because I model as well, I pretend that I've done it wrong like the children. Like, tell me what I've done wrong, and it is an increase in their confidence and because their confidence has increased, I think they are more engaged in the learning*. **END OF INTERVIEW**	Importance of independent learning

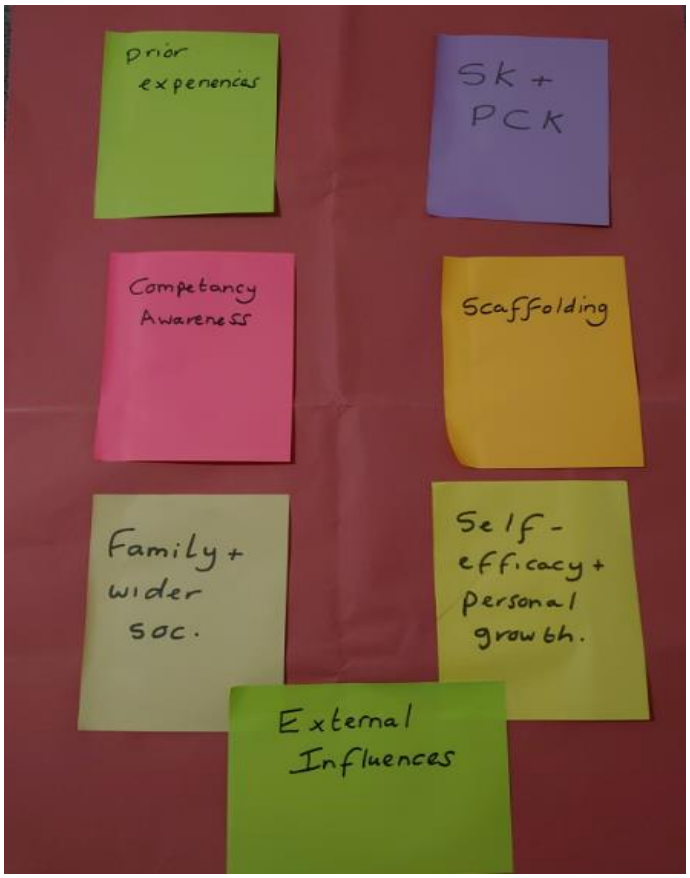
The next stage in the evaluation process was to cluster the experiential statements together under a broader heading that fitted together for each person, these are the Personal Experiential Themes (PET). Personal, as at this stage, these themes applied to the person and were idiographic. Experiential, as they related directly to the phenomena or the lived experience of the participant and themes as they reflect groupings of ideas rather than just individual statements. This was conducted in a very 'physical' and pragmatic manner. The interview transcripts (such as the one illustrated above) were cut up under the experiential statements strands and then grouped on large sheets of paper and under large post its with potential theme titles. This enabled 'playing' with the ideas and themes and allowed for refinement and the ability to stack ideas and sub themes together. An example of this stage is illustrated below (figure 24).

Figure 24:- Example of Personal Experiential Themes (PETs) Refinement Process



This system of grouping and labelling became the process of developing Group Experiential Themes (GET). Participants' individual PET maps were compared, and similar themes were then scrutinised, and similar themes were amalgamated together and others that were too idiographic or specifically individual were then rejected. See image below of final GET themes: -

Figure 25:- Final GET themes



This was in order to produce a coherent and meaningful data set. IPA focuses on the lived experienced of the individual and so it was important to ensure that the "idiographic is honoured" (Smith et al., 2022, p 101). However, it was logical to attempt to also rationalise the overarching themes to match with the RTA themes as presented in the previous chapter. Smith et al., (2022) does state that there is no single 'right way' to present findings and as the RTA data stems from the same participants, just from a different point in time and experience, it made logical sense to see if the same thoughts and issues were interwoven into the whole of the trainee's journey to teacher and beyond. It was also interesting to see if time had

changed and impacted upon any of their viewpoints and their own reflections on the evidence presented from their earlier data sets.

Table 14

RTA and IPA themes

RTA Theme	**IPA Group Experiential Theme**
Theme 1 Prior Experiences	**Theme 1** Prior Experiences
Theme 2 Pedagogical Content Knowledge (PCK)	**Theme 2** Pedagogical Content Knowledge (PCK) and Subject Knowledge (SK)
Theme 3 Competency Awareness	**Theme 3** Competency Awareness
Theme 4 Scaffolding	**Theme 4** Scaffolding
Theme 5 Critical incident/ personal responsibility	*Rejected as no new critical incidents were reported that were different to the RTA exemplars*
External influences:-briefly identified by 2 participants in the RTA data but insufficient to be a theme at that point.	**Theme 6** External Influences
	Theme 7 Family and Wider Society
	Theme 8 Self-Efficacy and Personal Growth

There are some slight differences in the themes, because the RTA datasets relate to the training period and the IPA to the post training and fully qualified period, and these will be explored in greater depth as each theme is discussed. There are also two new themes in IPA that did not arise in the RTA sets. Theme 7 stems from reflections by participants about their own families and growing up and their domestic attitudes towards maths and attitudes of the families at their schools around maths today. Theme 8 is focused on self-efficacy and personal growth, and

this came directly from the RTA evidence base. In some of the RTA data, self-confidence as a term was repeated by participants as something they needed and often perhaps lacked. I felt this needed greater probing and so one of the questions within the semi structured IPA interviews addressed this notion of confidence and growth and the responses to that question, now form the new theme 8.

Each IPA theme will now be explored in turn, utilising direct quotes from the participants from their IPA transcripts.

6.2.1.Theme 1-Prior Experiences

All of the participants discussed their prior experiences of maths in the IPA interviews. Memories varied however, from positive to negative and many now viewed their experience through the lens of a trained teacher, looking at teaching methods deployed as much as the role of the teacher themselves. These differed from the previous RTA dataset, which tended to be more emotive and linked to the personality of the teacher.

Harper and Gerry were both mature trainees (over 21 at entry), so their recollections went further back to the 1980s and 1990's but both tended to focus on the way things were taught: -

> I think looking back, I think it was probably the way that everything was taught in one manner. And you're like, going to school in the 80s, things were taught in a very set way. You know, it was this way or no way. And so, for me, I don't think the specific way was always a way that agreed with me. It was workbooks and moving along at your own pace, nothing like today. (Harper).

Gerry recalled the ability grouping system at primary school that clearly impacted on them in a negative way: -

> I remember in primary school we got put into groups. Obviously, we wouldn't know that was what happened, but that's obvious as I am a teacher now. I know what was happening. So, we had the higher group and the lower group basically and we had like an intermediate as well. Then in year five I went to the bottom group, and I think as a child I just knew why I was there; I wasn't good at maths.

Ability grouping clearly had an impact on their self-efficacy even at primary level, and this contributed to their self-labelling as not being good at maths.

Sam suggested the same but within a secondary school context, the idea that ability grouping and others being aware of your group level was humiliating to them, the manner in which it was carried out made the feeling worse: - "I think I was kind of in the bottom ability group because what would happen sometimes is the teacher would then pick us.[Children selected for extra support or intervention groups as had not been successful in the lesson] It was sometimes four of us from that class and then we'd go out of the class…. And I'd really feel it, embarrassed, everyone would see."

Viv had not commented on their education previously in the RTA data but in the IPA interview they were keen to explain that: -

> I loved maths and always have even though I was always further behind than everyone else because I'm summer born. I was very aware that in many subjects I was behind…, But maths on the other hand, it was a universal thing and there was only one right answer e.g., 5 and 5 = 10 and you could not go wrong, that really helped me.

The notion of maths having only 'one' right answer is a maths myth that we will return to explore later. This notion that maths is somehow different to the other curriculum subjects resonated with Umber, who stated: - "I was never a mathsy person. Never. I was one of those children. You get literacy or maths? I was a literacy." And: - "I hated it. And even through high school, I had to really revise, really revise for maths because it just didn't come natural to me." This concept that rather than having maths anxiety as such (no participant mentions maths anxiety as an entity) but instead some of the participants appear to be more comfortable with the idea that people split into 'maths people' and 'non-maths people'. This is clearly a myth but gives participants a feeling of comfort and allows an avoidance of feeling odd or different no matter which side they feel they fall on.

Several participants said that they had enjoyed maths at different points and most of this appeared to be to the teaching strategies (PCK) deployed, Piper stated: -

> At primary school. I absolutely loved maths. I understood maths then. [they were asked why?] … just a creative way that they used. So, we did lots and

> lots of practical and then, we applied it to visual… But it was made fun. It was just very creative, and my teachers taught it in such a fun way. I just loved maths. I understood maths and yeah, I just got it.

This remembrance of enjoyment and fun being tied to maths was echoed by Riley: - "I had one particular one (teacher) in the year 9. They made everything quite memorable and quite fun, so I could remember the concepts that I needed to. When you go through things as many times, and you aren't made to feel stupid."

The idea of being "made to feel stupid", or "humiliated", or as Gerry stated: - "I didn't contribute, in case I was wrong. I wouldn't feel confident to contribute because I wasn't sure if that was the correct answer." Sam commented: -I'd really feel it, so embarrassed, everyone would see." This sense of being made to feel different had commonality across the group, the deployment of ticks and crosses, verbal answering, group labelling or 'on the spot' contributions caused the participants to stand out and feel awkward and vulnerable in maths lessons, something they remembered, sometimes ten or more years later.

For all participants, prior personal school experiences with maths had clearly impacted on them. The semantics of their interviews were often loaded with strong emotional language and strong positive or negative feelings when talking about their own historic school experiences. The desire to ensure that the children they were now teaching did not have such negative experiences in maths and that their teaching should be an enjoyable experience , was a thread across both the IPA and RTA data sets.

6.2.2.Theme 2-Subject and Pedagogical Content Knowledge

This section examines the participants' understanding of the necessity for Subject Knowledge (SK) [The maths knowledge] and Pedagogical Content Knowledge (PCK) [the how to teach maths knowledge]. Every participant was directly asked what they felt the difference was between the two and which they felt was more important. This stemmed from my curiosity after the RTA datasets, as it was clear that their understanding of the educational terminology had expanded greatly over the course of the three years on the degree, and I wished to explore further and probe their understanding. The RTA data set theme 2 is only labelled PCK as at that point the

then trainees were unable to discern clearly between the two terms. In the IPA interviews the participants explained the difference between the two terms and had strong views on what they felt were the priorities, but no one suggested either aspect was not helpful, it was the degree of necessity and the timings that varied.

Piper was very clear on the need for both: -

> Think you need both. It needs strong subject knowledge. You need to know what you're teaching. You need to know it. You need to be teaching the children the right things in maths. But you also need to know how to teach, so you need to know what strategies are effective, what to do when they get stuck. So, I think it's a bit of both.

Whereas Viv was very explicit about why to them, PCK is the most vital: -

> No, being good at maths and being good at teaching maths is a totally different thing. You know, amazing PhD standard mathematicians will not be able to teach that to primary school children. They're the best at doing it, but they can't do it, break it down, teach it.

For Viv, knowing how to structure the knowledge to communicate it well to children was vital. Viv was teaching in a class with a high level of Special Educational Need so for them the notion of breaking down the learning to make it accessible for all was central to their current thought process.

Sam felt that strong prior research and personal responsibility on the topic material was most vital: -

> Firstly, I learnt that as a teacher, as long as your subject knowledge is secure, then I felt really confident because before I taught any math lesson or any topic in maths, I'd always make sure that I researched it enough. I know it well enough so I can address any misconception and I'm confident to teach all the abilities. And so, I think because of that, I felt so much more confident teaching maths.

To Sam personal confidence stemmed from knowing where the children might go wrong and how to correct it. For them it was key subject knowledge which built their own self efficacy; this is something that will be returned to within the self-efficacy theme.

Several of the participants stated that they had expected the university maths sessions to be like their school experience and focus on maths as a subject, so were surprised when it instead focused on PCK. Umber talked about their expectations: -

> I think you go to a maths lecture in uni, and I don't know what I was expecting. I don't know if I was expecting you to stand there and teach me maths the subject and do tests. Or if I was expecting you to teach me how to teach maths. So, I think when it was more of teaching you how to teach maths. You relax a little bit…. And understand more… I think the stuff that you did at uni helped. On how to teach it and what was expected of a maths lesson and the do's and the don'ts and things like that.

This comment suggests that the manner in which the ITE maths curriculum content is communicated to the trainees at the very start of the course needs to have greater explanation and clarity. Umber was clearly unsure what to expect in terms of content and in terms of teaching strategies. This will be explored again within the recommendations for future practice section.

Riley reflected that, although they had a good level of qualifications and subject knowledge in maths, the teaching aspect made it a totally different experience: -

> I think in terms of my own knowledge of maths, I felt like I had a decent grasp of subject knowledge but then to try and teach it, I think that was a whole kind of different ball game. Obviously, I was secure in my own knowledge. But then to try and understand what's going on in my head, to try and get it across clearly to a class, or a group, that was a big deal.

For Riley it was the PCK and the actual process of transforming the knowledge into teaching that was central.

Several of the participants talked about the importance of continually developing and improving both their SK and their PCK and taking personal responsibility for this.

Piper said: -

> If I was giving any advice to anyone, I'd say, I'd tell them and not to be so scared with teaching maths and as you develop as a teacher, as your knowledge of maths grows you become more confident. You know what strategies to use and what are effective.

Indigo had been a supply teacher for a while when they first gained QTS and felt this had improved both their SK and PCK:- "So over the time, where I got to go around the school and teach a range of maths in different classrooms, it basically then got me to an understanding of:- well it just continues to build on each other, like the bricks in my house!" (a direct reference to the sculpture they had created – see the findings of the RTA research, Figure 23).

6.2.3.Theme 3-Competency Awareness

This section considers the notion of the Conscious Competence Matrix (CCM) as explored in Chapter 3. As the IPA interviews were with the participants as fully qualified practicing teachers, and no longer novice trainees, the focus was on their reflections and if they could recognise their previous lack of knowledge and understanding. This reflects that at this point, (according to the matrix) they will have moved from an unconsciously incompetent position through consciously incompetent and onto consciously competent qualified teachers.

Two participants reflected on teaching the very youngest children and how they had originally thought that this would be the most straight forward maths teaching in comparison to older children, but in actual fact: -

> …I think laying the foundations in maths is almost harder. Those early concepts. Subitising and counting. They have to be done right. Much easier when they are secure and teaching them new bits and pieces to complement what they've already got. You've got to literally go in at the absolute baseline of it all. And start from scratch, that is hard. How do you start from scratch? Because that's actually a really difficult thing to do. But you know this whole subitising and the oneness of one, twoness of two, you know, it's like, oh actually this is different, so new, so you're almost learning over again with them. (Harper)

Harper had taught Key Stage Two children unexpectedly on their second placement because of Covid 19 factors altering her class and enjoyed it but reflected that they had thought it would be harder than it actually was. Instead, it was the Nursery and Reception classes that they found more challenging, for the reasons given above.

Piper had taken maths to a higher level in terms of qualifications and so when going into Reception classes they initially felt: -

> The basic method of maths in say Reception seemed ok, like I can count like I can add 10 confidently. That bit didn't worry me… But the idea of telling teaching someone how to tackle addition and subtraction right to 10. I just was scared that, I don't know… No, I wasn't scared. I was more worried that I wouldn't be able to do it and that they wouldn't understand the maths because of the methods I'd used to teach it… I knew the maths but not the how to teach them the maths bit, properly.

Both Harper and Piper acknowledged that originally, they had not considered how difficult it might be to teach the very youngest children and to start them on their maths journey, they had assumed it would have been easier, based on the level of subject knowledge required. They were unaware of the complexity of the PCK required. Umber summed it up, stating: -

> …. being higher up school in maths is probably easier because you told more, you are fed more. You know what you are doing and what comes before you and after. But then when you're in Reception and Nursery more so Nursery, I think. It's very much right. Well, they need to know that DM [Development Matters] aspect, how are you going to get it in there? If they've got a basis to build from, it's a lot easier than when they haven't. and you haven't in Nursery, you ARE the base and need to get it right…

This attitude did surprise and intrigue me, it was unexpected as I had expected trainees who had focused on 3–7-year-olds in their training to be daunted and possibly in awe of the maths taught higher up into Key Stage Two. The notion that in fact the beginning stages of maths knowledge are more difficult to grasp has potential implications for the ITE maths curriculum and how it is sequenced and taught that will be explored later in the recommendations section.

Maths mythology, the notion that maths is 'different' to other subjects and has specific traits that apply uniquely to maths, occurred in the IPA interviews as well as the RTA research.

Viv [who made a point about maths being different in their RTA] also talked about their prior experiences and why they liked maths more than English: - "Maths on the

other hand, it was a universal thing and there was only one right answer e.g., 5 and 5 = 10 and you could not go wrong."

Piper echoed this when they stated: -

> I think I think I like things that are black and white, so I used to like maths because it was either right or it was wrong, whereas English it was all over. And like you had to write answer the question in a certain way, but they were like lots of different answers, whereas it was just black and white….

Viv and Piper both enjoyed maths as a subject and very much felt this idea of right/wrong and clarity helped them understand the subject, even if the notion is mythic. Maths can be as ambiguous as any other curriculum subject and indeed requires teachers to present a range of strategies to solve problems.

Umber embraced the myth that there are 'maths' people and 'not maths' people and that they themselves were very much a literacy person: - "I was never a mathsy person. Never. I was one of those children. You get literacy or maths? I was always literacy…."

Acknowledging the idea of a myth that some people are 'maths' people and some are not allows the individual the 'excuse' that they were not good at maths for a reason, and it is nothing to do with them as a person or the effort they put in. Preferences for subjects may be binary but knowledge and skills are not and transcend narrow curriculum labels.

6.2.4.Theme 4-Scaffolding

All the participants were keen to talk about what supported and guided them to improve either their SK or their PCK in maths, during the degree course and in their first year as a teacher.

The process of teaching full maths lessons on placement was fundamental in developing the understanding of SK and PCK in several participants. Umber, when asked about what they felt had the most impact on their maths teaching, stated: -

> But I think when it came to me personally, I could sit and watch literacy like a lecture at uni and understand it, be fine. History. Geography, the same…. But I think with maths, from my point of view, I needed to do it. And needed to be

> thrown in and needed to just do it and I needed to make mistakes. Because with maths, I think it was very much you're saying that this is working for you, but will that work for me? And until I tried it at a placement and thought oh, yeah it does. That's when it went in and that's when it was learned knowledge, solid.

For Umber, the lectures and time spent exploring PCK strategies only became real and highly relevant once in placement at school. However, the notion of maths being an exceptional subject and somehow 'different' to others to both teach and learn runs through their comments. Harper, similarly, felt like the placements brought all the learning together: - "The getting stuck in, being able to apply the things we'd read, and you'd taught us, joining it up…"

Viv, who originally stated they were confident with maths, found their first placement difficult: -

> I remember the first-year teaching placement, I found it quite difficult because I knew how to do the maths… But I couldn't seem to get across how to say it to them, the explanation of how to understand it … I enjoyed placement as a whole, but it kind of like put a dampener on it (maths) made me feel like I couldn't do it… I had a lot of work to do, you know, to improve...

Viv acknowledged that they had to improve their PCK in order to explain and help the children to understand, and that the second and third practices were both much better because they had understood this and taken greater responsibility for their learning.

Sam felt it was the range and variety of placements, observing other teachers teaching maths that helped them: - "I would say my placements definitely made a big difference... I think going into different schools and just seeing the way teachers do things differently, like different maths schemes, you see so many different techniques... And yeah, different teachers as well. So that was really useful."

For others it was the knowledge and support of their mentor while on school placement that made a difference to them and their maths teaching.

Piper had clear recollections of first placement, and feedback from their mentor: -

> There was quite a lot of lessons in that first placement. Maths lesson feedback. My mentor said that was quite long. she said that they weren't effective. She told me that you did the input and then the product. There was no practical side, so they weren't applying what they've done. So, they didn't fully understand… Teaching maths became easy because I understood that the children had to-they had to do it practically first…

In this case focused mentor guidance enabled Piper to structure their lessons effectively, to support the children's understanding and improve their practice of maths. Mentor feedback reverberated through Piper's practice, to their current practice and beyond. They have followed this advice about lesson structure ever since. Piper stated: - "That's what I use in my teaching now. So, we do it on the board, but then I also model it practically so they can see…"

Riley had a similar early experience in a maths lesson on placement:

> Everything was just like it just seemed to go wrong. Like I knew what I wanted the children to know, but getting that out, making it clear, it just got so muddled and confused. And yeah, it wasn't, it wasn't a pretty lesson.

Again, granular advice was dispensed by the mentor and when asked what advice they would give a new trainee, Riley said: -"When on placement, just don't be afraid to give things a go, if things go wrong, then just reflect on them, because that's the way you learn, listen to your mentor, take their advice".

Mentoring support, direction and redirection had made an impact on both Riley and Piper and was something that both had carried forward with them into their full teaching roles.

Several of the participants explained that their own research, such as reading, finding on-line sources, and using maths teaching schemes had supported and scaffolded their maths teaching and personal development. This surprised me as researcher, nothing that I had researched had suggested this route as central in supporting development or knowledge acquisition. I had anticipated mentoring, placement and potentially university taught sessions supporting as themes but not independent research and online resources. This has implications for ITE practice in general and for the ITE maths curriculum and will be discussed in Chapter 8.

Sam felt that personal research helped them: - “I think normally when it was when I was planning, I'd say it was me because I'd always research, I'd read lots of things on whatever that topic was. I'd research and I'd read up loads on that topic. And so, I'd make sure I was really secure.”

Indigo also felt that personal research and online schemes and sources helped increase their knowledge, especially of PCK:-“ We had a lot of available information online with say White Rose, you've got Primary Stars, we've got Classroom Secrets, all those, help you know what to teach and then how to and with what resources, all helpful.”

Indigo expressed the view that during and post Covid on-line support had really improved, and they felt that: -

> There are lots of different places where you can access material and sources that sort of build upon each other. That mean that again obviously with the planning and the resources and the explanation that comes with them, there's an easy sort of route to go and find that information to better understand than there used to be.

This knowledge of the wealth of independent sources of support and resource was especially important to Indigo. They had been a supply teacher across a range of schools so needed their own resources and access to support more than the participants who had been working at one school with set resources or schemes. Independent research such as described above allowed the participants to improve their knowledge privately and not be exposed to public gaze or potential judgment by others such as colleagues, mentors or school leaders. This is important as previously noted that judgment, humiliation and shame feature strongly in the characteristics of the participants’ prior experiences, so personal and private research to improve their SK or PCK is a valid and sensible reaction to avoid this type of feeling.

University taught sessions were mentioned by several participants, often in the context of a ‘launchpad’ that started them off in their development of understanding.

Piper stated: - “I think obviously learning about maths in uni helped, lectures and study but then applying it… I think when I look back about what we learned at

university, we learn about the abstract, pictorial. No, actually concrete too. Yeah, the methods for pedagogy. I think that's when my understanding increased…"

Harper similarly suggested that the university sessions are a useful starting point: - "I'm glad I did the course, because it just taught me so much. I think in uni and blending it then. You give us where to go and what to do, but it's about being able to put it in practice and putting it into practice is so important."

All the participants were acutely aware of their need to learn and to keep learning. They valued the range of support mechanisms and resources that had been available to them as trainees and, recognised that as independent fully qualified teachers' continual development of knowledge and having a wide range of support and knowledge sources was essential.

6.2.5.Theme 5 – occurred only in the RTA data

6.2.6.Theme 6-External Influences

Within this theme the role of external pressures and influences, such as curriculum constraint, performativity and observation and inspection culture will be explored. In the RTA dataset an aspect that was mentioned by two trainees was that of curriculum constraint. This was insufficient in number to constitute as a theme but however was valuable as it suggested the direction that the IPA data would then take. The notion that lack of time and pressure to cover the curriculum content led to decisions being made about curtailing content or rushing through some content therefore not spending the time that the trainees felt was needed to really teach some aspects in sufficient depth and to ensure the children fully understood. Harper reflected that: -

> Would like more time to investigate in lessons, so that I feel more competent at teaching – struggle to break down EYFS and KS1 -With younger children, where there was no prior learning, knowing how to chunk down the learning into small enough steps was a challenge, in so little time. (RTA data)

They felt that they had to keep moving the learning on at a pace regardless of the child's particular needs.

Umber felt similarly constrained by the 'White Rose' maths scheme that their school had implemented and the way that it was organised. "Placement in Y2 – I thought the lessons didn't give the children enough time to learn fully." (RTA data)

Umber felt that the lessons did not dwell on the key concepts for sufficient time to become fully embedded with the children. The suggestion that the pressure of the speed and coverage required by the maths and the wider curriculum can distort learning was encountered by trainees at relatively early stages of their development. This is a surprising finding because I had expected the trainees, at this point, to be so focused on their own learning and own journey as not to notice the wider, systemic pressures from curriculum load and performativity and only discover this once in the classroom, full time.

Unlike in the RTA data, it was not surprising that these reflections arose more comprehensively within the IPA data, as the participants were now all classroom based full time teachers and so were facing the same challenges that are widely recognised by the teaching profession.

Two participants focused on the necessity of time and the pressure to cover the curriculum regardless of the children and their needs. They felt rushed to move on through the curriculum rather than spending the time that they deemed to be necessary to develop the children's understanding fully.

> Gerry explained: - But the pressure is to keep moving on. I don't feel like I've got time to take it as far back as where they need it to be… And I'm struggling with that at the minute, struggling. It's like mind over matter and I don't know what to do for the best and my team partner,[the other teacher who teaches the other side of the year] who is wonderful and amazing, she wants us to just get through the curriculum for the coverage, but I really want to unpick it…. the coverage and trying to get that in, that's the one thing I'm really finding hard…. [the other teacher] She's struggling as well. We are struggling together…

Riley was in an EYFS class and felt strongly that time needed to be spent on the development of early number understanding and not rushing to cover larger numbers: - "…That the getting that really in-depth knowledge of the numbers from one to 10 rather than rushing too soon, what we do is really important." Sam was

also in an EYFS class and felt similarly about a new maths scheme that they were doing: - “We think it's too challenging for Reception. So, we do have to kind of break it down and it moves quite away from the Early Learning Goals. It's on things that they don't really need to know, and Reception really needs to focus on their early number...”

All three had experienced the pressure of curriculum coverage demands at the expense, in their eyes, of the children’s full and in-depth understanding.

Harper and Umber both indicated that school leadership styles and structures tended to dictate teaching styles and pedagogy. Harper, (who had been a teaching assistant prior to training, and had worked in a greater range of schools) stated: - “You must be flexible, adaptable, and just when you think you've learned something, you go to a school and they're like, no, no, no, we do this here. We follow this one (scheme) and we do it like this. So, you are learning all over again to fit in…”

Umber was describing practice and pedagogy, but their final sentence was very telling: - “Make it interesting. Don't have them sit on the carpet or at tables for the full hour maths lesson. Because you're not going to get anything from them at that point. Be flexible. If your leadership will allow that….”

This suggests that Umber had already realised that teaching pedagogy is very much a hierarchical notion, and that pedagogy and practice needs to be given prior approval from the school leadership.

Viv was the only participant to mention Ofsted (The Office for Standards in Education, Children's Services and Skills) as their school had been inspected earlier that academic year. They talked about their mentor allowing them time to take the learning back a step: -

> My mentor going look, you can't move on until they've got it. She goes, you can spend all year on it if needs be. If they get it, fantastic, but you can't move on because they won't be able to build on top of the basics, this was the need, the basics….[I then asked why they felt their mentor was like that] Because we've just had Ofsted and got a good, which was a relief, and I was so pleased that I was an ECT …

Having had their Ofsted inspection was for Viv, a pressure release, they could now focus on what they felt was important, in terms of learning that benefited their class.

Viv and Indigo both discussed the pressure of teaching observations, the stress they felt but also the relief they felt when the feedback was positive and affirming.

Indigo described their first maths observation in their current school as: -

> My first observation was a maths one and I genuinely walked into that meeting, absolutely defeated, thinking that my lesson was terrible. And then the head teacher turned around after I'd waffled on for about 5 minutes and said right, just stop. Let me read you the feedback and it was massively positive. Of course, there was a couple of development points on there because that's the idea, but that shocked me as it was so positive.

Viv described the university tutor observations and the ones they now have in school as: - “where you come in and observe because it was quite, quite scary because even when I get observed now it's like oh, I still don’t like it, stressful.”

All the participants acknowledged the wider performativity culture in schools and felt various aspects did impact upon them and the pedagogy that they utilised. This ranged from the type of scheme deployed, to the time spent developing understanding and, at times, the frustration they felt when restricted by the ‘conveyor belt’ system of the curriculum.

6.2.7.Theme 7-Family and Wider Society

This section focuses on the participants’ views of their own home lives as children and their families’ views around mathematics. It also then considers the participants’ views of the wider public attitude towards maths that they were seeing in the families that they were now teaching.

The first section of this theme considers the participants own family life, their childhood, and the prevailing attitudes towards maths.

Harper and Indigo both acknowledged that maths was not a high priority in their own childhoods. Indigo stated: - “It wasn’t a thing at home” and Harper said their family were much more literacy focused and avoided maths: - “I think that it just wasn't given priority and I think that's possibly to do with how they felt about it as well.”

Viv’s family were not educationally minded, it was not a priority: - “. No one did work with me if I'm home. And I would never as a child to do homework. And because no

one was bothered, and as long as I was doing OK in school, they didn't realize, it wasn't something they thought about…"

Gerry linked their attitude to their mother's view: -

> My mum always used the phrase 'I never had any confidence in maths either' saying it was like me and I never had any confidence in maths, and I think it had a knock-on effect then, I just never really had much confidence and that I was like my mum.

Interestingly the two participants with the highest levels of maths qualifications stated that they had family support, although this did not always have the most positive outcomes.

> Piper explained: - my misconceptions were addressed because I had a maths tutor. And then my mum was doing maths with me at home because I didn't understand it. So, because I was doing maths all the time, but in different ways, I stopped enjoying it…

Riley had domestic support too, but with different outcomes: -

> My mum was very like hands on, wanting us to do well in everything. And obviously with that in terms of maths, she'd always push to make sure we were doing things right and getting make sure homework was complete. She was a support. Not sure she always felt comfortable herself but was supportive.

Two contrasting experiences, one where a family supported, and the participant felt positive from that experience and one who was supported, and it had the opposite impact.

Some of the participants explored the attitudes towards maths that they had noted in the parents and families of the children that they were currently teaching.

Piper had completed a maths workshop day for parents and reflected: -

> I think it's important that the parents understand as well. So, we did a maths workshop on Tuesday, and we showed the parents what we did in maths and why we did it this way and then the importance of maths games with them and they were quite a lot of things parents didn't really know, they didn't have the knowledge of maths. So, they were trying to teach them like in September

> how to add to how to add 2 numbers together. But because they didn't have the basic knowledge of how we start to teach them it didn't work well… I think it's really important to work with the parents as well. So, they understand what we are trying to do… I think quite a lot of my parents…. They struggle with maths.

Piper went on to explain that their parents tended to focus on children getting the 'right' answer and saying things such as: - "' No, you're doing it wrong', and that's just not how the children learn, they need to experiment."

This view coincides with one of the maths myths previously explored in theme three, that maths has one singular answer and way of reaching that answer, when in current maths teaching the notion is that many different strategies need to be explored and explained.

Harper was the only participant to explore the impact of Covid 19 and teaching children online, whilst parents were watching and listening to the teaching input.

> That was a real learning curve, especially as you'd got the parents at home listening in. So, I've really had to make sure that my subject knowledge was up to scratch because I thought if you've got parents at home that are good at this stuff, you know, listening in, I've got to make sure that I'm absolutely spot on. So that was quite a big pressure….

The participants clearly have a variety of family experiences, both in and out of the classroom, but the overarching notion that maths is 'different' to and from other subjects, and receives a different reaction from the wider public, especially parents in this case, appears to still apply.

6.2.8.Theme 8-Self-Efficacy and Personal Growth

This section explores the participants' own views of their development and growth and considers the question that they were all asked regarding self-confidence. This question emanated from the RTA data set, as the word confidence was raised in these many times. I therefore thought that the notion was worthy of probing and further discussion and asked a direct question in the IPA interviews.

The majority of participants took the question to mean self-confidence relating to their teaching, only Viv took it as thinking about themselves and their own journey in maths. They stated (in response to me asking what confidence in maths looked like):

> It didn't bring me down when you got it wrong. If you'd go up to the board and you'd do an answer and it was wrong, it wasn't awful it was, OK, let's unpick this together. And it was the I've got it wrong, but I know now how to do it right…. that is confidence…

The notion of resilience and knowing how to overcome obstacles occurred with several of the participants.

Gerry, who had been one of the most negative and fearful at the start of the course, stated: - “Yeah, yeah, I've come a long way. I was terrified to go into KS2 and even into Y3! I would have a good go at it, and I would unpick it and I would do, you know what I mean? I would. I would have a go at it. I would get my teeth into it…”

Indigo was similar: - “I think it means it's more of I feel like I can always have a go at it. I'm always willing to have a go at it. And then I feel that obviously with my confidence, I'm mostly successful with it as well, it is that having a go, not being defeated…”

Riley felt that confidence was: -

> Just have a go because you never know until you do. You try and then if it doesn't go right, then look back, what do I need to do to improve? Do I need to practise more? Do I need to look at this?... it's just been just not being afraid to give it a go. Build your confidence up and get lots of resources to support you. They really help….

Being able to reflect, change and not being afraid to seek help resonated with all these participants. Metacognition also stands out, the desire to challenge yourself and to not be afraid to get things wrong which is inspiring, both as a teacher and a learner.

For Umber and Sam, they both felt that to be confident at teaching maths you needed to have obtained a certain level of unconscious competency in the subject.

Umber’s view is a strong description of what unconscious competence could look like: -

> I think confidence feels like you know what you're talking about without having to think about it in your head. And you know what you're doing, and you would be confident enough to show that to somebody else and teach that to somebody else….

Sam stated in a similar way: -

> I'd say being able to teach it and knowing that if a child asked me a question, I'd be able to answer it without looking it up. Yeah. Or if a child didn't understand it, I'd be able to show them in a different way. So, I'd be able to use different methods to show them to help them get to the answer. Having the knowledge inside...

For these two participants confidence in maths involved the combination of SK and PCK with that knowledge having been embedded and practised. Knowing more themselves gave many of the participants greater self-efficacy and demonstrated that they desired an automaticity in their responses and maths knowledge and were on the journey to achieve this.

Several participants ended their interviews with personal reflections of themselves, their confidence and positionality regarding maths at the end of their first full year as a qualified teacher.

Indigo was keen to state that their current view of maths: - *“,* it is now my favourite. I do like teaching maths. I do enjoy now teaching maths and it's also nice that the class that I've got now enjoy the maths lessons.” And even … “I have been asked to shadow the maths lead next year, me, shadow the lead!”

Gerry explained that their journey had changed them: -

> Like maths. Oh, what do we need algebra for, and do we need fractions? Well, actually you do. You really do. It's everywhere. Maths is everywhere and I never understood that in the past. So, you know what my training has done to develop my understanding.

Gerry later confirmed that they had been asked to be the maths subject leader for EYFS and Key Stage One at their school. This cemented their successful trajectory from a GCSE grade D failure and someone who lacked self-efficacy in the subject to becoming a primary school maths leader.

6.3.Conclusion

In conclusion, this chapter has provided a comprehensive analysis of the IPA Group Experiential Themes (GETs) and has utilised the supporting evidence. By grouping and presenting the GETs, valuable insights were gained into the research participants' experiences and perspectives. The inclusion of direct quotations from the IPA interview transcripts has enhanced the credibility and authenticity of the findings, allowing for a more nuanced interpretation of the data.

Through this analysis, recurring themes have been identified, and significant factors have emerged and been presented. These findings shed light on the lived experiences of the participants and offer valuable implications for future practice and identified opportunities for potential future research.

The next chapter will discuss and explore the findings from both the RTA and the IPA research data sets in conjunction with the literature previously explicated.

Chapter Seven

7.Discussion Chapter

7.1.Introduction

The focus of this chapter is to discuss how the research findings explained in chapters five and six explicate and illuminate previous research and the existing body of literature addressing trainee primary teachers and mathematics. Similarities, differences and gaps in knowledge are explored and developed. The research findings will then be considered in relation to the theoretical framework structure of the Conscious Competence Matrix (CCM) based on the work of Howell (1982).

7.2.Family and Wider Social Mythology

The first area of discussion examines the views of the participants around maths and the public perception of maths. In the literature and the media, maths is perceived as specialist, 'geeky' and not for everyone. Several of the participants discussed the attitudes of the parents and families in their schools towards maths and confirmed that they were infused with mythology. Myths such as: - maths is not for everyone, maths comes naturally to some people, and maths is always just right or wrong (Coles & Sinclair, 2022) and these myths tend to stem from a lack of confidence and poor personal prior attainment or experiences. The participants agreed with the findings of the Williams review (Williams, 2008) suggesting that many of the families were not comfortable or confident working with their children on maths and maths homework. Piper stated, -

> I think quite a lot of my parents…. They struggle with maths…. I think some of the parents are scared to let their children explore with maths and some of the videos that I get sent back are very much a, 'do this and then do that'. The parents want them [the children] to focus on the answer… I spend time trying to explain to the parents that mistakes are good, especially in maths. (IPA interview extract)

The participants did not suggest that parents of their classes were avoiding supporting their children with maths, more that the strategies they deployed were different to the types of strategies that schools now use to teach maths, so they did not know how best to support their child with maths and were nervous. Scarpello's work (2007) suggested that parental beliefs towards maths can resonate and reverberate down the generations, so it is important for teachers to communicate the current methods and the pedagogical content strategies that are now used, clearly to parents, to attempt to break this cycle of negativity and lack of understanding. None of the participants said that the children in their classes did not like maths, in fact the participants prided themselves on the positive atmosphere they had inculcated around the subject. However, several did talk about the influence of parents and their reactions to home learning. Harper noted this during Covid 19, when parents were listening in to taught online sessions. Harper felt this put pressure on them to ensure that their teaching was meticulously accurate in terms of subject knowledge but also knew that they needed to teach the maths with the most appropriate pedagogical content to support both the parents and the children in their learning. Harper felt that in maths especially, it was vital they were teaching both the children and their parents the right knowledge and strategies to dispel any negativity toward the subject. This echoes the notion of the importance of metacognition (Education Endowment Foundation, 2021) that children should be aware of their own cognition and the most optimal ways to learn, for example, using misconceptions as learning opportunities, rather than negative experiences. Applying this knowledge to both the teaching and to the way the participants connected with the families they worked with was raised, with Piper stating: -

> trying to explain to the parents that actually mistakes are good, especially in maths…. they think that if they [the children] get it right all the time, that's really good. But if they make mistakes, that's like a really bad and that isn't what we say these days… It's from the children making the mistakes that they're learning…

Parents of the children also subscribed to some of the maths myths that the participants identified in themselves and others, such as maths having 'right answers' and that it is simply 'black and white' and that there are 'maths people' and 'non-maths people' (Dowling, 1998, Coles & Sinclair, 2022). Interestingly, amongst

the participants themselves, these myths were adhered to most frequently by the participants who enjoyed or were more successful with maths as a child than those who were not. Suggesting that the participants needed a 'reason' to be deemed good at maths over others who were less successful, and that was not due to personal effort, or aptitude based but that they were just fortunate to be a 'maths person'. This attitude was most prevalent in the training phase but remained into teaching, but interestingly, the participants did not seem to apply this notion to the children in their care, instead being very keen for all the children to achieve and not applying these myths to their classes. The participants were eager to make the maths experience enjoyable, fun, and to limit the opportunity for exposure and humiliation, and this extended beyond their classrooms to the families of the children in their classes too. Sending home videos to support with homework was one strategy deployed by a participant to support parents, and to try to change mythological attitudes. Other participants indicated they had sent home newsletters or had held parent maths after school training sessions or held family/friend maths open mornings. All these events were held with a desire to inform and educate the parents into understanding the strategies deployed in modern primary schools to teach maths and dispel any socially constructed negative attitudes.

The findings all suggest that the wider societal notion of maths being different and difficult still exist, but this tends to encroach from external sources beyond school, such as the media or family rather than emerging from the children themselves. This may be because the children are too young to have embedded these notions or that the negativity around maths in wider society is decreasing, it is not possible to know within the context and confines of this study. The 'maths identity' of the participants is intriguing as it appears to be complex and socially constructed, and yet intensely personal as the perceptions and mythology that they apply to themselves they do not apply to the children that they teach. They seem determined to not project myths around maths on to their classes.

7.3.Maths Anxiety

The next area of discussion is the concept of maths anxiety, as this is often linked with the previous topic, the societal belief of maths being widely disliked and feared. Literature about maths anxiety is expansive but at times evasive and very fluid. The

rationale for considering this topic was to examine if the early stress behaviours exhibited by trainees during taught maths sessions at the start of their degree were signs of maths anxiety. The work of Geist (2010) and Gresham (2008, 2018) state that maths anxiety in teachers, if not addressed, can be passed on and promulgate the notion that maths is not for everyone and that these concerns could impact on the very young children that the participants were training to teach. Therefore, it was important to probe this notion and see if there was any evidence to support it.

At the start of the study, I was convinced that trainees' emotional outbursts and strong emotive language in reaction to encountering unfamiliar maths, that I witnessed frequently as an initial teacher educator, were an indication of them having maths anxiety. The evidence of participants' attitudes towards maths gathered by the first word clouds showed negative tendencies through terms such as 'hard', 'struggle' 'panic' and 'scared'. However, over time, these expressions reduced and were replaced with more constructive terms such as 'grown in confidence' and 'confidence grown massively'. This concurs with the work of Hoffman (2010) who states that what the teacher thinks maths is, will shape the maths environment and teacher they become, thus the participants changed over the duration of their degree and so did their opinions. As a consequence of my research, I now conclude that participants in this study did not have maths anxiety, in terms of fear of the subject of maths itself. Instead, their emotive reactional outbursts were manifestations of their own poor prior experiences of maths, including their memories of what they felt were poor teaching and weak pedagogical approaches. The worry and fear exhibited by trainees was linked to maths pedagogy not to maths subject content knowledge. It was not the maths that made them worried, but the memories associated with maths lessons and often the actions of maths teachers. As a result of this change in comprehension, I have also reflected on my role as an educator and, that educators should avoid making assumptions about the rationale behind a response to learning but instead work to ascertain what the internal processes are behind the reaction.

The participants explored their prior maths teaching and learning experiences in both the RTA and IPA data, and several discussed the negative experiences that they had previously had with maths, within their secondary schools as pupils working towards exams, especially GCSE exams. This concurs with the work of Hembree (1990) and Lutovac and Kaasila (2011) who explored the impact of negative maths

experiences and stated that the impact of poor school experiences in maths often extended beyond childhood and then lessened into adulthood, and indeed this echoes the findings of the study. Although the participants' past experiences coloured their views and emotional reactions on the subject of maths it was the PCK of the style of maths teaching strategies deployed that caused the intense emotions. Participants use words such as 'humiliation', 'embarrassment' and 'shame' when discussing ability grouping, interventions, and exam preparation. It was the way the particular teacher had dealt with them at the time, and their approach that made the participant feel vulnerable and exposed. As Brown et al., (1999, p 302) stated: - "training must, for many, involve a considerable degree of 'unlearning' and discarding of mathematical baggage, both in terms of subject misconceptions and attitude problems." It was the manner in which the maths had been taught and the teaching strategies deployed, that had caused tension and anxiety and many of the participants were keen to ensure the children that they taught did not develop the same issues themselves. This has implications for ITE programmes as participants may need further guidance on how to avoid using inappropriate pedagogical techniques, both to avoid humiliating children but also to avoid focusing too much on making the lesson fun and not enough on learning. Balance is required to make the maths experience enjoyable, fun, but still rigorous and demanding and limiting the opportunity for embarrassing exposure and humiliation of the children, as this was particularly important to the participants.

While it's difficult to generalise from the small sample of this qualitative study, the research findings indicate that what might initially be construed as 'maths anxiety' in Primary trainees is better explained as an acute awareness of the impact maths pedagogy has on learners' experiences of maths, both positive and negative. This finding has implications for the design of the ITE maths curriculum, which is discussed in the following chapter in Conclusions and Recommendations.

7.4.Subject Knowledge and Pedagogical Content Knowledge

Pedagogy is defined simply in this study as: - "the act and discourse of teaching" (Alexander, 2004, p 1) and the work of Shulman (1986) highlighted seven types of pedagogic knowledge as discussed in Chapter 2. In this study, the pedagogical focus has been on Subject Knowledge (SK) and the relationship maths SK has with maths

Pedagogical Content Knowledge (PCK). Subject knowledge is the content of primary maths, it is the knowledge required to complete maths tasks and to 'do' maths successfully (Rowland and Ruthven, 2011). Pedagogical Content Knowledge is how teachers bridge the gap between the pupil and the subject knowledge. It is the teaching methodology for the subject (Geddis, 1993, Villegas-Reimers, 2003, Bostock, 2019).

Participants' own maths subject learning experiences as children, impacted on the pedagogical content knowledge (PCK) that they wanted to deploy themselves. Some of their negative prior experiences encouraged the participants to reflect on the way that they would teach maths and deploy PCK, and they all wanted to avoid the types of humiliation-based experiences they had felt. This agrees with Muijs and Reynolds 2002 study, their large-scale study of primary teachers and maths showed low self-efficacy was linked to prior negative experiences, and the participants who had negative prior experiences in my study did indeed have lower self-efficacy at the start of the degree programme. The participants wanted to avoid this negativity cycle in their own teaching and replicating their past experiences with the next generation.

During the IPA interviews, the participants were asked which of the two types of knowledge (subject knowledge or pedagogical content knowledge) they felt to be the most valuable. There was no clear preference for either. All felt both were essential, but the balance between the two needed to vary depending on what the participants felt they needed most at that point in the maths lesson. Several participants, such as Sam made strong links between subject knowledge and self-efficacy, they felt if they could support a child with misconceptions and had the knowledge to teach all ability ranges then they as teachers were much more confident in the lesson and felt able to handle anything challenging in that maths topic. Hall and Ponton (2005) suggested those on higher level maths content courses had higher self-efficacy than those on lower-level ones. Higher level courses would require a greater range of subject knowledge than lower-level ones, in the same way subject knowledge and self-efficacy appear to be interwoven. This has implications for trainee's teaching 3–7-year-olds and reinforces the notion that although they will only be formally assessed teaching 3–7-year-olds they still need to have a strong grasp of the subject content to the end of Key Stage Two as the QTS qualification enables them to teach beyond the one they trained in. Muijs and

Reynolds (2002) large scale research on teacher effectiveness in the UK and 'what works' in maths education also concluded that having strong subject knowledge impacted on self-efficacy, with primary teachers who felt they had strong subject knowledge feeling more confident about teaching maths, than those who did not. This strongly echoes the comments of the participants, concurring with the notion that teachers feel more confident in themselves as professionals, if they feel that they know more of the subject content and are able to answer unpredicted questions that may arise or deal more effectively with misconceptions that children may exhibit.

Although SK and PCK are much more tightly woven together in the participants' minds than they initially appeared to be, all the participants valued both types of knowledge and several expressed the opinion that improving their own SK would strengthen their professional confidence by improving their PCK strategies. Teachers need to know the subject content well to be able to be flexible in the type of pedagogy they then deploy, the two are interwoven. Indigo summed this up with reference to their house image, based on their RTA sculpture: - "well it just continues to build on each other, like the bricks in my house!" It is vital for ITE providers to ensure that trainees develop and construct their knowledge of the subject and the pedagogy of teaching the subject together, with neither taking precedence. In the current CCF orientated climate there is a danger that more generalist pedagogy becomes the focus in ITE, and that subject knowledge development and specific pedagogical content knowledge is overlooked.

7.5.External factors and control

This section considers the curriculum that the trainees experienced during their training and their reflections on the types of curricula that they experienced whilst on school placements and reflects on the issues of performativity and external control that emerged whilst on teaching practices and beyond, into their teaching roles.

The ITE maths curriculum the trainees are taught (Aspin, 2022) is a combination of Pedagogical Content Knowledge (PCK) and Subject Knowledge (SK) drawn from the National Curriculum and the EYFS Framework (Department for Education, 2013, 2014). Other aspects of the curriculum link to the Core Content Framework (Department for Education, 2019) and the sequencing and progression have been developed by me as the lead maths tutor for Primary ITE, other university tutors who

teach on the course and some lead maths teachers from partnership schools. Taught sessions are themed and a combination of SK identifying key aspects of knowledge and vocabulary required is taught and then all is linked to PCK. In line with the notion of the ‘connectionist teacher’ (Askew et al., 1997), the trainees are encouraged and guided towards joining specific subject knowledge together, with effective PCK, for example: - the notion that fractions, decimals, and percentages are all of the same origin and require linking together. Within taught sessions, age-appropriate primary school level practical maths resources are shared and uses demonstrated, model lesson sections are demonstrated by, and then practised by the trainees, on each other and explicated together. Every lesson ends with retrieval practice of essential knowledge and links made back to the key text (Haylock & Manning, 2018) for revision and self-audit. Aspects taught in the university sessions are then enacted in the three school teaching practices that the trainees are assessed in.

The participants comments indicate that they felt they benefited from the university taught curriculum, and that it had improved their subject knowledge, highlighted areas to develop and although some (such as Umber and Riley) were initially surprised at the PCK content of the taught sessions, (as they had anticipated the sessions to be purely subject knowledge based and similar to their lessons at secondary school) and they reflected that they found the content of the taught sessions very useful to their teacher development.

However, another aspect of the curriculum that the participants noted as being important to them, was that of external resources, be they practical manipulatives to use to scaffold the children’s learning in class or on-line or book-based resources to support their own independent subject knowledge development. Indigo expressed the opinion that: - “There are lots of different places where you can access material and sources that sort of build upon each other.” The work of Bottle (2005) and Drews and Hansen (2017) considered the importance of deploying appropriate resources both for children and teachers, recognising that children require scaffolding and support dealing with misconceptions. They also highlighted that teachers also require resources for personal CPD (Continuous Professional Development) support and further research. Since Covid 19 the range of on-line support and teaching resources has exploded to the benefit of the development of the trainee and indeed all teachers. The ability to improve both personal PCK and SK and explore practical

resources in privacy and therefore avoiding any external judgement or as previously referenced, the potential for public exposure or humiliation, which is a real concern for participants based on their prior experiences, is seen as a real benefit. This desire to extend and develop their own personal knowledge for their own gain, indicates a movement toward assuming greater personal responsibility for their development, a move into securing a professional identity and professional maturity.

The growth in recent years of a much greater range of resources has led to the creation of more Government approved schemes such as 'White Rose,' 'Power Maths' and 'Maths No Problem.' Schools are now following these and adopting them as their own curriculum, some deploying them in a narrow and performative manner, others more flexibly. The participants, especially as early career teachers, noted some frustration with these schemes and the 'top down' constraints, especially with curriculum time allocation. Some of the schemes had tight timescales to move children on in their learning, sometimes before the pupils were deemed to be ready by the teacher. This was commented on by several of the participants, Gerry stated: - "But the pressure is to keep moving on. I don't feel like I've got time to take it as far back as where they need to be…" This reflects the work of Ball (2003) who discusses the personal anguish of teachers and inner conflict when teachers cannot teach in the manner they would wish to. ECTs (Early Career Teachers) however, have only known centralised resources and curricula from the Core Content Framework in training, schemes of work from centralised maths 'hubs' and the dominant influence of NCETM (National Centre for Excellence in the Teaching of Mathematics) in maths. They are also enculturated into a culture of surveillance and observation, via Ofsted, so that the notion of developing a: - "profound understanding of fundamental mathematics" as Ma (2020) made clear, can be challenging as the teacher is having to move on through the scheme at the speed the scheme and the curriculum decides, eroding teacher autonomy further. The teacher then must operationalise a range of PCK strategies to bridge the curriculum rigidity, in order to be pertinent to the learning needs of the children. It was clear that the participants enjoyed having a wide range of resources and scaffolding available to them to research and expand their knowledge, but did not relish the notion, as stated by McCourt (2019, p 115) that: - "the curriculum moves on like a conveyor belt whether they grip ideas or not…" The participants had to balance their desire to spend longer

on a topic as they felt the children required more input to fully comprehend the content, with the need to move on to the next topic to ensure coverage of the curriculum. However, it was important to adhere to the curriculum plan so that the children would be in the right place in the subsequent year.

These findings echo the points made in the introduction and chapter two regarding maths having a distinct and at times problematic image that has led to more compliance and control being exerted than in other, less high-profile subjects. The participants were conscious and indeed enculturated into a world of data, targets and attempting to ensure every child reached ‘age appropriate’ or ‘greater depth’ in maths. However, their IPA interviews made it explicit that their main priorities remained enjoyment and positive experiences in maths, beyond the formal subject expectations and downward pressure. It should also be remembered that the participants had been trained and on placements with all of these external pressures and so the invisibility and indeed inevitability of performativity measures were ‘normal’ to them and as such just ‘part of teaching’ not something other and external. The participants also appreciated the wide range of freely available independent professional development resources, and this empowered them to take charge and extend their own knowledge base, many of which were part of the maths schemes as discussed. Despite the presence of performativity caveats and curriculum controls, which did impose certain limitations on their teaching freedom, and were acknowledged, the participants did not perceive these constraints as overwhelming or excessively intrusive, at this point in time.

7.6.Conscious Competence model-CCM

The CCM, as previously discussed in Chapter three, is based upon the accumulative work of several people and business organisations, most notably that of Broadwell in the 1960s, Burch in the 1970s and Howell in the 1980’s. Howell’s model is the most recent and well-developed model, hence its use in this study.

The structure of the CCM according to Howell, is revisited below, to reinforce the stages and develop and to explain the process of the person moving from one stage to another.

Stage 1: - Unconscious Incompetence

The individual is unaware of the requirements, knowledge and skills needed and is unaware of their own incompetence. This stage links back to the Dunning-Kruger Effect (1999) as described previously. The person is incompetent and unconscious of this. They may make mistakes and be unaware and indeed may present as overly confident, as they have not understood the complexity of the task and the effort required. An ‘ignorance is bliss’ standpoint.

Stage 2: - Conscious Incompetence

The individual is now aware of the requirements, knowledge and skills required and is aware of the shortfall in their own knowledge base. The person now knows that they do not know what is required sufficiently to be skilful and recognises that they have a great deal to learn to gain the necessary skills. However, improvement at this stage is dependent on trial and error, unhelpful or unproductive actions are abandoned and mimicking the mentor is very helpful at this stage. Success is more linked to chance and coping than developing insight and knowing which tool is appropriate for the task. Greater insight is required to improve in a systematic manner.

Stage 3: - Conscious Competence

The individual now comprehends the knowledge and skills required to complete the tasks. They are, however, very conscious of the steps in learning that they have taken to be able to execute the skill and are conscious of new or further learning that they require to progress and develop beyond the basic grasp. They are conscious and aware and must consciously think through each of the steps when completing the skill but are competent at completing this automatically. They know the range of tools required but automaticity is not yet achieved. This stage is analytic and self-aware. Howell states: - “The third level adds understanding. Understanding is knowing what you do and why it works or does not work”. (1982, p30).

Stage 4: - Unconscious Competence

The individual no longer must think consciously about completing the original new skill or task, it has become embedded, automaticity has occurred, and they can complete it unconsciously, without having to focus on each step. This is the end point of the matrix, to mesh the new understanding so that it becomes embedded and achieves automaticity, echoing the notion within cognitive load theory. This suggests

that reaching this point lightens the cognitive load as the person with automaticity must expend less effort and has a lighter mental load when performing the same activity (Feldon, 2007). The teacher at this point can operate without thinking about many aspects of the role that previously they had to expend energy and thought on. Broadwell (1969) suggested that it is this stage of actions becoming naturalised that can lead to the myth that teaching has innate attributes and reminds his readers that great teachers are not born but are a product of effort and hard work.

Howell does recognise a fifth stage to the CCM model, that of super-consciousness and that aspect will be discussed in the concluding chapter, it has little personally direct relevance to trainee and early career teachers.

7.6.1.Competence Matrix-Application to the Participant Journey

This section applies the research findings and relevant published literature to the CCM model. The evidence will be discussed in chronological order, as the earlier sets should indicate the earliest aspects of the matrix and move on to consider each stage of the CCM model in turn.

The rationale for the application of CCM and debate around the term ‘competency’ and the role of the Teacher Standards were explored in Chapter Three. The journey of the participants from novice trainee through to ECT will be explored here to ascertain if their view of the training journey reflects the Matrix process and, if so, does the Matrix require further refinement and extension.

The word clouds were the only data sets to involve the entire cohort of 26 trainees and were a ‘snapshot’ of their immediate thoughts and emotions. These clouds were the first indication that stage 1 of the CCM occurred (figures three to eight). The notion of unconscious incompetence was indicated by the participants deploying terms such as ‘simple,’ ‘lower numbers,’ ‘less complicated,’ from the first data set in 2018, which focused on the teaching of maths. The utilisation of such terms suggested that the trainees felt that teaching maths, as opposed to doing maths themselves as they had for their GCSE (General Certificate of Secondary Education) or in order to pass the teaching skills test, was going to be easier, especially when thinking about teaching the very youngest children. The trainees were all focused on the teaching and learning of children aged 3-7 and although some indicated it was

going to be ‘scary’ or ‘fun’ phrases such as ‘okay in Key Stage One’ or ‘Early Years easy’ indicating a rather casual attitude towards teaching young children not unlike the Dunning-Kruger (1999) model. They seemed to be blissfully ignorant of the challenges to come, and firmly situated, at this point, within an unconscious incompetence mindset.

The second word cloud (figure seven) collected after their first full teaching practice indicated similar statements such as ‘Key stage one better,’ and ‘Early years easier’ and a different but equally embracing the socially popular maths mythologically based comment of ‘Highers scary- lowers ok’ suggesting participants at this stage perceived teaching more able children to be more difficult than teaching less able children. All these statements reinforce that the trainees held onto the concept that teaching maths to children under seven years is not as challenging as teaching older children or those who are deemed more able, (Hodgen & Askew, 2007). This continues to situate them in an unconscious competence mindset.

The final word cloud organised around the notion of teaching maths constructed in September 2020 (figure eight) after the second teaching practice and just prior to their final one was starkly different in tone. This time phrases such as: - ‘Harder basics’ and ‘Difficult to extend and support weak’ (meaning the children who struggled most with maths), ‘EYFS (Early Years Foundation Stage) hard’ suggested that the trainees had emerged from their unconscious incompetence phase and were now much more aware of their lack of pedagogical content knowledge (PCK) (Shulman, 1986), so consciously incompetent. Phrases such as ‘methods and processes can be hard’ and ‘struggle and muddled explanations’ and ‘vocabulary vital’ demonstrate a clear emergence into awareness and indicated an understanding developing of the teaching methods and requirements that they needed to use. This was also an indication of the participants moving from conscious incompetence towards conscious competence. They were now aware of what they needed to do, in terms of the pedagogical content knowledge but were not yet fully competent in doing it, unsupported or without the guidance of their mentors. This may indicate a fluctuation between states depending on the topic area and age phase.

The experiences that participants reported upon during their teaching practices also indicated that the progression in the CCM is not linear or equally stepped. A ‘critical incident’ on placement or negative observations or mentor comments could indicate

a regression or uncover another aspect of unconscious incompetence. Comments such as: - “I thought teaching shape/time/division was going to be easy, but it wasn’t” or “my second placement was a steep learning curve and harder than I expected”, all indicate that progression through the CCM is specifically personal, and very fluid and does not reflect the overly simplified step model from figure 1 and 2.

The RTA evidence base produced reflective examples of acknowledgement and confirmation from the then trainees that they had been unconsciously incompetent with phrases such as:-“It wasn’t as easy as I thought…” (Indigo) and Viv who stated:- “ I thought it was going to be easier than it was…” when reflecting back upon their first year assessed teaching practice. Two others (Riley and Piper) had personally elevated levels of subject knowledge (SK) as they had achieved highly at GCSE, and one had an AS level in maths. They still recognised their unconscious incompetence however, with comments such as:-“ In first year I created a smiley face as I felt quite confident with maths myself and the thought of trying to teach maths was ok, it would be good…” coupled with:-“ After placement in Y1 I felt much less confident, I had a few lessons that didn’t go well, and I found it more difficult to teach maths than I had thought…”(Riley). The notion that being able to do maths themselves did not directly translate into being able to teach it effectively, appeared to disturb the two more able mathematicians more than those who struggled with doing maths at the start and had previously poor experiences. The more highly qualified participants were less intimidated by the subject knowledge requirements or their prior experiences at the start, unlike some of the others. Piper stated (when reflecting back on the sculpture they had created at the start of the course) :-“ I felt quite confident about maths [at the start of the course] and was confident about teaching maths and then now I have made one with a ‘wiggly’ face as sometimes I am alright with understanding teaching maths and how to explain it sometimes, I am not...”A recognition that they had been over confident and unconsciously incompetent at the beginning of the degree course. This mirrors the research of Adler et al., (2005) an international survey of published research into maths teacher education, who noted that maths subject knowledge did not predicate being an effective maths teacher but that there was insufficient research into the balance of the types of knowledge and experiences that improved new maths teachers.

The IPA semi structured interviews involved reflection by the participants over the three years of initial teacher education and then on to their first year as teachers. Several of the participants acknowledged and discussed the notion that they had thought teaching the youngest children was going to be easy resonating with the maths mythology previous discussed, (and another example of unconscious incompetence) as the maths subject content itself is not hard. However, the starting the maths learning journey off for very young children was more difficult than it first seemed: -

> "I think laying the foundations in maths is almost harder. Those early concepts…. You've got to literally go in at the absolute baseline of it all. And start from scratch, that is hard. How do you start from scratch? Because that's actually a really difficult thing to do." (Harper)

The realisation that starting a child's understanding of maths is actually not easy, was something the participants were aware of by the time of the IPA interviews. Piper stated: - … "I knew the maths but not the how to teach them the maths bit, properly." And Umber felt under pressure to ensure the children had a strong start in maths: - "If they've got a basis to build from, it's a lot easier than when they haven't. and you haven't in Nursery, you ARE the base and need to get it right…"

All these comments suggest that the participants moved from a state of unconscious incompetence, to being very conscious of their incompetence. They had made assumptions about how easy it would be to teach maths to young children because the maths subject knowledge required is minimal, but they were unaware of the total lack of prior knowledge the children had to build their learning upon. They had to understand that the children at this early stage had little to no prior knowledge and so had to build up their entire grasp of number and place value from the start. As Gerry stated: - "I just didn't know what I didn't know, I do now!"

The range of evidence and comments all indicate that the participants moved from an unconscious incompetent state at the course start, through to conscious incompetence at varying points during the degree process, this was often linked to events in their training journey, some of these were what was deemed to be critical incidents (Mason & Johnston-Wilder, 2004). These were points where a lack of knowledge was uncomfortably highlighted, and the trainee was compelled to develop

and improve their understanding, as indicated previously. Sometimes they faltered and regressed, so progression was not linear and was unique to each participant.

By the time of the final IPA interviews the trainees had all moved to the consciously competent stage and several were beginning to move towards unconsciously competent, the semantics and level of detail in their conversations around effective lessons demonstrated that.

Umber gave a good example of this mental shift, when stating that they now always: - "… just have a bank of activities in your head, those core activities that can be adapted higher and can be adapted lower and always start in the middle point and you can tweak". Thus, demonstrating that they had the confidence to just 'know' how to adapt a resource and did not have to have it all planned out in advance. This is an indication of automaticity in learning, that they 'just know' what will be useful and effective. Harper in an equivalent way, demonstrated confidence in being able to 'play' with lessons structure, content, and tailor it to the children's needs: - "don't be afraid to pull it back. Don't move too quickly. So, if your children aren't getting it, pull it back and don't be afraid to move on in a different direction, then revisit it later." Adaption and flexibility are indications that teaching pedagogy that once was difficult and an extra cognitive load has now become enculturated and the norm. This is an interesting viewpoint as others had commented on the lack of flexibility and at times very rigid managerial approach that their curriculum and scheme offered. Suggesting that the ECTs were aware of the approaches they wished to take, even if their circumstances did not currently allow for it.

This section has considered the research findings and evidenced how the CCM applies to the trainee and then to the qualified teachers. Demonstrating how they progress from raw unconscious incompetent novices who made huge assumptions about how children learn maths to trainees who were very aware of the gaps in their knowledge and understanding especially around the pedagogical content knowledge that they required. They then moved to being conscious competent practitioners who had passed their teaching practices and achieved the Teacher Standards. However, they remain conscious that their learning development is far from complete and that there will be other challenges ahead. Finally, the IPA interviews showed the potential for unconscious competence with some of the participants able to be flexible and demonstrate some automaticity within their teaching, knowing what the potential

misconceptions and pitfalls might be and methods to support and scaffold children to be successful.

7.7.Mentoring and ITE

The role of the mentor in supporting trainees on their assessed placements is an essential part of ITE (Ragins & Kram, 2008). Mentors are the first point of support, guidance and advice for every trainee teacher. Their role can be a crucial deciding factor in the trainees' progress, as their observations and judgements against the Teacher Standards are utilised in the final outcomes for all trainees and a good mentor can 'join the dots' between effective theory and practice (Perry et al., 2019).

The participants valued the support and guidance role mentors played as both trainees and later, as ECTs (ECTs have a mentor for the two years of the ECF programme (CCOT, 2022).

Mentors also will need awareness of the CCM, as the way the trainee presents themselves initially in the classroom is symptomatic of their current position in the CCM rather than a true reflection of themselves. Being too hard on a trainee that presents in an overconfident unconscious incompetent state could destroy their self-efficacy, which will already be weak and lead to the trainee, at worst, withdrawing from the course entirely. Ensuring that mentors are aware of the potential of unconscious incompetence and the process of the matrix and are able to lead the trainee into consciousness without destroying their self-efficacy, is essential. This will be explored further in the Conclusion and Recommendations chapter.

7.8.Conclusion

In conclusion, this chapter presents the research findings and their connection to the existing literature. It reveals that what was initially on a surface level an emotional reaction that looked like "maths anxiety" was actually a response to previous negative experiences of poor pedagogy, leading to implications for the pedagogical approaches preferred by the participants in their teaching. The study highlights the influence of broader social perceptions of mathematics, including myths and negativity, on both the participants, from their own families and the families of the

children they now teach. However, the participants expressed a powerful desire to challenge these perceptions through their own teaching.

Furthermore, the chapter examines the intertwined nature of Pedagogical Content Knowledge (PCK) and Subject Knowledge (SK), acknowledging that SK can be linked to self-efficacy and therefore requires strengthening during the Initial Teacher Education (ITE) period. The influence of external factors and control on teaching strategies are explored, with the participants recognising that they sometimes felt constrained by the curriculum and external managerialism and performativity. Nevertheless, they also demonstrated moments of personal empowerment and the ability to make changes in their teaching to better support their children. The benefits of personal research and self-study were also explored.

Finally, the research applies the CCM to the research evidence to evaluate its usefulness in describing the journey from novice trainee to Early Career Teacher (ECT). The findings indicate that the participants' journeys align with the matrix but that they do not follow an overly simplified step model, rather the journey is more fluid, with movement forward and regression back and much more learning to come. The role of the school mentor within the CCM and the necessity for wider awareness of the CCM in order to best support the trainee in their ITE journey is explicated and suggested. However, it is noted that the matrix process is not a straightforward, linear progression, and requires more development, as it is more complex and resembles the messiness and exploratory nature of research itself. The matrix will be further explored in the next chapter and a new metaphorical model developed to better encapsulate the CCM journey.

Chapter Eight

8.Conclusions and Recommendations

8.1.Conclusions

In this chapter, the original research questions and aims will be revisited and discussed informed by the rich evidence from the participant data. The intent is to bridge the gap between theory and real-world application, exploring the implications for practice in both university and in school settings and making recommendations, drawing upon the knowledge gained by the research, for both mentoring practice and ITE practice. The Conscious Competence Matrix has previously been discussed and applied to both trainee and early career teachers. In this chapter the notion of the CCM will be advanced and extended, and a new metaphor introduced in the recommendations section and developed to further conceptualise and apply the CCM to teacher development and initial teacher education.
Each research question will be discussed in turn.

8.2.Research Question One

How do undergraduate Primary ITE trainees' perceptions towards maths and teaching maths change over the duration of their training and into their first year of teaching?

Originally, I had thought that the novice trainee teachers' attitude towards maths stemmed from negative prior experiences and potentially maths anxiety as the work of Gresham (2018) suggested. However, the participants did not have maths anxiety as it was not the maths as a subject, that caused them their anxiety. It was the type of pedagogy and teaching strategies deployed by their teachers that had caused feelings of humiliation and embarrassment. This aligned closely with the work of Hunt and Sari (2019) who suggested that the notion of maths anxiety was more akin to a wider teaching anxiety instead. All participants had a determination to avoid making these pedagogical errors, as they perceived them, in their own teaching and ensure that in their lessons, maths was enjoyable and reported as ECTs that their pupils were enjoying maths.

In phase one of the research, when the trainees were novices, they did not know or understand the difference between subject knowledge (SK) and pedagogical content knowledge (PCK). Over the duration of the three years of the BA QTS Primary degree, they all came to understand what was meant by both terms, and all felt that both terms were essential to effective maths teaching. However, some participants felt there were times when one aspect was a greater requirement within a lesson than the other.

During the initial stages of the degree programme, it became apparent in the evidence that several maths myths were firmly embedded in the trainees' attitudes. Again, over the course of the degree, these attitudes were examined and dispelled. Several of the participants originally thought that maths for the older children would be harder for them to teach, endorsing a known myth. By the time of their final practice, this myth had been fully dispelled, and they felt that teaching the initial stages of maths to the youngest children was the most challenging. The weight of wanting to get these early concepts 'right' for their classes ran strongly through the IPA interviews with participants. Other myths such as maths only having 'right' answers and that people tend to be 'maths people or literacy people' had also reduced but still had not been completely dispelled. For example, the two most highly qualified participants clung to the notion that maths is something that is more 'natural' to some people than others. This suggested to me that they needed a reason beyond hard work to 'blame' for their maths success. Yet neither of these participants would want the children in their classes to think in that way. This concurs with the work of Coles and Sinclair (2022) who challenge these maths myths and dogmas and see them as problematic as they work against the ambitions of schools and teachers to make maths more accessible to all.

The impact of the popular media perception that maths is 'differently difficult', was revealed by some of the myths explored above, but none of the participants discussed it in terms of their classes or pupil's views. However, some parents' negative attitudes towards maths were explored and highlighted as something the ECTs felt they wished to dispel and instead to encourage better understanding and embed stronger maths conceptual understanding in parents as well as children. Performativity and top-down political and managerial pressures from an overburdened curriculum and focused political agenda were not obvious to the very

novice trainees. As their class responsibility grew with each teaching practice, and their awareness of the broader school landscape widened, so did their understanding of the influence of these on their teaching and the pressures they could exert on the curriculum delivery model that they had to deploy. The need to balance all these pressures with their own drive to put the children's learning needs first, did lead to issues of internal conflict amongst some of the participants and their developing professional persona. However, it needs to be remembered that although from an exterior lens the impact of performativity is present, from an interior view these trainees had never worked in any other landscape, so the current culture was simply 'normal' to them.

Scaffolding and support systems were vital to the participants at all stages of their degree and then into their ECT years. Initially, university input and direction and then the impact of school mentors were cited by participants as key for moving their understanding forward. Post Covid 19 and on final teaching practices, it was noted that participants sought out external resources, notably those found online, which had made a large contribution to the participants' knowledge development and understanding. The need for support was acknowledged as universal across their developmental journey, but effective in-school mentoring ran through the RTA and IPA data as being absolutely vital.

Overall, the participants' perceptions of maths changed profoundly during the chronology of the study. They emerged from often damaging personal experiences of maths within secondary school, through three sometimes difficult and challenging teaching practices into fully qualified teachers able to reflect and articulate their personal mathematical journey. They were able to recognise that they would continue to develop and change as professionals and indeed, reflected and commented on their emerging professional identity. Some of them have gone on to lead the maths in their schools and support others in their own maths development journeys too. It is vital that ITE educators understand the initial perceptions and potential barriers to learning that new trainees bring with them into their training programmes. These attitudes do ameliorate over time but require discussion and acknowledgement, to avoid potentially damaging myths embedding into another generation.

8.3.Research Question Two

How useful is the Conscious Competence Matrix (Howell, 1982) for understanding the development of trainees' self-evaluation of their teaching competency: drawing on the experience of primary maths trainees?

The CCM is highly valuable when examining the progress of trainee teachers' development. As previously discussed, the trainees began their teaching degree journey often in a state of unconscious incompetence. Many had very little experience of school and teaching beyond their own educational experiences or, if they had been working or volunteering in school, it was often at the teaching assistant level, so the deeper pedagogical knowledge required to plan effective lessons and teach a class, was new. The word cloud evidence and the RTA data made it clear that ignorance and a ‘how hard can it be’ attitude permeated the early novice stages of the degree course, towards teaching maths. The participants reflected later in the IPA interviews that they thought the teaching was going to be easier than it was, purely because they did not know or understand the PCK required. Thus, very clearly being unconscious of their own incompetence.

Moving out of the first stage of the CCM, from unconscious incompetence to becoming conscious of their own incompetence varied in timescale for each participant. For some it was caused by a ‘critical incident’ as described by participant Gerry, that forced them to recognise their own short comings, for others it was a “car crash” of a lesson observation, comments by class mentors or their own acknowledgement that planning and teaching maths was a very different and new experience to being the child in the classroom. This change can be emotive and even shocking for some, as Piper and Riley found. They had both found maths enjoyable at secondary school and achieved highly in exams, and so had assumed that teaching maths to 3–7-year-olds would be straightforward. When it was more of a challenge than they predicted, both found it difficult to adjust.

Being able to describe this ‘unaware’ state as unconscious incompetence is especially useful to guide and support mentors in the early days of school placements when trainees can make glib and generalised comments regarding teaching and learning, but these comments stem from a position of ignorance. The label itself of ‘unconscious incompetence’ is less helpful when referring directly to trainees as the term incompetence is problematic and judgemental which may erect

further barriers to their receptiveness to learning. Consequently, later in this chapter suggestions are made for more supportive terms to describe the different stages of the CCM.

The second stage and third stages of the CCM appear to flow more gently into each other, compared to the sudden realisation at the end of stage one. As the trainees gained more experience, they were more aware and knew they had knowledge gaps. They began to be conscious of their issues and worked with mentors and resources to improve and develop their PCK and SK. Their awaking to ignorance moved them into wanting to know more (conscious incompetence, stage two), and then doing something proactively about the gaps they had found. However, they still required vigilant guidance and support from mentors at this stage, as stage two remains trial and error based. Close guidance and direction from mentors and tutors are required to understand what is effective in practice, why it is effective and when to deploy.

The trainees could also revert to earlier stages in the matrix when they need to apply new knowledge or encountered a new or unfamiliar situation. Changing year groups, for example, (which all trainees must do) could send a trainee back from feeling competent to incompetent and even to aspects of unconscious incompetence. Harper explained that teaching in the EYFS had made them realise that teaching maths from the very start of a child's journey was a great deal more challenging than they had expected and predicted. Participants commented that some maths topics that they had assumed would be easy, such as shape, were much harder to teach effectively and that they had required much more support and scaffolding from their mentors than they had predicted. Thus, although the matrix diagram is presented in a very linear way and sometimes described or drawn as even steps (figures 1 and 2) , in application it is uneven and fluid, with trainees oscillating between the phases defined by the matrix. With the momentum forward initially (as no trainee can go back to that original point of initial ignorance), there may be steps forward, then some regression when new and unknown situations are encountered, and new knowledge is being constructed.

Stage three, that of conscious competence, can best be described as the stage of the new car driver. They are able to drive but every process takes thought and conscious effort, going through a roundabout takes huge concentration levels,

nothing is smooth and automatic, every action is consciously taken. In this study, every trainee reaches this point uniquely, typically within the second or at the start of third teaching practice, when they can plan and teach competently but they still require ‘nudges and reminders’ from the mentor to remember to do something or they forget new or recently introduced, or unfamiliar strategies. It is important for mentors to recognise this, as it is this stage which places the most cognitive load on the trainee. For the trainee teacher there is much to remember in terms of juggling pedagogy, subject knowledge and PCK all at the same time.

However, and again, a very much personal and individual development, the trainee then, with practice, embeds aspects of practice into automaticity, becoming more flexible and able to adapt their teaching, changing lessons and shortening or extending input based on the needs of the children. This is unconscious competency, stage four, when they just ‘know’ what to do and require fewer ‘nudges’ from their mentor. Tacit knowledge is developing from the wider range and depth of teaching experiences they have had. Mentoring at this stage, should be less directed and more of a coaching discussion about what options there are and what can be polished and tweaked instead. This stage usually begins from the end of training and develops into the first few years of teaching, but again is idiographic. Nevertheless, a change of subject, a change of scheme or year group can enforce a backstep into conscious competency, where new processes and knowledge must be consciously practised to make them automatic.

Overall, the CCM as described by Howell (1982) is an extremely useful tool for mapping the circuitous journey of a novice trainee teacher becoming a fully qualified and much more experienced one. However, my research demonstrates it is not a tight matrix or as a stepped process as it is typically drawn and envisioned (see chapter three for examples in figures 1 and 2) but instead, a fluid, iterative and highly individual process. Each stage has its own attributes, and the trainee may move forward and backwards when new learning is encountered and may remain longer in some stages than others. This fluid motion requires awareness on the part of both trainee and mentor, as apparent regression may cause anxiety for both and concerns that the trainee is failing when they are regrouping and learning and will then move forward after they have consolidated. The labels for each stage are also very problematic as they can have negative connotations which may prevent a

trainee listening and engaging with discussion, no one would want to be deemed incompetent for example. New more inclusive titles are required before presenting this matrix to mentors or to trainee teachers and are suggested later in this chapter.

8.4.Research Question Three

What are the implications for ITE and ECT programmes in supporting Primary trainee teachers and Early Career Teachers considering the CCM.

The implication for teacher training and development programmes lies within enabling all those who work with ITE trainees and ECTs to understand at which stage their trainee or ECT are at on the CCM. For staff working with trainees and ECTs, be they in school as mentors or staff providing centre-based training, understanding the notion of the CCM has potential to empower them to support their trainee or ECT effectively. Knowing which stage their ECT or trainee is at will allow them to refine the input and better target the support level required. Providers can ensure that all engaged in the journey of a trainee or ECT are aware of the CCM and the distinct stages. Then providers need to understand and expand the stages to explicate and exemplify what behaviours and strategies are exhibited and what support is required in each stage. The support a novice requires at stage one will look different to a trainee moving into stage three, for example.

For mentors, understanding what it means to be at stage one, in unconscious incompetence should mean that they can identify early over-confidence and supportively guide the trainee into consciousness, rather than misinterpreting this stage as arrogance. This does happen and mentors can then be too harsh with vulnerable novices which can lead, at the most negative, to the trainee withdrawing from the course entirely. Within provider training sessions, again the knowledge of stage one CCM may mean that trainees are resistant to some aspects of training as they think that they already know it. The suggestion would be to ensure that trainees are exposed early on to in-school experiences and must engage with groups and whole classes of children to dispel the barriers that the unconscious competence stage raises, especially around children's knowledge and behaviour.

The organisation of some aspects of the ITE curriculum may need to be altered to allow for unconscious incompetency. Utilising the example of my Primary ITE maths curriculum, knowledge of early years maths strategies is currently taught early in the autumn term of the first year, because I tend to teach concepts in a chronological

order. However, now with my understanding of CCM, I intend to move this teaching so that it coincides with their EYFS specific placement in the spring. The year one trainees will then receive the input and can then be in school to work with the children who are at that stage and age, and this should dispel notions that it is easy to embed early maths concepts. This should address a maths ‘myth’ and the unconscious competence issue at the same time. Other subject areas may need to reconsider their curriculum sequencing for similar reasons.

Mentors need to be aware that trainees can move forward and backwards in the CCM and that trainees who have had one assessed practice and then change age phases, may regress and struggle until they adapt to the new expectations, in the new setting with new children. A trainee who may have reached conscious competence with one class may regress to conscious incompetence and struggle to comprehend how to speak to much younger or older children or how to adapt their behaviour management knowledge and strategies for a different age phase. This will require patience and support from the mentor, recognising the cognitive load upon the trainee. This can also happen with ECTs, they may have excelled in their final placement and indeed, been able to demonstrate unconscious competence traits. However, starting at a new school, with a different age phase, expectations, and structures, may move them back to conscious competence or even conscious incompetence. This could make the mentor concerned that the ECT is weak or potentially failing when, if supported, scaffolded, and encouraged to apply the skills that they have, just in a new context, they will be just as successful as they were on final practice and should not be judged too harshly, too soon. This concurs with the work of Toom et al., (2017) in their research amongst Finnish first year student teachers, who stated: -” professional agency – as human agency more generally – is continuously constructed and re-constructed depending on the context, object of activity and prior learning experiences.” (p 126).

Working with both ECTs and trainees', providers who understand the CCM, and are then able to make ‘the implicit, explicit’ and offer sufficient challenge without overwhelming the cognitive load and to offer sufficient support to move them on in their stages and thought processes. This can be helpful to providers at all stages of teacher development, from novice in ITE through to ECT and even to NPQ level. The Teacher Standards are the only professional ‘hurdle’ for assessing teacher

competency in England, so the CCM offers a bespoke language to describe the trainee and provides an opportunity for targeted on-going CPD, regardless of the stage of development the individual is at.

8.5.Research Aims

1. To analyse and interpret primary ITE trainees' perceptions towards Maths as a subject, during their training and into their first year of practice.

The trainees' perceptions towards maths as a subject were interesting as initially, based on my prior experiences as an ITE maths tutor, I had assumed that the emotional reactions that I had witnessed from trainees were due to having anxiety about maths. However, upon consideration of the research findings it was not the subject of maths that had caused the reactions but prior experiences of being taught maths. The poor pedagogy and negative experiences of the trainees in their childhoods had skewed their attitudes towards maths as a subject and they associated it with negativity. Over time and as they developed their professional persona, these prior experiences coalesced into a desire to not make the children that they taught feel the same about the subject. As they gained both subject knowledge and pedagogical subject knowledge their self-efficacy improved, and several participants acknowledged that secure subject knowledge gave them greater confidence in the classroom as it helped them to support the children with misconceptions more effectively. By their ECT years all the participants were much more positive about maths and teaching maths than they had been at the start of the degree course.

2. To analyse and interpret primary ITE trainees' perceptions towards Maths teaching during their training and into their first year of practice.

As the word clouds initially suggested, the notion of teaching maths to 3–7-year-olds appealed much more strongly to the novice trainee teachers, than doing maths did. Their embryonic reactions were embedded in unconscious incompetence (Howell, 1982) an over confidence in their knowledge that young children were only learning the most basic maths and so teaching that to them would be easy. However, once they embarked on their teaching practices, the trainees soon realised that the maths mythology they had believed in was untrue and that teaching maths, regardless of age phase, required a complex range of pedagogical content knowledge and skills.

Over time, their confidence and skill levels grew, often by developing their own knowledge and skills further by use of maths schemes or by their own research. By the time they had become ECTs all the participants stated that they enjoyed teaching maths and two of the participants had been asked to lead maths or part of the maths curriculum in their schools, demonstrating that something the participants originally perceived be easy, which then became a challenge, they were now successful at.

3. To evaluate and develop Howell's (1982) Conscious Competence Matrix for application to initial teacher education.

The CCM does apply very effectively to the journey of a trainee teacher, making different stages of professional development transparent to mentors and providers and enabling a common discourse between all the varied partners in teacher development. This is crucial as currently there is a dearth of description due to the summative nature of the Teacher Standards, everything is skewed towards the end of the training period and the application of summative descriptors. All the stages of the CCM were visible in the trainees and then the participant evidence and their progression and have been evaluated in previous sections. However, there are aspects of the CCM that are problematic. The labels for each stage are descriptive but can be construed as negative or judgemental in tone and this would make it difficult to share the CCM with trainee teachers or ECTs in its current form. I propose changing the titles of each stage to make the titles more relatable to, less potentially offensive, and more specific to teaching.

Stage One- Unconscious Incompetence becomes simply – Novice. Simply someone inexperienced in a situation.

Stage Two-Conscious Incompetence becomes- Learner. They are now aware of their inexperience and are in a position where they can begin learning the knowledge and skills required.

Stage Three- Conscious Competence becomes-Practitioner. They are now practising the skills and knowledge but not yet achieving automaticity.

Stage Four-Unconscious Competence- becomes-Teacher. They have passed the Teacher Standards and are applying their knowledge and skills with growing automaticity.

Stage Five- Howell (1982) deems this to be Unconscious Super Competence. This in my version of the CCM, becomes The Guide. These are teachers who now have the knowledge and skills of the four stages but are also aware of the things that are automatic to them and can explicate these to those at the other stages and are able to guide them in developing their practice. They can make 'the implicit, explicit.' This is the stage mentors should be at or developing towards, to be able advance others.

I have also adapted the CCM diagrammatically and applied a new metaphor to the CCM to make it easier to access visually and be more relatable to. This is important as I want the CCM to be utilised as a shared language between mentor and tutor and trainee, as a descriptor of the position of the trainee in their developmental continuous journey, giving teachers a road map for development rather than just an end point. The Teacher Standards are the only generalised descriptor of competency, and they are only of use at the end of the trainee journey, whereas the CCM deployed as a language and descriptor can be beneficial from the start of the programme and ongoing throughout the career of a trainee and teacher. This is developed further in the recommendations section below.

8.6.Contribution to Knowledge

The research questions have been expedited and answered and therefore, the research aims have all been met by the study. The use of IPA as a methodology in a new and unfamiliar context, the close examination of an under researched cohort of trainee teachers over an extensive period of time and the development of the CCM as a potential metaphor to support teacher development have all added to the knowledge base around the journey of a trainee teacher to a fully qualified early career teacher and into their wider career.The development and application of the CCM to ITE and beyond, as an individualised teacher development tool, makes a novel and unique contribution to knowledge and has the potential for further development and wider application to other educational training situations.

8.7.Recommendations

8.7.1.ITE Maths Curriculum Developments

The first recommendation to be drawn from the research, is that trainees at the very start of their ITE journey need to be supported to understand that the way they are taught national curriculum subjects in ITE is different to the way they have been taught as children at school. This applies strongly to maths as the evidence gathered suggests that the novice trainees assumed that they would be 'doing' maths calculations etc when they actually are taught a balance between subject knowledge (the what) and the pedagogical content knowledge (the how). An early understanding of this may perhaps ameliorate some of the fears and emotionality expressed by trainees early in their training, once they know they are not going to be 'tested'.

My second recommendation is that tutors also need to ensure that any trainees whose prior experiences of maths have been negative have been supported in order to be able to move forward more positively. They may also need support with deploying a range of pedagogical strategies and not avoid those that they link to their personal negative memories of maths. For example, being taught how to use a 'cold calling' strategy with children (where children do not put their hand up to answer, but the teacher selects a child to answer from all the of the class) without making a child feel vulnerable or humiliated as perhaps they once were.

The third recommendation based on the findings, is for ITE providers to ensure that effective personal CPD resources are suggested to both trainees and ECTs and that these are critiqued for quality and effectiveness. The participants indicated that they had found self-study a very useful tool for their CPD development. The market for curriculum content, subject knowledge and support materials, both free and costed is now enormous. However, quality can be variable in these resources, and it is advisable for trainees and ECTs to be supported in knowing how to select and critique for best fit and most effective use. Mentors, schools, Academy chains and ITE providers could all support and guide in this.

Recommendation four is that ITE providers should consider the sequencing of their maths curriculum (and potentially other subjects too) to ensure that they have the

best potential impact, when mapped against the CCM stages. For example, I have indicated that I will move when I teach EYFS maths so that it coincides with their time in an EYFS setting to dispel the myth that EYFS maths is ‘easy’ to teach and to also impact more effectively once the trainees have started to move beyond stage one of the CCM. Moving input to a time when the trainees have been into school and started to teach should hopefully reduce their level of unconscious incompetence and begin to build their knowledge when they are best placed to received it.

Although my research did focus upon trainee teachers who were training with 3–7-year-old children I consider that all my recommendations to be transferable to all trainee primary teachers.

8.7.2.IPA

IPA is a relatively new methodology in for educational research. Although knowledge of IPA techniques is increasing in all aspects of social science, I would strongly recommend that more educational research is conducted using IPA methodology. Both my methods (RTA and IPA) suited the study and worked effectively together for generating a rich, rounded picture of the research topic. However, IPA enables the researcher to reflect and revisit the data whilst recording their own thoughts, and this has a great deal of potential that can extend beyond the psychology domain. The concept of the ‘treble hermeneutic’ offers differing aspects of reflection and access to seeing how participants change over time, in a tangible way, whilst offering the participants greater agency and ownership to further reflect on their own thoughts. The IPA process enables revisiting and peeling away layers rather like an archaeologist, revealing a new and different facet each time.

Having re-read my own IPA data sets, I have several ideas for potential new areas of research beyond the original ambition and boundaries of this study. For example, further examining the way the participants view how children learn and explore their views on current teaching strategies, the impact of performativity and curriculum constraint on those who are trained within the culture and how views change through the initial and later stages of their training.

8.7.3.CCM

The application of the CCM (Howell, 1982) to trainee teachers and ECTs was one of the unique contributions to knowledge made by this study. I have already suggested renaming the stage titles in order to make them more acceptable to the audience they apply to, and to the mentors and providers who may be applying the CCM to their trainees and ECTs. However, I now wish to go beyond this and suggest my own metaphor and original diagrammatical representation of the CCM. The use of metaphors is helpful when discussing theory, as it improves accessibility and gives the reader an image to help them construct their own interpretation of the theory. Swedberg (2014) suggests human beings like to construct patterns to make sense of their world, indeed Aristotle found metaphors useful as they made ideas visible and inspiring.

However, metaphors are very personal and specific, so this is the one that I find works for me personally. I am a keen hiker and have completed various long-distance footpaths and trained as a walking leader and mountain guide, so for me, this metaphor makes very personal sense.

I envisage the structure of the CCM not as a rigid set of steps or a linear progression through a matrix, as depicted in figures 1 and 2 of Chapter three. Instead, I see it as a dynamic journey, akin to ascending a series of mountains. Trainees navigate through valleys, climb foothills, ascend to summits, and venture beyond to conquer new challenges and explore unseen peaks and descend into troughs throughout their entire teaching career, journeying onwards and on a journey of perpetual development and change.

In my metaphor, the novice stage one trainee set out at sea level, about to embark on a long walk up a mountain. They have obviously gone on a walk before, so make assumptions about the appropriate footwear, clothing, food and effort required and terrain covered. Early on in their journey however, they encounter problems such as heavy rain, or challenging terrain, their coat leaks or they get a blister on their foot and recognise that the clothing/footwear/food and effort required was much more rigorous than they had anticipated. This is Base Camp 1 moving from unconscious incompetence to conscious incompetence or in my terms, *novice to learner*.

At this point, the learner on the path starts to take notice of the guide on the walk and buy the boots the guide suggests or take advice on the most appropriate coat or what and when to eat. How to approach difficult terrain will mean the guide going first and giving the learner a hand up and showing the learner exactly where to put their feet. Eventually the learner starts to copy the guide, in their intent and actions and moves to Base Camp 2, from conscious incompetence to conscious competence, from *learner to practitioner.*

This is the section of the route where the practitioner now starts to work out for themselves when to put on their coat, to be able to predict when they might need to eat or when it might rain. They still need input and support from the guide however, as nothing yet comes naturally when making decisions, and challenges such as new terrain or challenging weather conditions can make the practitioner head back to a previous basecamp and have to work their way back up, learning as they go. They may also encounter false peaks, this is when the practitioner feels like they have reached the summit only to find it was not the top and there was more to do (at the end of a teaching practice for example and then starting their first teaching job). Learning eventually that there is never an ultimate summit, there is always another peak.

With time and effort, the practitioner reaches the summit of that mountain and achieves the status and title of *teacher*. At this point they can walk a range of terrain with ease, know the correct clothing to wear or what to select from, to read the weather signs and can adapt their walking to their surroundings and terrain. They are at ease with the process of walking up **this** specific mountain. However, walking up a **different** mountain, on a different day, in different weather conditions will require further guidance, mentoring and more knowledge and personal development.

This is pivotal, the first summit is only that, the first summit, there will be other summits to ascend and new challenges to face. This developmental journey is continuous and iterative. This is where Howell's foundational stepped model of the CCM (figure 2) requires further development. Every mountain path has new false peaks, unfamiliar terrain, or weather patterns so for every change in year group or new responsibility such as subject leadership the teacher requires a deliberate retreat or a series of retreats back into conscious competency, moving back to a previous base camp, where new skills have to be honed and mastered and support

given. The teacher never regresses back to the beginning, never back to ignorance and sea level, the knowledge gained is not lost, just applied, or adapted and modified and extended. They then move forward again, learning and relearning every time. Hence the notion of a journey metaphor, not a singular end point, but one of a trajectory of continuous evolution and growth.

Once the teacher has walked and experienced a wide range of mountains and returned to previous base camps and learned to handle the emotions of false peaks and troughs, they may wish to move to the role of the guide. The guide can return to sea level and appreciate the discombobulation of the novice, instruct the learner and support and guide the practitioner. They also recognise the automaticity of the teacher's skills and are able to explicate these to the novice. This is the role of the school-based mentor, they are *the guide*. They can recognise and acknowledge the unconscious incompetent, direct the conscious incompetent and support the competent. They can then also support the qualified teacher (if working with ECTs or in teacher CPD) to refine their skills and indeed support them to become mountain guides themselves. The guide, however, will embark upon walking up new peaks, with unfamiliar terrain and new obstacles to encounter and indeed they may require guides with greater experience than themselves to support and advise them at points. The process of learning, moving forward and regressing to previous CCM stages is continual and iterative for the duration of the teacher's professional life.

There are also external factors that the walker/trainee needs to be mindful of, these are the factors such as dangerous terrain or bad weather conditions. Ofsted, performativity, school culture and community can all impact from the exterior. Internal factors can also impede progress, from personal prior school experiences, to family, health and personal financial issues for example. These are the equivalent of blisters, sore knees and the poor sleep that all long distant walkers may suffer from. These events may mean regression back to a previous stage, to learn again and move forward.

This metaphor provides a tangible and relatable image for understanding the learning process and mapping the challenges faced by trainee teachers and ECTs. It also emphasises the importance of guidance, direction and support along the circuitous and ongoing journey as well as acknowledging the continuous development and adaptation required in different teaching contexts (for example,

walking up different mountains and then dealing with false peaks in unfamiliar situations). The notion of a perpetual journey, sometimes at a summit, other times back to a base camp stresses the idea that teachers are never ‘compete’ or finished products’ but that everyone is on their individual journey of exploration and learning, and all are at different stages.

The metaphor is useful as a way to explain and share the abstract development of the trainee into the various stages of the CCM, using language which is accessible and positive (informing someone that they are unconsciously incompetent is unlikely to be the start of a positive and developmental conversation). My metaphor enables me to discuss and describe the trainee journey and the role of the mentor and trainee within that. In the absence of comprehensive descriptors beyond the Teacher Standards, this metaphor fills a crucial space, facilitating constructive discussion between trainees and mentors, particularly during the nascent stages of the trainee to teacher journey. It is an accessible metaphor that does not require personal experience in order to relate to it and gives a clear context and framework for all to engage with and therefore, to invest in.

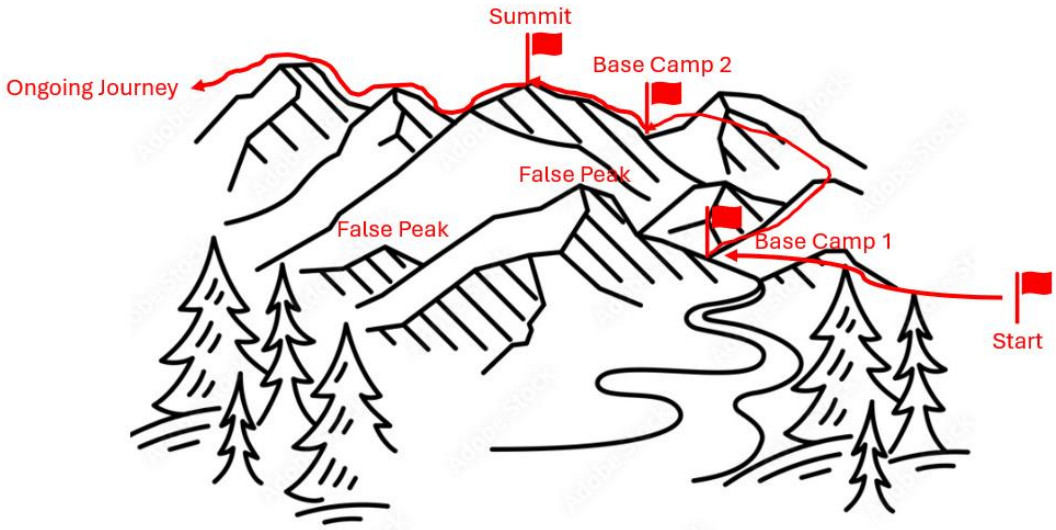
The image below (figure 26) captures my metaphor in a diagrammatic form, which I think better represents the journey of my participants, from novices walking up to base camp 1 where they move to being learners, coping with false peaks and potential regression. Then reaching base camp 2 where they become practitioners to finally reaching the summit and becoming teachers, where more mountains and more potential journeys hove into view. The journey then starts again, but never quite from the sea level total novice point.

Having acquired a wealth of knowledge, and aware of the continual development aspect of the journey, the teacher then may become mountain guides sharing their wisdom with new novices and supporting them on their journey. The learning journey is never ending, with constant iterations of development, movement around false peaks, troughs, and new territory throughout a teacher’s career. Movement into leadership roles, for example, will mean new mountains to climb and unfamiliar terrain to encounter, other events such as changing schools, moving year groups and taking on a new subject to lead are all central to the professional life of a primary school teacher. As described in chapter three, the CCM cycle is iterative, fluid and continual, not neat and stepped but untidy and at times, those who have been the

guide for others may still require guidance and support from others, highlighting the central importance of continual CPD and PCK/SK development to all teachers, no matter what prior experiences they may have had. New terrain is always around the corner.

No teacher or school leader is ever the 'finished article' but is walking somewhere along the mountain path, sometimes alone, sometimes with a guide, sometimes returning to a basecamp, at other times reaching new summits, or descending into troughs, but the teaching journey is an endless developmental pathway, with new learning and discovery just around the next bend. The diagram illustrates this continual adventure, mapping new terrain.

Figure:26



Howell's (1982) Core Competence Matrix reimagined as a mountain climbing expedition.

References

About the NCETM. (n.d.). NCETM. Retrieved March 2, 2023, from https://www.ncetm.org.uk/about-the-ncetm/

Adler, J., Ball, D. L., Krainer, K., Lin, F., & Novotná, J. (2005). Reflections on an Emerging Field: Researching Mathematics Teacher Education. Educational Studies in Mathematics, 60(3), 359–381. https://doi.org/10.1007/s10649-005-5072-6

Ahmed, W., Minnaert, A., Kuyper, H., and Van Den Werf, G. (2012). Reciprocal relationships between math self-concept and math anxiety. *Learn. Individ. Dif.* 22, 385–389. doi: 10.1016/j.lindif.2011.12.004

Alase, A. O. (2017). The Interpretative Phenomenological Analysis (IPA): A Guide to a Good Qualitative Research Approach. International Journal of Education and Literacy Studies, 5(2), 9. https://doi.org/10.7575/aiac.ijels.v.5n.2p.9

Alexander, R. (2004). Still no pedagogy? principle, pragmatism and compliance in primary education. Cambridge Journal of Education, 34(1), 7–33. https://doi.org/10.1080/0305764042000183106

Alexander, R. (2011). Evidence, rhetoric and collateral damage: the problematic pursuit of 'world class' standards. Cambridge Journal of Education, 41(3), 265–286. https://doi.org/10.1080/0305764x.2011.607153

Allen, R. E., & Wiles, J. (2016). A rose by any other name: participants choosing research pseudonyms. Qualitative Research in Psychology, 13(2), 149–165. https://doi.org/10.1080/14780887.2015.1133746

Amin-Hanjani, S., & Haglund, M. M. (2022). Editorial. "Sometimes wrong, never in doubt" or "fake it till you make it"? Neurosurgical Focus, 53(2), E10. https://doi.org/10.3171/2022.5.focus22286

Andrews, P. E., & Xenofontos, C. (2014). Analysing the relationship between the problem-solving-related beliefs, competence and teaching of three Cypriot primary teachers. Journal of Mathematics Teacher Education, 18(4), 299–325. https://doi.org/10.1007/s10857-014-9287-2

APA Dictionary of Psychology. (2023, February). Retrieved March 8, 2023, from https://dictionary.apa.org/consciousness

Applying Theory to the Design of Cultural Competency.Academic Medicine. (n.d.). LWW. https://journals.lww.com/academicmedicine/Fulltext/2003/06000/Applying_Theory_to_the_Design_of_Cultural.7.aspx

Arthur, J., Waring, M., Coe, R., & Hedges, L. V. (2017). Research Methods and Methodologies in Education (2nd ed.). SAGE.

Ashcraft, M. H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. Current Directions in Psychological Science, 11(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. Psychonomic Bulletin & Review, 14(2), 243–248. https://doi.org/10.3758/bf03194059

Askew, M., Brown, M., Rhodes, V., Wiliam, D., & Johnson, D. W. (1997). The contribution of professional development to effectiveness in the teaching of numeracy. Teacher Development, 1(3), 335–356. https://doi.org/10.1080/13664539700200030

Askew, M., Rhodes, V., Brown, M., Wiliam, D., & Johnson, D. (1997). Effective Teachers of Numeracy: Report of a study carried out for the Teacher Training Agency. London: King's College, University of London.

Aspin, K. (2022). Maths Curriculum Overview BA. In University of Huddersfield.

Unpublished

Aubrey, C., Godfrey, R., & Dahl, S. (2006). Early mathematics development and later achievement: Further evidence. Mathematics Education Research Journal, 18, 27-46.

Back, J., Sayers, J., & Andrews, P. (2013, February). The development of foundational number sense in England and Hungary: A case study comparison. In Proceedings of the eighth congress of the European Society for Research in Mathematics Education (pp. 1835-1844).

Ball, D. L. (1988). Unlearning to Teach Mathematics. *For the Learning of Mathematics*, *8*(1), 40–48. http://www.jstor.org/stable/40248141

Ball, D. L. (1990). The Mathematical Understandings That Prospective Teachers Bring to Teacher Education. Elementary School Journal, 90(4), 449–466. https://doi.org/10.1086/461626

Ball, D. L. (1991). Advances in Research on Teaching: A Research Annual (J. E. Brophy, Ed.; Vol. 2). JAI Press(NY).

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching. Journal of Teacher Education, 59(5), 389–407. https://doi.org/10.1177/0022487108324554

Ball, S. J. (2003). The teacher's soul and the terrors of performativity. Journal of Education Policy, 18(2), 215–228. https://doi.org/10.1080/0268093022000043065

Ball, S. J. (2018). The tragedy of state education in England: Reluctance, compromise and muddle— a system in disarray. Journal of the British Academy, 6, 207–238. https://doi.org/10.5871/jba/006.207

Back, J., Sayers, J., & Andrews, P. (2013, February). The development of foundational number sense in England and Hungary: A case study comparison. In Proceedings of the eighth congress of the European Society for Research in Mathematics Education (pp. 1835-1844).

Bandura, A. (1977). Social Learning Theory. Englewood Cliffs, N.J. : Prentice Hall.

Bandura, A. (1997). Self-Efficacy: The Exercise of Control. Macmillan.

Basit, T. N. (2003). Changing practice through policy: trainee teachers and the National Numeracy Strategy. Research Papers in Education, 18(1), 61–74. https://doi.org/10.1080/0267152032000048587

Bates, A. T., Latham, N. K., & Kim, J. (2011). Linking Preservice Teachers' Mathematics Self-Efficacy and Mathematics Teaching Efficacy to Their Mathematical Performance. School Science and Mathematics, 111(7), 325–333. https://doi.org/10.1111/j.1949-8594.2011.00095.x

Beilock, S. L., & Maloney, E. K. (2015). Math Anxiety. Policy Insights From the Behavioural and Brain Sciences, 2(1), 4–12. https://doi.org/10.1177/2372732215601438

Bekdemir, M. (2010). The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students. Educational Studies in Mathematics, 75(3), 311–328. https://doi.org/10.1007/s10649-010-9260-7

Bennett, N., & Carre, C. (2002). Learning to Teach. Routledge.

BERA Statement on Close-to-Practice Research. (n.d.). https://www.bera.ac.uk/publication/bera-statement-on-close-to-practice-research

Berger, R. (2015). Now I see it, now I don't: researcher's position and reflexivity in qualitative research. Qualitative Research, 15(2), 219–234. https://doi.org/10.1177/1468794112468475

Bibby, T. (2002). Shame: An emotional response to doing mathematics as an adult and a teacher. British Educational Research Journal, 28(5), 705–721. https://doi.org/10.1080/0141192022000015543

Birkeland, J., Baste, V., Eriksen Ødegaard, E., & Kruk, R. (2020). Observation as a professional tool in Norwegian kindergartens and kindergarten teacher education. *Cogent Education*, *7*(1). https://doi.org/10.1080/2331186X.2020.1789381

Bjerke, A. H., & Solomon, Y. (2020). Developing Self-Efficacy in Teaching Mathematics: Pre-Service Teachers' Perceptions of the Role of Subject Knowledge. Scandinavian Journal of Educational Research, 64(5), 692–705. https://doi.org/10.1080/00313831.2019.1595720

Black, S. A. (2015). Qualities of Effective Leadership in Higher Education. Open Journal of Leadership, 04(02), 54–66. https://doi.org/10.4236/ojl.2015.42006

Blatchford, P. (1996). Pupils' views on school work and school from 7 to 16 years. Research Papers in Education, 11(3), 263–288. https://doi.org/10.1080/0267152960110305

Boaler, J. (2009). The Elephant in the Classroom: Helping Children Learn and Love Maths.

Boaler, J. (2014). Research Suggests that Timed Tests Cause Math Anxiety. Teaching Children Mathematics, 20(8), 469–474. https://doi.org/10.5951/teacchilmath.20.8.0469

Boehm, L. E. (1994). The Validity Effect: A Search for Mediating Variables. Personality and Social Psychology Bulletin, 20(3), 285–293. https://doi.org/10.1177/0146167294203006

Bostock, J. (2019). Exploring in-service trainee teacher expertise and practice: Developing pedagogical content knowledge. Innovations in Education and Teaching International, 56(5), 605–616. https://doi.org/10.1080/14703297.2018.1562358

Bottle, G. (2005). Teaching Mathematics in the Primary School: The Essential Guide. A&C Black.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. Qualitative Research in Sport, Exercise and Health, 11(4), 589–597. https://doi.org/10.1080/2159676x.2019.1628806

Braun, V., & Clarke, V. (2021). Thematic Analysis: A Practical Guide. SAGE.

Breen, L. J. (2007). The researcher “in the middle”: Negotiating the insider/outsider dichotomy. The Australian Community Psychologist, 19(1), 163–174.

British Educational Research Association [BERA]. (2018). Ethical Guidelines for Educational Research, fourth edition (2018). BERA. https://www.bera.ac.uk/publication/ethical-guidelines-for-educational-research-2018

Broadwell, M. M. (1969, February 20). Teaching For Learning (XVI.) - Gospel Guardian vol.20, no.41, pg.1-3a. https://www.wordsfitlyspoken.org/gospel_guardian/v20/v20n41p1-3a.html

Brookfield, S. (2002). Using the lenses of critically reflective teaching in the community college classroom. New Directions for Community Colleges, 2002(118), 31–38. https://doi.org/10.1002/cc.61

Brophy, J. (1992). The de-facto national curriculum in US elementary social studies: critique of a representative example. Journal of Curriculum Studies, 24(5), 401–447. https://doi.org/10.1080/0022027920240501

Brown, T., McNamara, O., Hanley, U., & Jones, L. (1999). Primary Student Teachers' Understanding of Mathematics and its Teaching. British Educational Research Journal, 25(3), 299–322. https://doi.org/10.1080/0141192990250303

Burn, K., & Mutton, T. (2015). A review of 'research-informed clinical practice' in Initial Teacher Education. Oxford Review of Education, 41(2), 217–233. https://doi.org/10.1080/03054985.2015.1020104

Buxton, L. (1981) Do you panic about maths? Coping with maths anxiety, London: Heinemann

Bygstad, B., & Munkvold, B. E. (2011). Exploring the Role of Informants in Interpretive Case Study Research in IS. Journal of Information Technology, 26(1), 32–45. https://doi.org/10.1057/jit.2010.15

Byrne, D. (2017). What are ontology and epistemology. Project Planner, 10, 9781526408495., 10, 9781526408495.

Carey, E., Devine, A., Hill, F., Dowker, A., McLellan, R., & Szucs, D. (2019). Understanding Mathematics Anxiety: Investigating the experiences of UK primary and secondary school students. Nuffield Foundation, University of Cambridge. https://doi.org/10.17863/cam.37744

Carruthers, E., & Worthington, M. (2011). Understanding Children's Mathematical Graphics: Beginnings In Play: Beginnings in Play. McGraw-Hill Education (UK).

Casad, B. J., Hale, P., & Wachs, F. L. (2015). Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. *Frontiers in Psychology, 6,* Article 1597. https://doi.org/10.3389/fpsyg.2015.01597

Castle, P., & Buckler, S. (2021). Psychology for Teachers. SAGE.

Chamberlain, K. (2011). Troubling methodology. Health Psychology Review, 5(1), 48–54. https://doi.org/10.1080/17437199.2010.520113

Chavez, C. (2015). Conceptualizing from the Inside: Advantages, Complications, and Demands on Insider Positionality. The Qualitative Report. https://doi.org/10.46743/2160-3715/2008.1589

Chestnut, E. K., Lei, R. F., Leslie, S., & Cimpian, A. (2018). The myth that only brilliant people are good at math and its implications for diversity. *Education Sciences (Basel)*, *8*(2), 65. https://doi.org/10.3390/educsci8020065

Chick, H., Pham, T., & Baker, M. (2006). Probing teachers' pedagogical content knowledge: lessons from the case of the subtraction algorithm. 29th Conference of the Mathematics Education Research Group of Australasia, 1, 139–146.

Clegg, S., & McAuley, J. (2005). Conceptualising Middle Management in Higher Education: A multifaceted discourse. Journal of Higher Education Policy and Management, 27(1), 19–34. https://doi.org/10.1080/13600800500045786

Clements, D. H., & Sarama, J. (2020). Learning and teaching early math: The learning trajectories approach. Routledge.

Clough, P., & Nutbrown, C. (2012). A Student's Guide to Methodology. SAGE.

Cockcroft, W. (1982). The Cockcroft Report. Her Majesty's Stationery Office 1982.

Coe, R., Aloisi, C., Higgins, S., & Elliot-Major, L. (2014). What makes great teaching? In The Sutton Trust (Ed.), https://www.suttontrust.com/our-research/great-teaching/.

Cohen, L., Manion, L., & Morrison, K. (2017). Research Methods in Education. Routledge.

Coles, P. A., & Sinclair, P. N. (2022). I Can't Do Maths! Why children say it and how to make a difference. Bloomsbury Publishing.

Creswell, J. W. (2013). Qualitative Inquiry and Research Design: Choosing Among Five Approaches. SAGE.

Crotty, M. (1998). The Foundations of Social Research: Meaning and Perspective in the Research Process. SAGE.

Davies, P., Connolly, M. P., Nelson, J. L., Hulme, M., Kirkman, J., & Greenway, C. (2016). 'Letting the right one in': Provider contexts for recruitment to initial

teacher education in the United Kingdom. Teaching and Teacher Education, 60, 291–302. https://doi.org/10.1016/j.tate.2016.09.003

Davis, A., Goulding, M., & Suggate, J. (2017). Mathematical Knowledge for Primary Teachers. Routledge.

Definition of competence. (2023). In Cambridge Dictionary.

Denscombe, M. (2017). The Good Research Guide: For Small-scale Social Research Projects.

Department for Education. (2011, July 13). Teachers' standards. GOV.UK. Retrieved March 1, 2023, from https://www.gov.uk/government/publications/teachers-standards

Department for Education. (2013, September 28). National Curriculum in England: mathematics programmes of study. GOV.UK. Retrieved March 1, 2023, from https://www.gov.uk/government/publications/national-curriculum-in-england-mathematics-programmes-of-study

Department for Education. (2014, March 31). Early Years Foundation Stage (EYFS) statutory framework. GOV.UK. Retrieved March 24, 2023, from https://www.gov.uk/government/publications/early-years-foundation-stage-framework--2

Department for Education. (2019, November 1). Initial Teacher Training (ITT): Core Content Framework. GOV.UK. https://www.gov.uk/government/publications/initial-teacher-training-itt-core-content-framework

Desforges, C., & Cockburn, A. (1987). Understanding the Mathematics Teacher: A Study of Practice in First Schools. Taylor & Francis.

Dewey, J. (2012). How We Think. Wyatt North Publishing, LLC. (Original work published 1910)

DfEE. (1999). National Numeracy Strategy -Framework for teaching Mathematics (ISBN 0855229225). Cambridge University Press.

Does Math Make You Anxious? (2015). PISA in Focus. https://doi.org/10.1787/5js6b2579tnx-en

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics Anxiety: What Have We Learned in 60 Years? Frontiers in Psychology, 7. https://doi.org/10.3389/fpsyg.2016.00508

Dowling, P. (1998). The Sociology of Mathematics Education: Mathematical Myths / Pedagogic Texts. http://ci.nii.ac.jp/ncid/BA3424346X

Dreger, R. M., & Aiken, L. R. (1957). The identification of number anxiety in a college population. Journal of Educational Psychology, 48(6), 344–351. https://doi.org/10.1037/h0045894

Drews, D., & Hansen, A. (2017). Using Resources to Support Mathematical Thinking: Primary and Early Years. Learning Matters.

Dunning, D. (2011). The Dunning–Kruger Effect. Elsevier eBooks, 247–296. https://doi.org/10.1016/b978-0-12-385522-0.00005-6

Dwyer, S. C., & Buckle, J. L. (2009). The Space Between: On Being an Insider-Outsider in Qualitative Research. International Journal of Qualitative Methods, 8(1), 54–63. https://doi.org/10.1177/160940690900800105

Education Endowment Foundation. (2021 October 27). Improving Mathematics in the Early Years and Key Stage 1. EEF. Improving Mathematics in the Early Years and Key Stage 1 | EEF (educationendowmentfoundation.org.uk)

Education Endowment Foundation. (2021, October 27). Metacognition and Self-regulated Learning. EEF. https://educationendowmentfoundation.org.uk/education-evidence/guidance-reports/metacognition

Ehrlinger, J., Johnson, K. L., Banner, M., Dunning, D., & Kruger, J. (2008). Why the unskilled are unaware: Further explorations of (absent) self-insight among the incompetent. Organizational Behavior and Human Decision Processes, 105(1), 98–121. https://doi.org/10.1016/j.obhdp.2007.05.002

Epstein, D., Mendick, H., & Moreau, M. (2010). Imagining the mathematician: young people talking about popular representations of maths. Discourse, 31(1), 45–60. https://doi.org/10.1080/01596300903465419

Ernest, P. (1996). Popularization: Myths, Massmedia and Modernism. In International Handbook of Mathematics Education. (Vol. 4). Springer -Kluwer International. https://doi.org/10.1007/978-94-009-1465-0_22

Eva, K. W., Cunnington, J. P. W., Reiter, H. I., Keane, D., & Nor

man, G. R. (2004). How Can I Know What I Don't Know? Poor Self-Assessment in a Well-Defined Domain. Advances in Health Sciences Education, 9(3), 211–224. https://doi.org/10.1023/b:ahse.0000038209.65714.d4

Evidence For Learning. (2023, 28 February) Improving mathematics in the early years with children aged 3-7 years. EFL. https://evidenceforlearning.org.au/education-evidence/guidance-reports/early-maths

Feldon, D. F. (2007). Cognitive Load and Classroom Teaching: The Double-Edged Sword of Automaticity. Educational Psychologist, 42(3), 123–137. https://doi.org/10.1080/00461520701416173

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments Designed to Measure Attitudes toward the Learning of Mathematics by Females and Males. Journal for Research in Mathematics Education, 7(5), 324. https://doi.org/10.2307/748467

Fink, A. (2019). Conducting Research Literature Reviews: From the Internet to Paper. SAGE Publications.

Finlay, L. (2011). Phenomenology for Therapists: Researching the Lived World. John Wiley & Sons.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906–911. https://doi.org/10.1037/0003-066x.34.10.906

Flick, U. (2020). Introducing Research Methodology: Thinking Your Way Through Your Research Project. SAGE Publications Limited.

Foucault, M., Agulhon, M., Castan, N., Duprat, C., Ewald, F., Farge, A., . . . & REVEL, J. (1981). Questions of method-an Interview with Foucault, Michel. I & c, (8), 3-14. (n.d.).

Furlong, J., Campbell, A., Howson, J. Y., Lewis, S., & McNamara, O. (2006). Partnership in English Initial Teacher Education: Changing Times, Changing Definitions – Evidence from the Teacher Training Agency National

Partnership Project. Scottish Educational Review, 37(3), 32–45. https://doi.org/10.1163/27730840-03703004

Galič, M., Timan, T., & Koops, B. (2017). Bentham, Deleuze and Beyond: An Overview of Surveillance Theories from the Panopticon to Participation. Philosophy & Technology, 30(1), 9–37. https://doi.org/10.1007/s13347-016-0219-1

Ganley, C. M., and Vasilyeva, M. (2014). The role of anxiety and working memory in gender differences in mathematics. *J. Educ. Psychol.* 106, 101–105. doi: 10.1037/a0034099

Geddis, A. N. (1993). Transforming subject-matter knowledge: the role of pedagogical content knowledge in learning to reflect on teaching. International Journal of Science Education, 15(6), 673–683. https://doi.org/10.1080/0950069930150605

Geist, E. (2010). The Anti-Anxiety Curriculum: Combating Math Anxiety in the Classroom. Journal of Instructional Psychology, 37(1), 24–31. https://www.andrews.edu/sed/gpc/faculty-research/montagano-research/the-anti-anxiety-cur.pdf

Gibson, S. L., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. Journal of Educational Psychology, 76(4), 569–582. https://doi.org/10.1037/0022-0663.76.4.569

Giorgi, A. (2010). Phenomenology and the Practice of Science. Existential Analysis.

Goodall, D. (2014). An Interpretative Phenomenological Study Exploring Designated Teachers' Experiences of Supporting Looked After Children. DEdCPsy Thesis.

Goodman, J. L. (1984). Reflection and teacher education: A case study and theoretical analysis. Interchange, 15(3), 9–26. https://doi.org/10.1007/bf01807939

Gordon Training International. (2012, May 15). Learning a New Skill is Easier Said Than Done - Gordon Training International. https://www.gordontraining.com/free-workplace-articles/learning-a-new-skill-is-easier-said-than-done/

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. https://doi.org/10.1080/0141192022000015543a

Greene, M. (2014). On the Inside Looking In: Methodological Insights and Challenges in Conducting Qualitative Insider Research. The Qualitative Report. https://doi.org/10.46743/2160-3715/2014.1106

Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers. Teaching Education, 19(3), 171–184. https://doi.org/10.1080/10476210802250133

Gresham, G. (2018). Preservice to Inservice: Does Mathematics Anxiety Change With Teaching Experience? Journal of Teacher Education, 69(1), 90–107. https://doi.org/10.1177/0022487117702580

Grouws, D. (2006). Handbook of Research on Mathematics Teaching and Learning: (A Project of the National Council of Teachers of Mathematics). IAP.

Gullander, O. E. (1974). Conscious Competency: The Mark of a Competent Instructor. Canadian Training Methods. https://www.eric.ed.gov/?id=EJ102181

Hadfield, O. D., & McNeil, K. (1994). The relationship between Myers-Briggs personality type and mathematics anxiety among preservice elementary teachers. Journal of Instructional Psychology, 21(4), 375.

Hall, J., & Ponton, M. K. (2005). Mathematics Self-Efficacy of College Freshman. Journal of Developmental Education, 28(3), 26. http://files.eric.ed.gov/fulltext/EJ718579.pdf

Hammersley, M. (1992). The Paradigm Wars: reports from the front. British Journal of Sociology of Education, 13(1), 131–143. https://doi.org/10.1080/0142569920130110

Hammersley, P. M. (2007). Educational Research and Evidence-Based Practice. SAGE.

Hansen, A., Drews, D., Dudgeon, J., Lawton, F., & Surtees, L. (2014). Children's Errors in Mathematics. Learning Matters.

Harper, D., & Thompson, A. R. (2011). Qualitative Research Methods in Mental Health and Psychotherapy: A Guide for Students and Practitioners. John Wiley & Sons.

Hart, S. A., & Ganley, C. M. (2019). The Nature of Math Anxiety in Adults: Prevalence and Correlates. *Journal of numerical cognition*, *5*(2), 122–139. https://doi.org/10.5964/jnc.v5i2.195

Haylock, D. (1995). Mathematics Explained for Primary Teachers. SAGE.

Haylock, D., & Manning, R. (2018). Mathematics Explained for Primary Teachers. SAGE.

Heidegger, M. (1967). Being and Time. Blackwell Publishing.

Hellawell, D. E. (2006). Inside–out: analysis of the insider–outsider concept as a heuristic device to develop reflexivity in students doing qualitative research. Teaching in Higher Education, 11(4), 483–494. https://doi.org/10.1080/13562510600874292

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematics Anxiety. Journal for Research in Mathematics Education, 21(1), 33. https://doi.org/10.2307/749455

Higginson, I., & Hicks, A. (2006). Unconscious incompetence and the foundation years. Emergency Medicine Journal. https://doi.org/10.1136/emj.2005.033373

Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and individual differences*, *48*, 45-53.

Hodgen, J., & Askew, M. (2007). Emotion, identity and teacher learning: becoming a primary mathematics teacher. Oxford Review of Education, 33(4), 469–487. https://doi.org/10.1080/03054980701451090

Hoffman, B. (2010). “I think I can, but I’m afraid to try”: The role of self-efficacy beliefs and mathematics anxiety in mathematics problem-solving efficiency. Learning and Individual Differences, 20(3), 276–283. https://doi.org/10.1016/j.lindif.2010.02.001

Holmes, A. B. (2020). Researcher Positionality - A Consideration of Its Influence and Place in Qualitative Research - A New Researcher Guide. Shanlax International Journal of Education, 8(4), 1–10. https://doi.org/10.34293/education.v8i4.3232

Houldsworth, A. (2018). Conscious Competence in Interprofessional Learning in Healthcare Education. MedEdPublish, 7, 39. https://doi.org/10.15694/mep.2018.0000039.1

Howell, W. S. (1982). The Empathic Communicator. Wadsworth Publishing Company. University of Minnesota.

Hoy, A. W., Hoy, W. K., & Davis, H. A. (2009). Handbook of Motivation at School (K. R. Wentzel & A. Wigfield, Eds.). Routledge.

Hunt, T. K., Clark-Carter, D., & Sheffield, D. (2011). The Development and Part Validation of a U.K. Scale for Mathematics Anxiety. Journal of Psychoeducational Assessment, 29(5), 455–466. https://doi.org/10.1177/0734282910392892

Hunt, T. K., & Sari, M. (2019). An English Version of the Mathematics Teaching Anxiety Scale. International Journal of Assessment Tools in Education, 436–443. https://doi.org/10.21449/ijate.615640

Husserl, E. (1999). The Essential Husserl: Basic Writings in Transcendental Phenomenology. Indiana University Press.

Initial teacher training (ITT): criteria and supporting advice. (2022, August 26). GOV.UK. https://www.gov.uk/government/publications/initial-teacher-training-criteria/initial-teacher-training-itt-criteria-and-supporting-advice

Jackson, E. (2008). Mathematics anxiety in student teachers. Practitioner Research in Higher Education, 2(1), EJ1130555.

Johnston-Wilder, S., & Mason, J. (2004). Fundamental Constructs in Mathematics Education. Routledge.

Jones, M., & Straker, K. (2006). What informs mentors' practice when working with students and new teachers? An investigation in mentors' professional knowledge base. Journal of Education for Teaching, 32(2), 165–184.

Kara, H. (2015). Creative Research Methods in the Social Sciences: A Practical Guide. Policy Press.

Keleş, O., Taş, I., & Aslan, D. (2016). Metaphor perceptions of pre-service teachers towards mathematics and mathematics education in preschool education. Educational Research and Reviews, 11(14), 1338–1343. https://doi.org/10.5897/err2016.2727

Kincheloe, J. L., & Tobin, K. (2015). The Much-Exaggerated Death of Positivism. BRILL eBooks, 15–32. https://doi.org/10.1163/9789463000765_003

Kivunja, C., & Kuyini, A. B. (2017). Understanding and Applying Research Paradigms in Educational Contexts. International Journal of Higher Education, 6(5), 26. https://doi.org/10.5430/ijhe.v6n5p26

Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. Journal of Personality and Social Psychology, 77(6), 1121–1134. https://doi.org/10.1037/0022-3514.77.6.1121

Kullberg, A., Kempe, U. R., & Marton, F. (2017). What is made possible to learn when using the variation theory of learning in teaching mathematics? Zdm – Mathematics Education, 49(4), 559–569. https://doi.org/10.1007/s11858-017-0858-4

L Chap-Sam, & P Ernest. (2000). A Survey of Public Images of Mathematics. Research in Mathematics Education, 2:1, 193-206, DOI: 10.1080/14794800008520076, 2:1, 193–206. https://doi.org/10.1080/14794800008520076

Lane, A. N., & Roberts, C. (2020). Phenomenological study of medical interns reflecting on their experiences, of open disclosure communication after medication error: linking rationalisation to the conscious competency matrix. BMJ Open, 10(5), e035647. https://doi.org/10.1136/bmjopen-2019-035647

Lane, A. N., & Roberts, C. (2022). Contextualised reflective competence: a new learning model promoting reflective practice for clinical training. BMC Medical Education, 22(1). https://doi.org/10.1186/s12909-022-03112-4

Larkin, M., & Thompson, A. (2012). Qualitative Research Methods in Mental Health and Psychotherapy (D. Harper & A. R. Thompson, Eds.). John Willey & Sons.

Larkin, M., Watts, S., & Clifton, E. (2006). Giving voice and making sense in interpretative phenomenological analysis. Qualitative Research in Psychology, 3(2), 102–120. https://doi.org/10.1191/1478088706qp062oa

Lather, P. (1986). Research as Praxis. Harvard Educational Review, 56(3), 257–278. https://doi.org/10.17763/haer.56.3.bj2h231877069482

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and individual differences*, *19*(3), 355-365.

Lee, J. S., & Ginsburg, H. P. (2009). Early childhood teachers' misconceptions about mathematics education for young children in the United States. *Australasian Journal of Early Childhood*, *34*(4), 37-45.

Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. New Directions for Program Evaluation, 1986(30), 73–84. https://doi.org/10.1002/ev.1427

Ling, L., & Ling, P. (2016). Methods and Paradigms in Education Research. IGI Global.

Livingston, J. A. (2003). Metacognition: An Overview. In Educational Resources Information Centre (No. TM034808). ERIC.

Lopez, K. M., & Willis, D. G. (2004). Descriptive Versus Interpretive Phenomenology: Their Contributions to Nursing Knowledge. Qualitative Health Research, 14(5), 726–735. https://doi.org/10.1177/1049732304263638

Luft, J., & Ingham, H. (1961). The Johari window. Human Relations Training News, 5(1), 6–7.

Lutovac, S., & Kaasila, R. (2011). Beginning a pre-service teacher's mathematical identity work through narrative rehabilitation and bibliotherapy. Teaching in Higher Education, 16(2), 225–236. https://doi.org/10.1080/13562517.2010.515025

Lutovac, S., & Kaasila, R. (2018). Future Directions in Research on Mathematics-Related Teacher Identity. International Journal of Science and Mathematics Education, 16(4), 759–776. https://doi.org/10.1007/s10763-017-9796-4

Ma, L. (1999). Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States. Routledge.

Ma, L. (2020). Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States. Routledge.

MacDonald, A., & Murphy, S. (2021). Mathematics education for children under four years of age: A systematic review of the literature. Early years, 41(5), 522-539.

Macnab, D., & Payne, F. (2003). Beliefs, Attitudes and Practices in Mathematics Teaching: Perceptions of Scottish primary school student teachers. Journal of Education for Teaching, 29(1), 55–68. https://doi.org/10.1080/0260747022000057927

Malinsky, M. A., Ross, A. H., Pannells, T. C., & McJunkin, M. (2006). Math Anxiety in Pre-Service Elementary School Teachers. Education 3-13, 127(2), 274–279. https://eric.ed.gov/?id=EJ765826

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological science*, *26*(9), 1480-1488.

Mannay, D. (2015). Visual, Narrative and Creative Research Methods: Application, reflection and ethics. Routledge.

Manthey, D. E., & Fitch, M. J. (2012). Stages of competency for medical procedures. The Clinical Teacher, 9(5), 317–319. https://doi.org/10.1111/j.1743-498x.2012.00561.x

Mason, J. (2002a). Qualitative Researching. SAGE.

Mason, J. (2002b). Researching Your Own Practice: The Discipline of Noticing. Routledge.

Mason, J. (2018). Qualitative Researching. SAGE Publications Limited.

Mason, J., & Johnston-Wilder, S. (2004). Fundamental Constructs in Mathematics Education. Psychology Press.

Matua, G. A., & Van Der Wal, D. M. (2015). Differentiating between descriptive and interpretive phenomenological research approaches. Nurse Researcher, 22(6), 22–27. https://doi.org/10.7748/nr.22.6.22.e1344

Maxwell, J. A. (2021). Why qualitative methods are necessary for generalization. Qualitative Psychology, 8(1), 111–118. https://doi.org/10.1037/qup0000173

Mayer, D. C. (1999). Measuring Instructional Practice: Can Policymakers Trust Survey Data? Educational Evaluation and Policy Analysis, 21(1), 29–45. https://doi.org/10.3102/01623737021001029

McCourt, M. (2019). Teaching for Mastery. John Catt Educational.

McNaught, C., & Lam, P. K. (2014). Using Wordle as a Supplementary Research Tool. The Qualitative Report. https://doi.org/10.46743/2160-3715/2010.1167

Mercer, J. (2007). The challenges of insider research in educational institutions: wielding a double-edged sword and resolving delicate dilemmas. Oxford Review of Education, 33(1), 1–17. https://doi.org/10.1080/03054980601094651

Merriam, S. B., Johnson-Bailey, J., Lee, M., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: negotiating insider/outsider status within and across cultures. International Journal of Lifelong Education, 20(5), 405–416. https://doi.org/10.1080/02601370120490

Middleton, J. A., & Spanias, P. (1999). Motivation for Achievement in Mathematics: Findings, generalizations, and criticisms of the research. Journal for Research in Mathematics Education, 30(1), 65. https://doi.org/10.2307/749630

Mill, J. S. (2022). Auguste Comte and Positivism. BoD – Books on Demand.

Miller, R., Chan, C. S., & Farmer, L. B. (2018). Interpretative Phenomenological Analysis: A Contemporary Qualitative Approach. Counsellor Education and Supervision, 57(4), 240–254. https://doi.org/10.1002/ceas.12114

Montague-Smith, A., Cotton, T., Hansen, A., Price, A. J. (2017). Mathematics in Early Years Education. United Kingdom: Taylor & Francis

Moos, D., & Pitton, D. (2014). Student teacher challenges: using the cognitive load theory as an explanatory lens. Teaching Education, 25(2), 127–141. https://doi.org/10.1080/10476210.2012.754869

Moran, D. (2002). Introduction to Phenomenology. Routledge.

Moses, J., & Knutsen, T. (2012). Ways of Knowing: Competing Methodologies in Social and Political Research. Palgrave Macmillan.

Moustakas, C. (1994). Phenomenological Research Methods. SAGE Publications.

Muijs, D., & Reynolds, D. (2002). Teachers' Beliefs and Behaviors: What Really Matters? The Journal of Classroom Interaction, 50(1), 25–40. http://files.eric.ed.gov/fulltext/EJ1100408.pdf

Muijs, J. (2018, March 3). Ofsted boss calls for teachers to prove subject knowledge. Schools Week. https://schoolsweek.co.uk/ofsted-boss-calls-for-teachers-to-prove-subject-knowledge-to-stay-qualified/

National Numeracy (Ed.). (2019). Building a Numerate Nation: confidence, belief and skills. In https://www.nationalnumeracy.org.uk/sites/default/files/documents/Building_a_numerate_nation/building_a_numerate_nation_report.pdf.

Noe, R. A. (1988). An Investigation of the Determinants of Successful Assigned Mentoring Relationships. Personnel Psychology, 41(3), 457–479. https://doi.org/10.1111/j.1744-6570.1988.tb00638.x

Noon, E. (2018). Interpretative Phenomenological Analysis: An Appropriate Methodology for Educational Research? Journal of Perspectives in Applied Academic Practice, 6(1 (2018)), 75–83.

Norton, S. A. (2017). Primary Mathematics Trainee Teacher Confidence and its Relationship to Mathematical Knowledge. Australian Journal of Teacher Education. https://doi.org/10.14221/ajte.2017v42n2.4

Nowell, L., Norris, J. M., White, D. L., & Moules, N. J. (2017). Thematic Analysis. International Journal of Qualitative Methods, 16(1), 160940691773384. https://doi.org/10.1177/1609406917733847

Noyes, A., Brignell, C., Jacques, L., Powell, J., & Adkins, M. (2023). The mathematics pipeline in England Patterns, interventions and excellence. In The University of Nottingham (Ed.), https://www.nottingham.ac.uk/research/groups/crme/documents/maths-pipeline-report.pdf University of Nottingham.

Ofsted. (2017) Bold Beginnings: The Reception Curriculum in a sample of good and outstanding primary schools. https://www.gov.uk/government/publications/reception-curriculum-in-good-and-outstanding-primary-schools-bold-beginnings

Ofsted. (2019). Education Inspection Framework (EIF). Education inspection framework (EIF) - GOV.UK (www.gov.uk)

Ortlipp, M. (2015). Keeping and Using Reflective Journals in the Qualitative Research Process. The Qualitative Report. https://doi.org/10.46743/2160-3715/2008.1579

Ottesen, E. (2007). Reflection in teacher education. Reflective Practice, 8(1), 31–46. https://doi.org/10.1080/14623940601138899

Oxford Languages and Google - English | Oxford Languages. (2022, August 12). https://languages.oup.com/google-dictionary-en/

Pagnini, F., Sidey-Gibbons, C., & Castelnuovo, G. (2012). The importance of an idiographic approach for the severe chronic disorders—the case of the amyotrophic lateral sclerosis patient. Frontiers in Psychology, 3. https://doi.org/10.3389/fpsyg.2012.00509

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. Journal of Educational Psychology, 86(2), 193–203. https://doi.org/10.1037/0022-0663.86.2.193

Pearson Education. (2019). A Guide to Tackling Maths Anxiety. https://www.pearson.com/uk/content/dam/one-dot-com/one-dot-com/uk/documents/subjects/mathematics/guide-to-tackling-maths-anxiety-power-maths-report.pdf

Pendergast, D., Garvis, S., & Keogh, J. (2011). Pre-Service Student-Teacher Self-efficacy Beliefs: An Insight Into the Making of Teachers. Australian Journal of Teacher Education, 36(12). https://doi.org/10.14221/ajte.2011v36n12.6

Percipio Global Ltd. (2022, November 30). How we work. EEF. https://educationendowmentfoundation.org.uk/about-us/how-we-work

Perry, E., Booth, J., Owen, D., & Bower, K. (2019). The Curriculum for Initial Teacher Education: Literature Review. In Sheffield Hallam University. Sheffield Institute of Education.

Pietkiewicz, I. J., & Smith, J. D. (2014). A practical guide to using Interpretative Phenomenological Analysis in qualitative research psychology. Czasopismo Psychologiczne, 20(1). https://doi.org/10.14691/cppj.20.1.7

Plake, B. S., & Parker, C. E. (1982). The Development and Validation of a Revised Version of the Mathematics Anxiety Rating Scale. Educational and Psychological Measurement, 42(2), 551–557. https://doi.org/10.1177/001316448204200218

Povey, H. (1997). Beginning mathematics teachers' ways of knowing: the link with working for emancipatory change. Curriculum Studies, 5(3), 329–343. https://doi.org/10.1080/14681369700200016

Prendergast, M. (2009). the scholar dances. Qualitative Inquiry, 15(8), 1373–1375. https://doi.org/10.1177/1077800409332079

Puteh, M. (2002). Qualitative research approach towards factors associated with mathematics anxiety. In Proceedings of the 3rd international mathematics education and society conference. Copenhagen: Centre for Research in Learning Mathematics.: Vol. pp 1-5. Centre for Research in Learning Mathematics.

Ragins, B. R., & Kram, K. E. (2008). The Handbook of Mentoring at Work: Theory, Research, and Practice. In SAGE Publications, Inc. eBooks. https://doi.org/10.4135/9781412976619

Rahmani, M. (2020). Medical Trainees and the Dunning–Kruger Effect: When They Don't Know What They Don't Know. Journal of Graduate Medical Education, 12(5), 532–534. https://doi.org/10.4300/jgme-d-20-00134.1

Rand, D. G., Ross, R., Koehler, D. J., & Fugelsang, J. A. (2017). Dunning–Kruger effects in reasoning: Theoretical implications of the failure to recognize incompetence. Psychonomic Bulletin & Review, 24(6), 1774–1784. https://doi.org/10.3758/s13423-017-1242-7

Refugio, C. N., Galleto, P. G., & Torres, R. (2019). Competence landscape of grade 9 mathematics teachers: Basis for an enhancement program. Cypriot Journal of Educational Sciences, 14(2), 241–256. https://doi.org/10.18844/cjes.v14i2.4125

Renaud, K., Zimmermann, V., Schürmann, T., & Böhm, C. (2021). Exploring cybersecurity-related emotions and finding that they are challenging to measure. Humanities & Social Sciences Communications, 8(1). https://doi.org/10.1057/s41599-021-00746-5

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology, 19(6), 551–554. https://doi.org/10.1037/h0033456

Rita Brown. (2015, March 9). Blast from the Past: Donald Rumsfeld on Unknown Unknowns [Video]. YouTube. https://www.youtube.com/watch?v=aNenoOODMhM

Rogers, K., Luton, R., Biggs, H., Biggs, R., Blignaut, S., Choles, A. G., Palmer, C. G., & Tangwe, P. T. (2013). Fostering Complexity Thinking in Action Research for Change in Social Amp; 8211;Ecological Systems. Ecology and Society, 18(2). https://doi.org/10.5751/es-05330-180231

Ross, L. E. (2017). An account from the inside: Examining the emotional impact of qualitative research through the lens of “insider” research. Qualitative Psychology, 4(3), 326–337. https://doi.org/10.1037/qup0000064

Rouse, L. (2013, June 9). A Change of View: Using Visual Methods to Explore Experience in Qualitative Research. JEPS Bulletin. https://blog.efpsa.org/2013/05/15/a-change-of-view-using-visual-methods-to-explore-experience-in-qualitative-research/

Rowland, T., Huckstep, P., & Thwaites, A. (2005). Elementary Teachers’ Mathematics Subject Knowledge: the Knowledge Quartet and the Case of

Naomi. Journal of Mathematics Teacher Education, 8(3), 255–281. https://doi.org/10.1007/s10857-005-0853-5

Rowland, T., Martyn, S., Barber, P., & Heal, C. (2000). Primary Teacher Trainees' Mathematics Subject Knowledge and Classroom Performance. Research in Mathematics Education, 2(1), 3–18. https://doi.org/10.1080/14794800008520064

Rowland, T., & Ruthven, K. (2011). Mathematical Knowledge in Teaching. Springer Science & Business Media.

Ruffell, M., Mason, J., & Allen, B. L. (1998). Studying attitude to mathematics. Educational Studies in Mathematics, 35(1), 1–18. https://doi.org/10.1023/a:1003019020131

Rumsfeld, D. (2011). Known and Unknown: A Memoir. Penguin.

Ruona, W. E. A., & Gilley, J. W. (2009). Practitioners in Applied Professions: A Model Applied to Human Resource Development. Advances in Developing Human Resources, 11(4), 438–453. https://doi.org/10.1177/1523422309344719

Saddler, Y., & Sundin, E. (2020). Mature students' journey into higher education in the UK: an interpretative phenomenological analysis. Higher Education Research and Development, 39(2), 332–345. https://doi.org/10.1080/07294360.2019.1672624

Sam, L. C., & Ernest, P. (2000). A survey of Public Images of Mathematics. Research in Mathematics Education, 2(1), 193–206. https://doi.org/10.1080/14794800008520076

Scarpello, G. (2007). Helping Students Get Past Math Anxiety. Association for Career and Technical Education (ACTE)., 82(6), 34–35.

Schenk, S., Poell, R. F., De Lange, W., & Simons, P. (2018). Improving performance management interviews between managers and professionals: A longitudinal study on talking about the development of complex new social behavior. The Psychologist-Manager Journal. https://doi.org/10.1037/mgr0000067

Schmidt, L. K. (2016). Understanding Hermeneutics. Routledge.

Schon, D. A. (1984). The Reflective Practitioner: How Professionals Think In Action.

Schuler, S., & Wittmann, G. (2010). How can games contribute to early mathematics education?–A video-based study. CERME 6–WORKING GROUP 14, 2647.

Shulman, L. P. (1986). Those Who Understand: Knowledge Growth in Teaching. Educational Researcher, 15(2), 4–14. https://doi.org/10.3102/0013189x015002004

Shulman, L. P. (1999). Taking Learning Seriously. Change: The Magazine of Higher Learning, 31(4), 10–17. https://doi.org/10.1080/00091389909602695

Sikes, P. (2003). Making the Familiar Strange: A new look at inequality in education. British Journal of Sociology of Education, 24(2), 243–248. https://doi.org/10.1080/01425690301898

Sikes, P. (2004). Doing Educational Research (C. Opie, Ed.). SAGE.

Skemp, R. (1976). Relational Understanding and Instrumental Understanding - National Council of Teachers of Mathematics. https://www.nctm.org/Publications/Mathematics-Teaching-in-Middle-School/2006/Vol12/Issue2/Relational-Understanding-and-Instrumental-Understanding/

Skene, K., O'Farrelly, C. M., Byrne, E. M., Kirby, N., Stevens, E. C., & Ramchandani, P. G. (2022). Can guidance during play enhance children's learning and development in educational contexts? A systematic review and meta-analysis. Child Development, 93(4), 1162-1180.

Smith, J. A., Flowers, P., & Larkin, M. (2009). Interpretative Phenomenological Analysis: Theory, Method and Research. SAGE Publications.

Smith, J. A., Flowers, P., & Larkin, M. (2022). Interpretative Phenomenological Analysis: Theory, Method and Research. Sage Publications Limited.

Smith, J. D. (2008). Reflecting on the development of interpretative phenomenological analysis and its contribution to qualitative research in psychology. Qualitative Research in Psychology, 1(1), 39–54. https://doi.org/10.1191/1478088704qp004oa

Smith, J. D. (2010). Interpretative phenomenological analysis: a reply to Amedeo Giorgi. Existential Analysis, 21(2), 186–193.

Smith, ,J. Flower, P and Larkin, M (2009),Interpretative Phenomenological Analysis: Theory, Method and Research. (2009). Qualitative Research in Psychology, 6(4), 346–347. https://doi.org/10.1080/14780880903340091

Sood, S., & Jitendra, A. K. (2007). A comparative analysis of number sense instruction in reform-based and traditional mathematics textbooks. *The journal of special education*, *41*(3), 145-157.

Stripp, C. (2016, April 20). What is teaching for mastery in maths? Schools Week. https://schoolsweek.co.uk/what-is-teaching-for-mastery-in-maths/

Sunak, R., MP & Prime Minster's Office. (2023, April 17). PM speech on Improving Attainment in Mathematics: 17 April 2023.

Swedberg, R. (2014). The art of social Theory. Princeton University Press.

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. Learning and Instruction, 4(4), 295–312. https://doi.org/10.1016/0959-4752(94)90003-5

Tan, J. B., & Yates, S. (2011). Academic expectations as sources of stress in Asian students. *Social Psychology of Education*, *14*, 389-407.

Thornton, A (ed), C. C. O. (2022). The Early Career Framework Handbook (2nd ed.). SAGE.

Telang, A., Rathod, S., A Supe, Nebhinani, N., & Mathai, S. (2017). Faculty views on competency-Based medical education during mentoring and learning web sessions. An Observational Study. Journal of Education Technology in Health Sciences, 4(1), 9–13.

Thomas, G. (2011). How to Do Your Case Study: A Guide for Students and Researchers. SAGE Publications.

Thomas, G. (2013). How to Do Your Research Project: A Guide for Students in Education and Applied Social Sciences. SAGE Publications Limited.

Thomas, G. (ca. 2023). How to Do Your Research Project: A Guide for Students (4th ed.). SAGE.

Toom, A., Pietarinen, J., Soini, T., & Pyhältö, K. (2017). How does the learning environment in teacher education cultivate first year student teachers' sense of professional agency in the professional community? Teaching and Teacher Education, 63, 126–136. https://doi.org/10.1016/j.tate.2016.12.013

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: capturing an elusive construct. Teaching and Teacher Education, 17(7), 783–805. https://doi.org/10.1016/s0742-051x(01)00036-1

Tucker, K. (2014). Mathematics through play in the early years. SAGE.

Tuffour, I. (2017). A Critical Overview of Interpretative Phenomenological Analysis: A Contemporary Qualitative Research Approach. Journal of Healthcare Communications, 02(04). https://doi.org/10.4172/2472-1654.100093

Tufte, E. R. (2001). The Visual Display of Quantitative Information (2nd ed.). Graphics Press.

Underhill, A. (1992). The role of groups in developing teacher self-awareness. ELT Journal, 46(1), 71–80. https://doi.org/10.1093/elt/46.1.71

University of Huddersfield. (2019). Data Protection Policy. https://www.hud.ac.uk/media/policydocuments/Data-Protection-Policy.pdf.

Villegas-Reimers, E. (2003). Teacher Professional Development: An International Review of the Literature.

Vitello, S., & Greatorex, J. (2022, January 26). What is competence? A shared interpretation of competence to support teaching, learning and assessment. Cambridge University Press & Assessment. Retrieved March 9, 2023, from https://www.cambridge.org/news-and-insights/insights/What-is-competence-A-shared-interpretation-of-competence-to-support-teaching-learning-and-assessment

Vygotsky, L. (1980). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.

Wheater, R., Durbin, B., McNamara, S., & Classick, R. (2016). Is mathematics education in England working for everyone? NFER analysis of the PISA performance of disadvantaged pupils. In https://www.nfer.ac.uk/media/2079/pian01.pdf. NFER.

Williams, H. J. (2022). *Playful Mathematics: For Children 3 to 7*. Sage Publications UK.

Williams, P. (2008). Independent review of mathematics teaching in early years settings and primary schools : final report - Digital Education Resource Archive (DERA). https://dera.ioe.ac.uk/8365/

Willig, C. (2008). Introducing Qualitative Research in Psychology. McGraw-Hill Education (UK)

Willig, C. (2013). Introducing Qualitative Research In Psychology. McGraw-Hill Education (UK).

Willingham, D. T. (2009). Is It True That Some People Just Can't Do Math? American Educator, 33(4), 14–19.

Wilson, S. (2015). "I Was in Year 5 and I Failed Maths": Identifying the Range and Causes of Maths Anxiety in First Year Pre-Service Teachers. Mathematics Education Research Group of Australasia, 643. http://files.eric.ed.gov/fulltext/ED572514.pdf

Wilson, S., & Thornton, S. (2006). To heal and enthuse: Developmental bibliotherapy and pre-service primary teachers' reflections on learning and teaching mathematics. MERGA 29, 1, 35–44.

Wu, S. S., Barth, M., Amin, H., Malcarne, V., and Menon, V. (2012). Math anxiety in second and third graders and its relation to mathematical achievement. Front. Dev. Psychol. 3:162. doi: 10.3389/fpsyg.2012.00162

Wyse, D., Brown, C., Oliver, S., & Poblete, X. (2018, November). BERA Statement on Close-to-Practice Research. https://www.bera.ac.uk/publication/bera-statement-on-close-to-practice-research

Yardley, L. (2000). Dilemmas in qualitative health research. Psychology & Health, 15(2), 215–228. https://doi.org/10.1080/08870440008400302

Yilmaz, K. (2013). Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. European Journal of Education, 48(2), 311–325. https://doi.org/10.1111/ejed.12014

Yin, R. K. (2009). Case Study Research: Design and Methods. SAGE.

Young, C. B., Wu, S. S., and Menon, V. (2012). The neurodevelopmental basis of math anxiety. *Psychol. Sci.* 23, 492–501. doi: 10.1177/0956797611429134

Zimmermann, J. (2015). Hermeneutics: A Very Short Introduction. Oxford University Press, USA.

Appendices

Appendix 1

Participant information and consent forms (unsigned and scanned versions)

University of Huddersfield
School of Education and Professional Development

Participant Information Sheet (E3)

Research Project Title: *Student teacher relationships with mathematics-PILOT*
Thank you for reading this. I am inviting you to take part in my research project. This sheet gives you a little information about it. Please ask me if something isn't clear.

What is the purpose of the project?
I am conducting a pilot study to explore trainee teacher's views of mathematics at different points of the BA Primary QTS course, I am looking at emotional and personal reflections.
Why have I been chosen?
As a third year trainee you are at the end of your ITT experience and as such can reflect upon your learning journey, it is that experience I wish to explore in greater depth.
Do I have to take part?
No, not if you don't want to. You can also withdraw at any point – you don't need to say why.
What do I have to do?
You will be asked to create 2 models that reflect your feelings about mathematics at the start of the 3 year programme and how you feel now. You will share your model and explain it to another trainee while being recorded on the ipads, in order to capture the images and data.
Are there any disadvantages to taking part?
No, as far as we know. If you are worried, please talk to me (the researcher) or get in touch with Emma Salter at the University of Huddersfield, who is my supervisor.

Will all my personal details be kept confidential?
Yes. Any information about you which is collected will be strictly confidential. Data will be anonymised before being used in my thesis. It will comply with the Data Protection Act and ethical research guidelines and principles. Everything will be stored securely.

What will happen to the results of the research study?
The results of this research will be part of the pilot for my PhD looking at trainee teachers and their journey into becoming maths teachers.
Who has reviewed and approved the study, and who can be contacted for further information?
Dr Emma Salter, Tel: 01484 478282, E.Salter@hud.ac.uk
Name & Contact Details of Researcher: - K.aspin@hud.ac.uk

University of Huddersfield

School of Education and Professional Development

Participant Consent Form (E4)

Title of Research Study: *'I'm rubbish at maths!': A critical evaluation of Primary ITT undergraduates' learning journeys as emerging Primary Maths teachers*

- ☐ I confirm that I have read and understood the participant Information sheet related to this research, and have had the opportunity to ask questions.
- ☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.
- ☐ I understand that all my responses will be anonymised.
- ☐ I agree to take part in the above study

Name of Participant: .....

Signature of Participant: .....

Date: 8/5/18

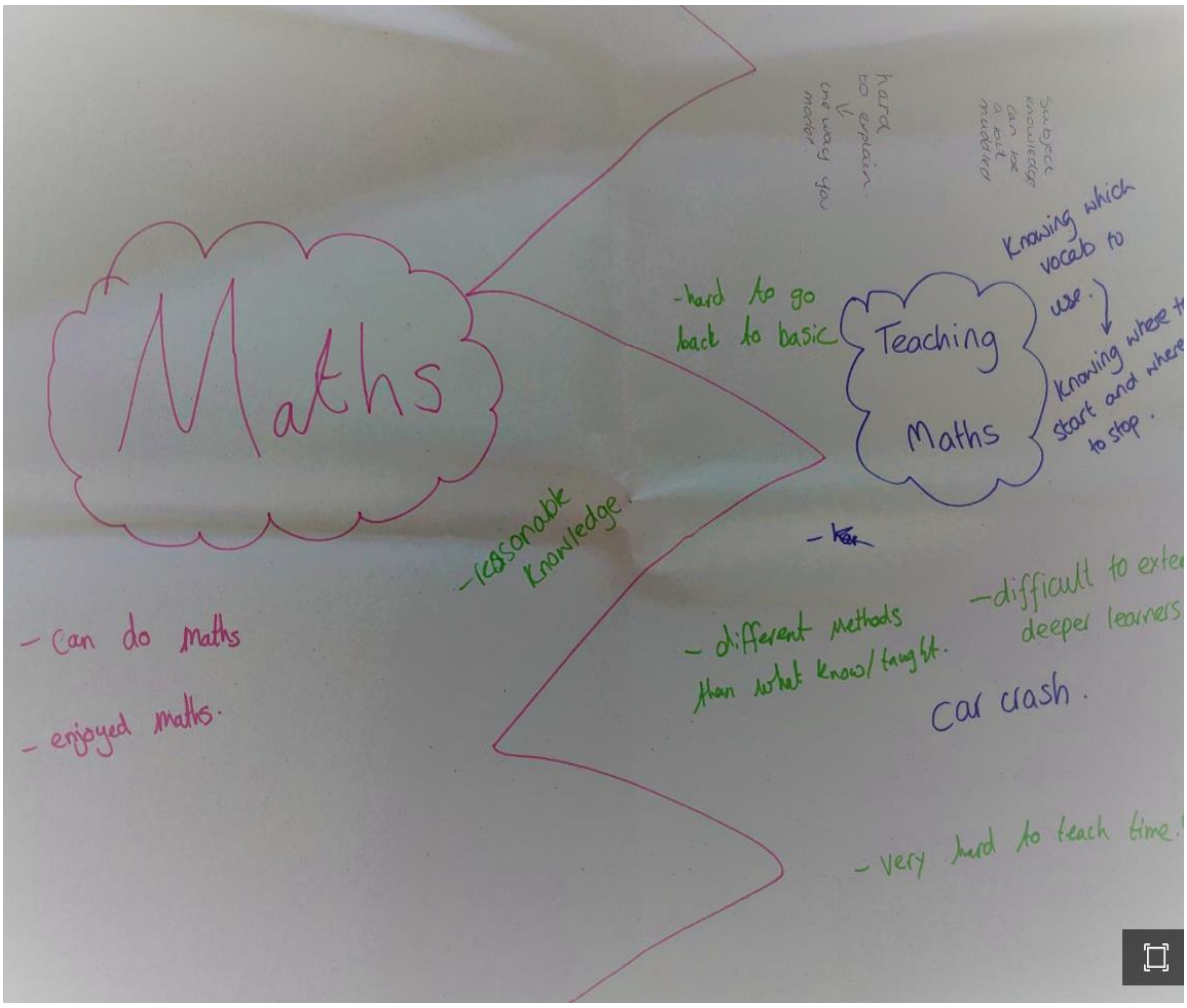
Name of Researcher: K V Aspin

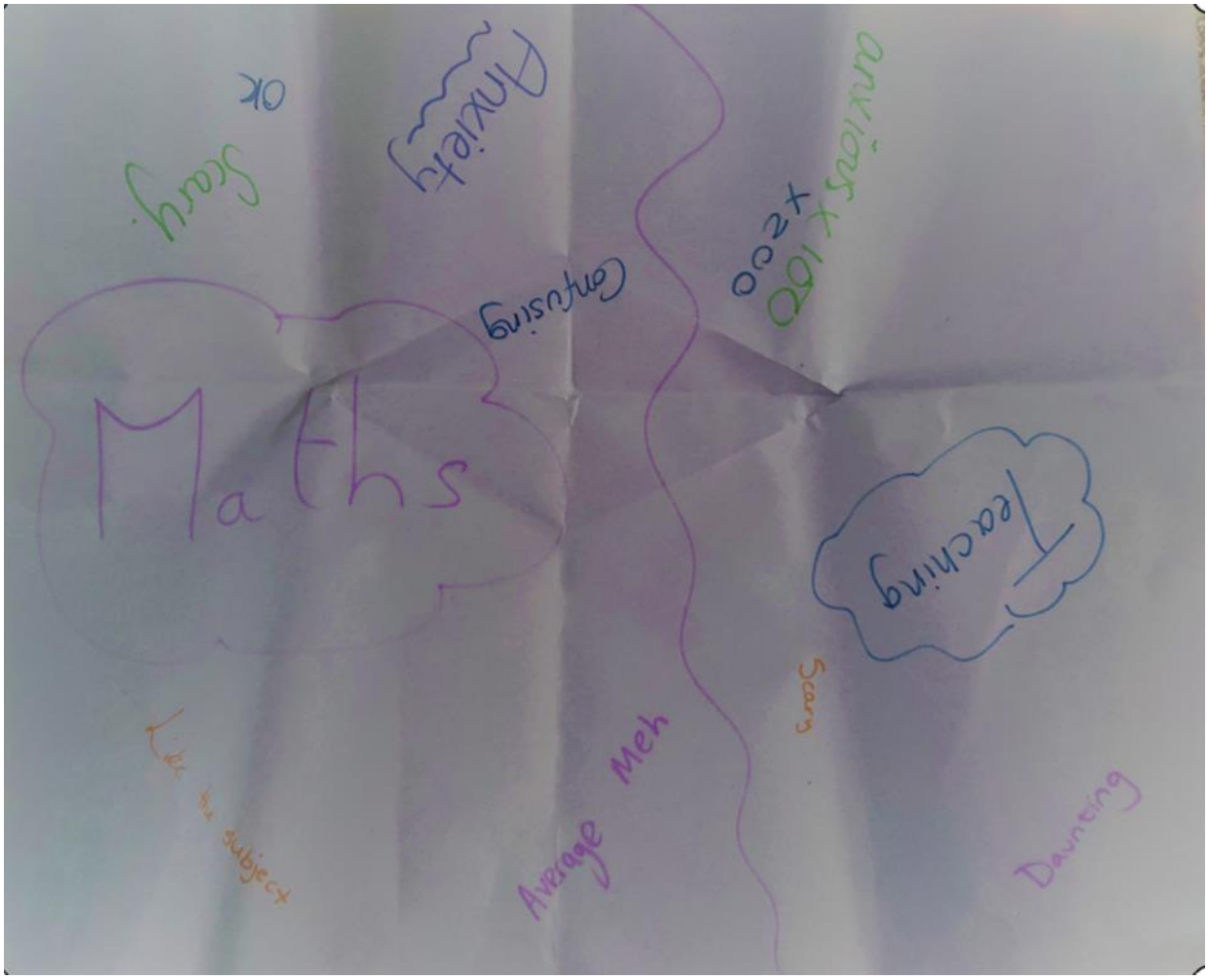
Signature of Researcher: KVASPIN

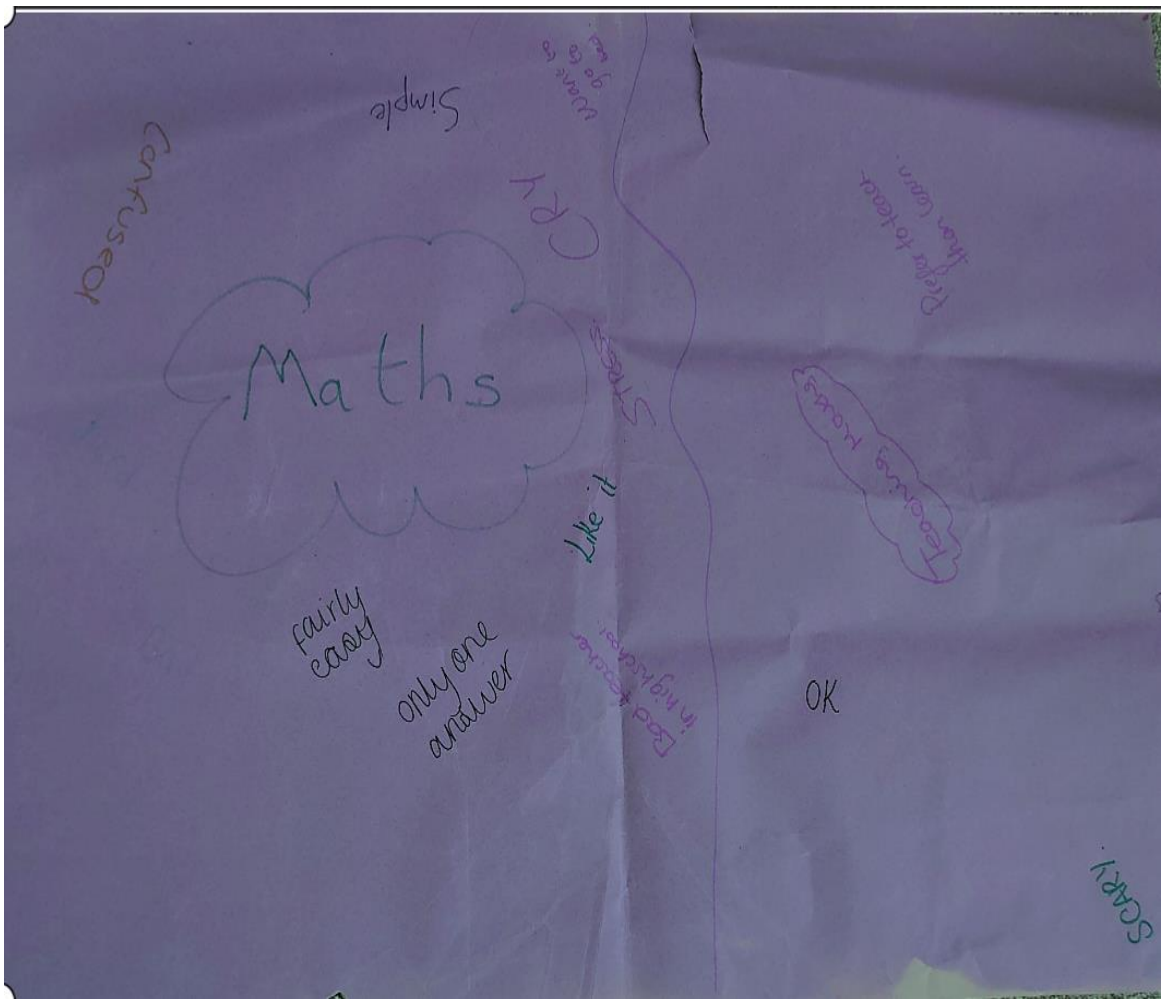
Date: 8/5/18

Appendix 2

Examples of raw data from the Word Cloud data collection

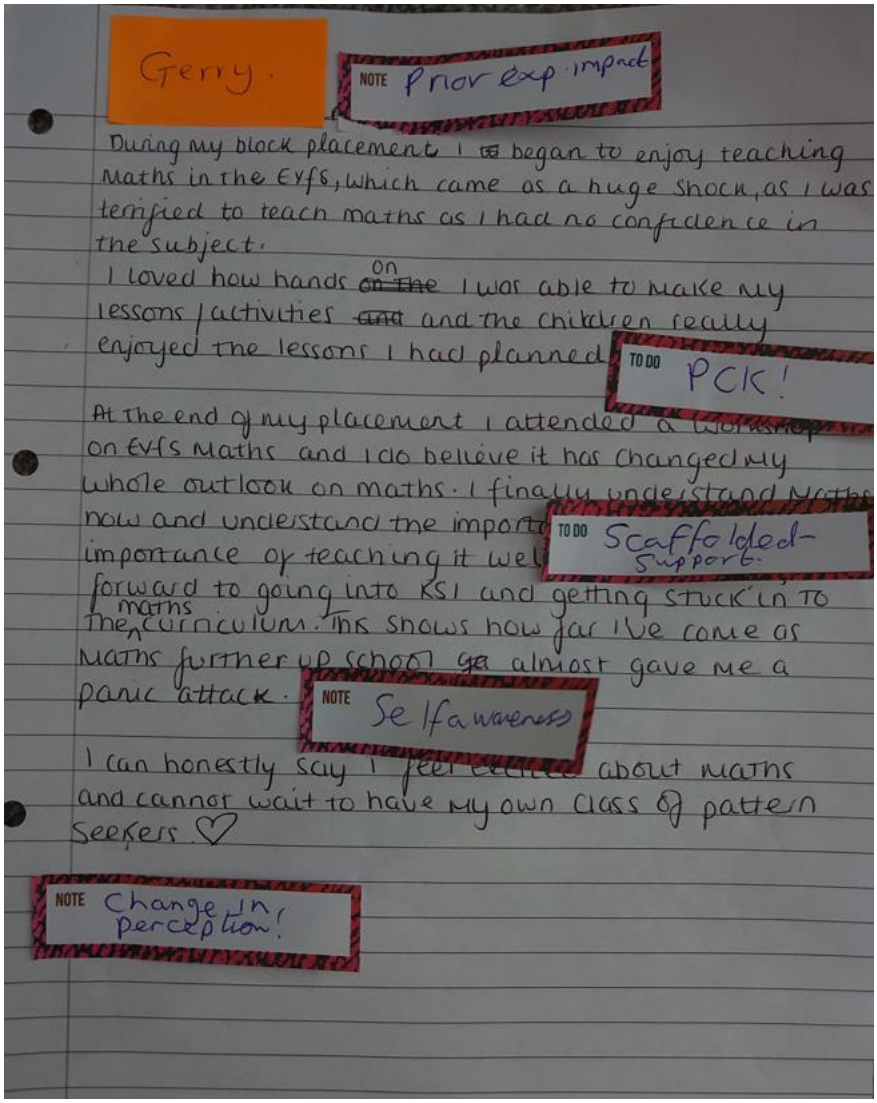



Maths
Anxiety
Enjoying
Teaching
Like the subject
Average Meh
Scary
Daunting

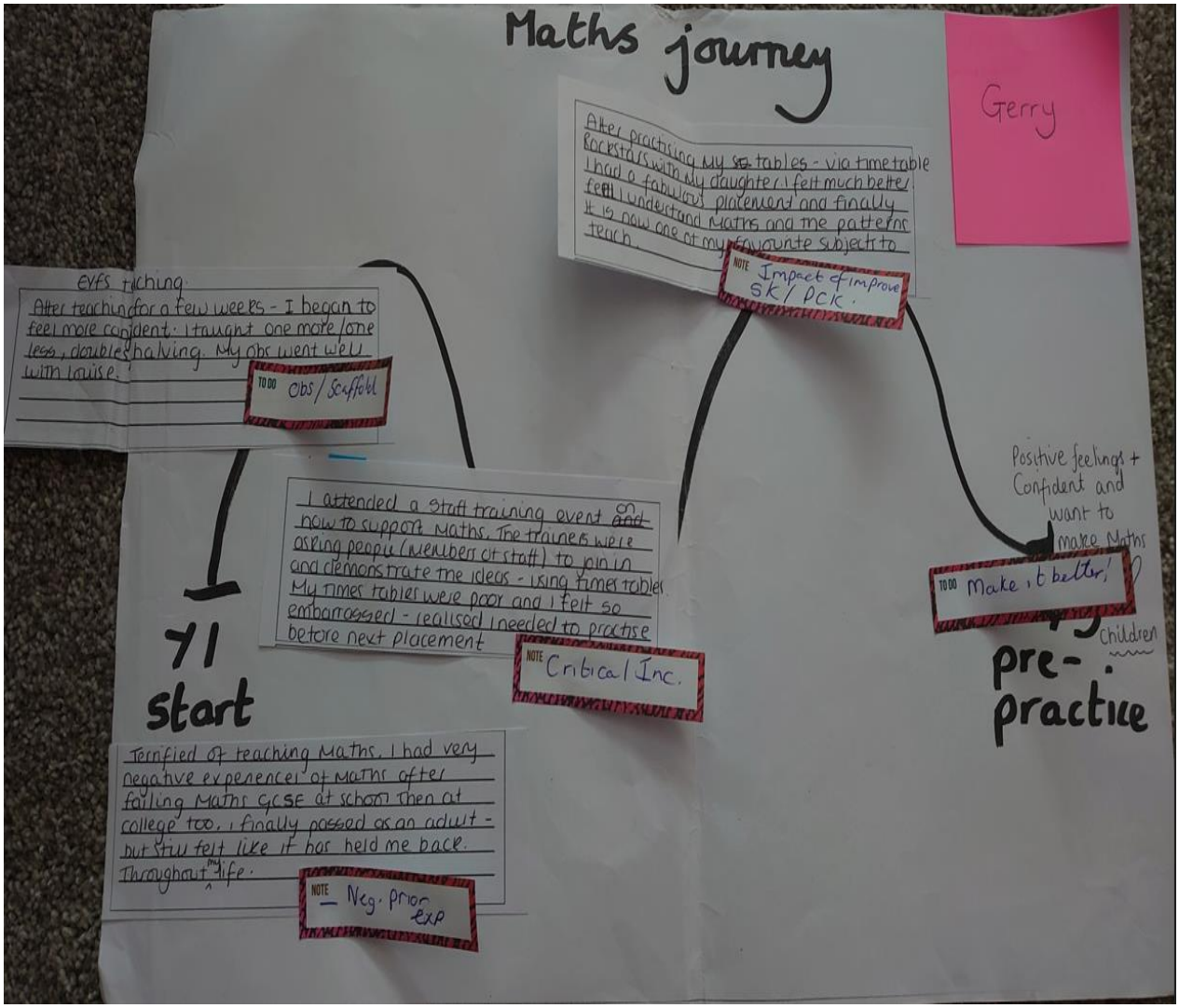

Maths
Simple
Confused
CRY
Stress
Like it
fairly easy
only one answer
OK
Scary
Prefer to learn from Learning models

Appendix 3

Examples of the RTA data and coding process, from the participant Gerry. Taken from raw evidence, through coding iterations.



Refection and post it initial codes.



Journey map with initial codes – this was re-shared with the participants in the IPA interviews.

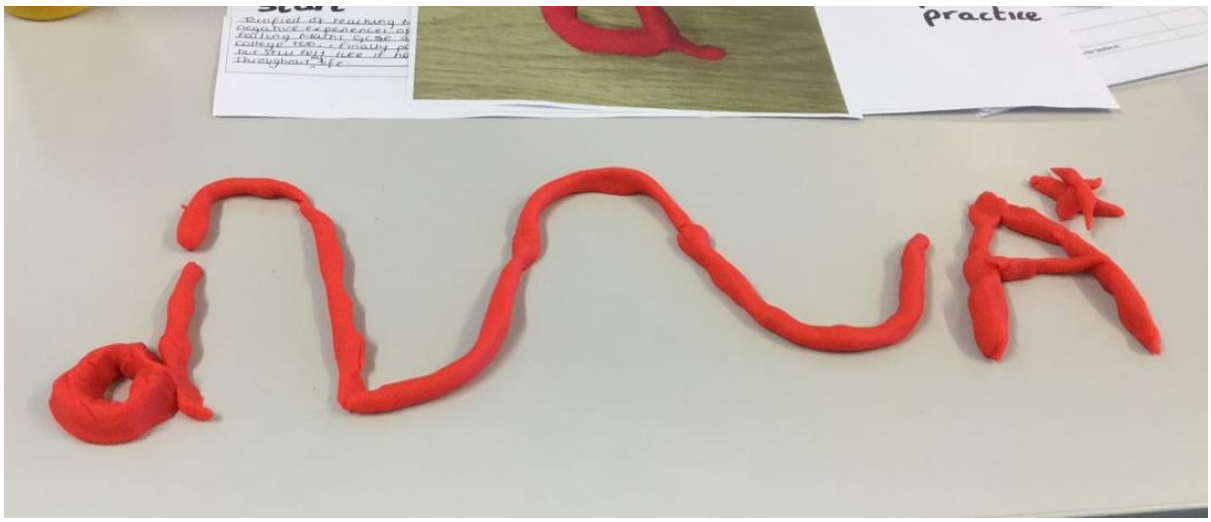
Image Sept Year 1

Trainee GERRY

Gerry had created the letter d from playdough - iPad interview transcript

So, my symbol is the letter d, because this is the grade that I got when I did my maths GCSE at sixteen years old, I was very upset and disappointed at this grade and it has stuck with me ever since. This has led to me losing all my confidence and enjoyment of maths from that time onwards, even up to this day and having obtained my maths GCSE later on, I still feel that disappointment sharply.

Image Sept Y3



Trainee Gerry - iPad transcript

I created a play dough letter d originally, and my new creation (d and wiggly snake leading to an A*)

Shows my journey from my d and how I felt at the start, very clouded by that GCSE result, and my journey with ups and downs from practice, but that now the A* represents my feelings now, that I feel confident and much more positive about teaching maths, I finally understand maths better myself, and as a teacher I aim to make maths fun and enjoyable and that is what I believe I lacked myself as a child. Therefore, I don't want to pass on any negative feelings that I had here (indicating the d) into my final year and into my teaching career, I have finally become positive where there was only negative.

Guide to codes:-

Yellow:- reference to prior experiences of maths

Cyan:-Emotional language and impact on confidence

Pink:- Link to pedagogical content knowledge

Grey:-indicates a change in relationship to maths

RTA raw data grouped under themes Gerry	
Theme	Evidence (quotes in italics)
Subject knowledge +impact of previous education/secondary school /emotional lang	*Maths has always been something I struggled with* (reflection) Language *terrified..* Negative experience of maths D at GCSE -this was the sculpture created - *still feel that disappointment sharply. (video 1*) *So my symbol is the letter d, because this is the grade that I got when I did my maths GCSE at sixteen years old, I was very upset and disappointed at this grade and it has stuck with me ever since. This has led to me losing all my confidence and enjoyment of maths from that time onwards-video* 1 *Gained lots of SK during lectures* - reflection *Don't want to pass on any negative feelings (*image interview 2)
Pedagogical Content Knowledge (the how I teach it)	*Terrified of teaching maths* (Year 1 view) *At the start I had no idea how to teach maths or what approach to take* - Reflection *finally understand maths better myself, and as a teacher I aim to make maths fun and enjoyable and that is what I believe I lacked myself as a child.* *Image 2* *I finally understand maths now and the importance of teaching it well (journey)*
Dunning Kruger/Unconscious incompetence	No evidence
Scaffolding/Knowledgeable other notion	*The teacher created excitement*- from own school exp *observation with tutor went well*- affirmation –journey map
Critical incident – realisation of personal responsibility	*I attended a staff training event on how to support in maths. Trainers were asking staff to join in and demonstrate the ideas using times tables. My times tables were poor, I felt so embarrassed. I realised at the moment that I needed to practise before next placement.* (journey) *I finally understand maths better myself* - Image interview 2

Appendix 4

Semi Structured Interview Guide for the IPA interviews

In line with the recommended structure of IPA, interviews have been viewed as a "conversation with a purpose" (Smith et al.,2022 p 54). A flexible guide was applied to all of the interviews conducted in the research. This allowed for reflexivity on behalf of the researcher, having a structure to guide the conversation and ensure that the interview had sufficient depth. Leaving room for diversification and greater depth probing of key themes.

The key themes emerged from the earlier creative methods data sources, these were used as the framework for the guide, scaffolding the questions and 'warming up' the participants and allowing them to re-engage with the topic and data that was gathered several years ago. Since IPA methodology directs the focus to be upon how participants make sense of their world and experiences, the interview conversation focused upon these key incidents or critical incidents (Mason 2002, Mason and Johnston Wilder, 2004) that the participants had originally identified in the creative methods research undertaken whilst on the degree course.

All interviews began with an initial 'warm up/catch up 'conversation as it had been over six months since the researcher and the participants had met. This also allowed the researcher to situate the conversation and gauge the participants wellbeing, and if there were any social or emotional issues that may arise (in line with BERA guidelines 2018 and duty of care).

1) Let's talk about your early maths experiences, you stated in your initial interview and your model building that maths hadn't been a great experience for you, can you talk more about that?
2) Where there any specific incidents that you can recall that impacted upon you and your relationship with maths?
3) Your journey through the BA course suggests that you became more at ease with maths, (show the journey map) would you agree with that? What were your placement maths experiences like? Where there are critical incidents that stand out to you?

4) How do you feel about maths now as a teacher with almost a year of experience?
5) Reflecting on your full journey from early days trainee to teacher, what has made the biggest difference to your maths teaching and confidence in the subject? E.g., Pedagogical content knowledge/subject knowledge/ greater experience etc.
6) What does a confident primary maths teacher look like to you?
7) What are your next steps in developing your maths and maths teaching skills?

The above are suggestions if the conversation diverts or takes a different direction, this is welcomed, and the key focus remains exploring the development of the participant and their emotional and personal views of the subject.