THE GAP BETWEEN THEORY AND PRACTICE IN PRIMARY MATHEMATICS: PGCE STUDENTS' PERSPECTIVES ON 'TEACHING FOR MASTERY'

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Abstract

This thesis applies a constructivist perspective to the analysis of primary PGCE students' perceptions of the theoretical and practical aspects of their teacher training. It provides a discussion of the prevailing discourses in initial teacher education as well as that of the 'mastery' curriculum for mathematics that is prevalent in primary schools in England. The study takes a 'partially mixed method' approach to the collection of data; data were collected from a questionnaire given to the whole cohort of PGCE students who were pursuing a strength in mathematics at a medium-sized university in the West of England in the academic year 2017-18. This was used in conjunction with semi-structured telephone interviews that were conducted with a sample of eight of the students in the spring and summer terms of 2018. A Friedman Test of differences as well as a *post-hoc* Nemenyi Test was conducted on questionnaire data to highlight significant findings. The interview data underwent thematic analysis. The study finds that students do encounter difficulties when implementing the theoretical aspects of their training in practice and that this is influenced by a number of enabling and constraining factors both at university and at school. The thesis makes a methodological contribution in arguing the case for the use of telephone interviews in educational research and in exemplifying issues around insider/outsider fieldwork. It also makes recommendations for professional practice in terms of partnership between schools and higher education institutes as well as recommendations about training for mentors and those supporting primary PGCE students in schools. Finally, the thesis identifies a so called 'matryoshka effect' that inhibits students' ability to make use of their learning from university in school and it argues the case for a 'matryopraxis' approach to learning that uses these research findings for improving the training of primary education students.

Author’s Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of this thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Signed:…………………………………………   Date: 20th November 2021

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Chapter 1 - Introduction

According to Jean Piaget,

> '… all knowledge is tied to action, and knowing an object or an event is to use it by assimilating it to an action scheme ...' (Piaget, 1971, p. 14).

As this insight suggests, theory (knowledge) and practice (action) have a symbiotic relationship. In education, practice relies upon theory and without practice, theory is of limited usefulness. This thesis is concerned with the link between theory and practice in primary education.

From the early stages of my own primary school teaching career, I have been involved in supporting student teachers during their teaching practices in school, first as a teacher in whose class the students taught and then as their mentor in school. I have worked with students following different routes to Qualified Teacher Status (QTS), including Bachelor of Education (BEd) degrees, the Post Graduate Certificate in Education (PGCE) and the Graduate Teacher Programme (GTP) and its successor, School Direct. I have encountered students with a range of backgrounds and from all stages of life. Common to the vast majority of students has been the importance that they have placed on the school-based elements of their training and, conversely, the derision with which some have viewed their university-based study. Over the years, this has led to many conversations about the nature of what students learn at university and the extent to which they apply this learning to their classroom practice. Many of these conversations have featured the terms 'theory' and 'practice' with 'practice' usually portrayed as the more relevant of the two. Indeed, during an informal conversation held with a PGCE student about the theory that she had learned at university, she explained that she had '… had a lecture on that ...' and that Kolb and Vygotsky were educational theorists. When asked about Kolb and Vygotsky's ideas and their relevance to her, she said that she could not really remember. Why should this be? What difficulties do students have in translating the 'theory' they have learned into their 'practice' and, significantly, what 'theory' do universities choose to teach to their students? It is hoped that this study will provide a deeper examination of this area.

For the past six years, I have also been a Training Manager with responsibility for the School Direct primary teacher training programme for a partnership of thirty-nine primary, infant and junior schools in Gloucester. This role involves finding and overseeing school-based placements for trainee teachers and providing a programme of training sessions for the trainees. Training sessions take place each week and have a different focus (mathematics, the humanities, SEND, behaviour management, for example). They are provided by teachers from within the partnership of schools and seldom make reference to works of educational theory; indeed, it is quite possible for students to gain QTS without any explicit reference to theory or theoretical thinking whatsoever.

My reasons for undertaking this research are eloquently summarised by Munn (2006). As she has suggested,

> ...it is through the initial preparation of teachers that one demonstrates not only how highly teachers are valued within a society, but also what it is that is judged important for them to know and for them to be able to do. The structures, processes and curriculum of initial teacher education and training provide us therefore with an indication of the aspirations that a society holds for its future and in particular for the future citizens who will be taught by students currently entering the profession. (Munn, 2006, p. 1)

In short, if education is important, then the education and training of new educators is also important.

In addition to my responsibility for student teachers, I have also been a mathematics subject leader for a number of years and have particularly enjoyed working with generalist PGCE students who were pursuing a strength in mathematics. As a part of their course, students are required to use the work of significant educational theorists (typically the works of Vygotsky, Piaget and Bruner) as the basis for case studies of children's misconceptions of and difficulties with learning in mathematics. Each year, students have admitted some difficulty in seeing their classroom practice in terms of theoretical frameworks and have questioned the value of doing so.

In the Early Years Foundation Stage (EYFS) and in Key Stage 1 (KS1) in particular, the level of mathematics that the children encounter is, for the student teachers, easy and nowhere near approaches the minimum GCSE grade C that is required in order to be a primary teacher. The challenge of teaching young children mathematics does not lie in the difficulty of the concepts for adults, but rather in the difficulty of the concepts for the children. Planning to teach children mathematics in a progressive and inherently meaningful way is a difficult task that is not simply a question of showing children how to calculate. Student teachers must understand cognitive development and become adept at identifying and addressing misconceptions in order to build upon the children's tentative and developing understanding. This requires a level of professional intellectualism that goes beyond some popular perceptions of the difficulty of teaching young children.

In September 2014, a new National Curriculum for primary schools became statutory and the new expectations provided challenges for experienced teachers and students alike. The changes to the mathematics programmes of study were particularly prominent so an investigation into the ways in which student teachers were being prepared for this seemed apt. Initially, I had intended to focus on how student teachers made use of educational theories in their teaching of calculation to children in Key Stage 1. At the time of preparing my research proposal, this was a topic of great, national interest and progression in addition, subtraction, multiplication and division skills was under scrutiny. However, I have completed this thesis through a period of particularly rapid change in mathematics education and it quickly became apparent that my own research interests had to evolve along with the prevailing discourses in education. 'Teaching for mastery' has now become a concept that is commonplace in primary schools, so exploring how student teachers apply their learning from university to teaching for mastery has become more relevant and interesting as time has gone on. A detailed explanation of this follows in Chapter 3, but in brief, teaching for mastery is concerned with teaching for understanding. Rather than simply equipping children with procedural fluency, a mastery curriculum aims to cover mathematical ideas at a deep, conceptual level. Exponents of the mastery curriculum reveal that it is rooted in sound, theoretical thinking and there are examples of such theories in Chapter 3. With such a heavy focus on mastery, the ways in which students use the work of educational theorists as they analyse the way that children do maths is of great interest. As my own expertise lies in primary education, this study focuses on the ways in which primary PGCE students use the work of educational theorists to make sense of teaching for mastery.

1.1 Research aims

This study acknowledges that both theory and practice play a part in the preparation and training of prospective teachers and it is not my intention to attempt to decide which makes the greatest contribution. Indeed, Biesta et. al. (2014, p. 1) refer to 'unhelpful dichotomies' such as 'theory versus practice' that do little more than give theory a 'bad name'. Similarly, this study does not aim to denigrate the contribution made by schools and teachers to the training of new teachers. Moreover, my research is concerned with the theory that is accessed in course literature by primary Postgraduate Certificate in Education (PGCE) students who chose to develop a particular strength in mathematics. The research aims to explore the effectiveness of the use of educational theories in the mathematics education and training of primary school teachers. It is intended to contribute to the understanding of the enabling and constraining factors that affect student teachers as they use theories of learning in their classroom teaching practice while they are training. The study examines the learning experiences of student teachers based on their own perceptions and it does not assume that there is a reality out there waiting to be discovered.

In order to ensure that my aims are met, I have identified five research questions that not only divide the overall research aim into more realistic portions, but that also lend themselves to specific theoretical and methodological approaches. The research questions that this study endeavours to answer are set out below:

1. How does the mathematics course literature accessed by primary PGCE students compare with the original sources of learning theory to which it pertains?
2. To what extent do student teachers draw upon educational theories in the planning, delivery and evaluation of their mathematics lessons within the context of a 'mastery curriculum'?

3. What are the enabling and constraining factors that student teachers face when using educational theories from their university teaching in their own mathematics teaching in school?
4. What are the implications for the continued role of universities in the education of primary mathematics teachers?
5. Is there a need for adult learning theory to describe the learning of primary PGCE students?

1.2 A brief history of teacher education

There are a number of routes to Qualified Teacher Status (QTS) but they all fall into one of two categories: school-led and university-led learning. The former takes place in schools and is characterised by practical experience and the latter through collaboration between universities and schools with a greater emphasis on theoretical aspects of learning.

Historically, all those in possession of a university degree could be teachers without any further study. For those without a bachelor's degree, the Certificate in Education (Cert. Ed.) offered a route into teaching that followed two years of study. In 1963, The Robbins Report on Higher Education was published and as a result, Teacher Training Colleges were reformed as Colleges of Education. In addition to this, prospective teachers now had access to a BEd degree. The BEd became more established through the 1980s when a bachelor's degree became the required standard (and replaced the Cert. Ed.) for new teachers in the United Kingdom. Its rise in popularity was significant in two ways: firstly, it raised the profile of studying education as a subject in its own right and, secondly, it marked the desire for professionalism among primary teachers. Alongside education degrees, prospective teachers can still gain QTS through a one-year PGCE following successful completion of a relevant bachelor's degree. The PGCE remains a popular route into primary teaching for both new graduates and 'career changers' and adheres to a long-held belief that it is important to make teaching a masters level profession. The decision to make the PGCE a masters level qualification (carrying 60 CATS points, the equivalent to one third of a masters degree) was not without disputation. As the course can only be taken following successful completion of a first degree, it is (quite literally) a 'post-graduate' qualification. However, it remains questionable whether trainees can truly be a ‘novice’ teacher at the same time as being a ‘master’ of it.

Despite this apparent desire for academic validity in Initial Teacher Education (ITE), in 1997 the GTP was launched by the (then) Teacher Training Agency (TTA) and became a work-based route to QTS whereby trainees were employed by a school and essentially ‘learned on the job’. To begin with, the programme was aimed at those changing career and was seen as a means of addressing a shortage of teachers. In 2013, the GTP was re-branded ‘School Direct’ and remains an employment-based pathway to teaching but attracts a diverse range of applicants including ‘career changers’, those already working in non-teaching roles in schools and new graduates. In addition to this, ‘teaching schools’ are now commonplace and provide a place where trainees can learn and develop competence in the classroom. Indeed, a former Secretary of State for Education, Michael Gove was quoted as saying that, ‘The best people to teach teachers are teachers’ and the National College for Teaching and Leadership is currently promoting ‘teacher research’ as a means to generate new competencies. It has even been questioned whether teaching is a profession at all or simply a skilled trade (Laitsch, 2018, Ingersoll and Merrill, 2011). Laitsch (2018) actually draws an interesting distinction between the two that has significant implications for this study. For him, teaching as a trade is a knowledge-based occupation concerned with the application of *skills* whereas teaching as a profession is a theory-based occupation that is concerned with the application of *principles*. From my experience, it seems likely that teaching is characterised by a mixture between the two, although Laitsch’s (2018) distinction does suggest that theory is an essential aspect of the professionalism of teachers.

This gradual shift in emphasis from university to school-based ITE could be indicative of a number of underlying issues. To begin with, there is a significant financial implication. Students applying for undergraduate and postgraduate teacher training programmes are subject to tuition fees that are typically in excess of £9000 per year whereas for school-based ITE, trainees are employed by a school and therefore paid as they train. This alone could go some way to explain the rise in popularity of non-university based programmes. There may also be a change in perception of the most important needs of trainee teachers, a need to produce more teachers quickly, or simply the government's desire to sunder the relationship between universities and schools. As far-fetched as it may seem, the latter remains a strong possibility with the (then) Education Secretary Michael Gove accusing leading academic staff from universities who questioned his radical curriculum reforms of 'bad academia'. He further publicised his views by defining *'The Blob'* as, 'The network of education gurus…who drew gifted young teachers away from their vocation and …towards ideologically driven theory' (Kelleher, 2013). According to the Department for Education's (DfE) 2011 publication 'Training the next generation of outstanding teachers', teachers 'perform better' when they have received 'extensive initial training in schools' (DfE, 2011, p. 13). Despite this, they also recognise that universities bring 'great strengths' to teacher training.

It is interesting to note the subtle yet significant use of terminology used to describe prospective teachers following different training routes: those studying at university on a BEd or PGCE programmes are referred to as 'students' whereas those following an employment-based programme (such as School Direct) are called 'trainees'. This disparity suggests that those following university-based programmes are deemed to be studying education in a formal sense while those following employment-based routes are merely learning the practical skills that will enable them to teach a class of children. On many occasions, this has led me to question what the trainees following the School Direct route to QTS are missing out on and conversely, what students following a more traditional BEd or PGCE programme gain from the study of educational theory. Similarly, the terms 'Initial Teacher *Training*' (ITT) and 'Initial Teacher *Education*' (ITE) have been used interchangeably for a number of years but, again, I believe that the subtle shift in terminology says a lot about the way in which the preparation of new teachers is perceived. Initial Teacher *Training* suggests an apprenticeship model when new teachers learn from others in the workplace whereas Initial Teacher *Education* suggests that the new teachers are being taught in a formal sense and are therefore students. There is the sense that the terms are used hierarchically although according to Wubbels (1992b) a constructivist stance offers a clear distinction between training and education. With that said, it is important to be clear that constructivism is directly concerned with learning and how individuals develop knowledge, skills and understanding is only indirectly concerned with teaching. According to Wubbels (1992b, p. 619), ‘The former [training] may lead to the replication of a behavioural response; the latter [education] aims at generating autonomous conceptual understanding.’ Within the context of learning to teach, there is invariably an aspect of replicating behavioural responses when students learn to manage a class of children yet simultaneously, student teachers must also be educated in order to develop autonomous conceptual understanding of what and how to teach. Rather than one taking precedence over the other, it seems likely that students must be both trained and educated in order to become effective teachers. As this study is concerned with those following a taught, PGCE route to QTS, I will refer to them as *student teachers* throughout this thesis and references to their preparation will be referred to as Initial Teacher Education. This is because I am primarily concerned with their construction of pedagogical subject knowledge rather than their ability to manage a class and crucially, constructivism provides a theory of learning, not a theory of teaching.

With the introduction of a new ‘Core Content Framework for ITT’ (DfE, 2019), the role of universities in educating the next generation of teachers is in the limelight and the quality of their provision under scrutiny. It leads me to question how useful student teachers find their learning at university and what exactly is the ‘ideologically driven theory’ that Gove is concerned about? After all, if prospective teachers are able to gain QTS without any study of educational theory or, indeed, without setting foot in a university, why do universities still include it in their curricula of undergraduate and postgraduate ITE programmes?

1.3 Identification of a lacuna

The question of how theory and practice contribute to the development of student teachers is, by no means, a new one and there have been a number of studies that have explored the relationship between the two. For example, Asher and Malet (1999) and Foster (1999) based their studies on secondary PGCE students while Holligan’s (1997) research was based on the work of primary BEd students. This thesis differs because it is based on the perceptions of primary PGCE students. In some ways, it builds on the work of Cheng et. al. (2012) because it investigates how primary student teachers make sense of the school and university-based elements of a ‘consecutive’ model of ITE (like the PGCE) rather than in an undergraduate BEd programme. In addition to reigniting the theory/practice debate in general terms, this study contributes to an understanding of how theories support the development of student teachers with specific regard to the mastery curriculum for mathematics that is, in itself, based upon theory. It is contextualised by my own approach to theory, my theoretical perspective in the thesis and enriched by my insider/outsider expertise.

1.4 Theoretical perspective

Throughout the thesis, I draw upon the theoretical framework of constructivism to analyse children's learning, the learning of the student teachers and my own learning as a teacher, teacher educator and research student. Constructivists believe that learners actively construct their own knowledge and understanding rather than being passive recipients of if. A learner's experiences and their reflections on them build knowledge that is personal (and inherently meaningful) to each individual. Within the broad concept of constructivism there are two key schools of thought: cognitive constructivism and social constructivism. Cognitive constructivism suggests that the process of knowledge construction depends on an individual's subjective interpretation of their experiences. Social constructivism holds that knowledge is socially dependent and that knowledge construction occurs through interaction with others. Both aspects of constructivism play an important part in this thesis. As children's learning and student teacher's learning is socially situated in schools and universities, social constructivism becomes a useful theoretical perspective. However, as this thesis is also concerned with my own learning within my own subjective reality, I shall be using the tenets of cognitive constructivism in the discussion of my own learning and development.

Constructivism may seem an odd choice given the mathematical context of the thesis. While, at a high level, mathematics is abstract in nature and therefore subject to interpretation, constructivism rejects the existence of fixed, objective truths and this is inherently at odds with preconceptions about reality that are commonplace in primary mathematics education. Mathematics is often seen as a subject in which answers are either right or wrong and learning about it means to be taught something of the body of mathematical knowledge that exists. The performance-related framework within which children learn mathematics is, to a large extent, mirrored in the way in which student teachers learn about mathematics teaching and neither children nor students have time to explore meaning or make personal connections with the content before they must move on to different areas of learning. Although, by its very nature, constructivism cannot produce a fixed teaching procedure, building upon individual understanding of mathematics for both children and students is relevant because this thesis is, first and foremost, concerned with how students acquire the knowledge, skills and understanding to teach mathematics effectively.

As a cognitive constructivist, Ernst von Glasersfeld rejects the notion that there is an objective body of existing knowledge that can be communicated by means of language. Rather, he presents an alternative epistemology ('Radical Constructivism') that takes into account an individual's cognitive isolation from reality where knowledge serves to *organise* experiences (Wubbels, 1992b). The work of von Glasersfeld draws upon and develops Piaget's genetic epistemology that refutes the notion of cognitive activity merely producing representations of an ontological reality. Rather, it presents cognition 'as an instrument of adaptation the purpose of which is the construction of viable conceptual structures' (von Glasersfeld, 2002, p. 59). The concept of cognitive viability becomes a recurring theme throughout the thesis and is used to frame some of the difficulties that the students faced when applying theories to their teaching practice.

Von Glasersfeld (2002, p. 54) described Piaget as '… the pioneer of the constructivist approach to cognition in this century' although he also admits that Piaget's work can be difficult to understand and that it is frequently misinterpreted. As such, this thesis adopts a constructivist perspective and uses the seminal ideas of both Piaget and von Glasersfeld as a lens through which to view the theory and practice of Initial Teacher Education. It is hoped that this will provide both an additional layer of analysis to my findings and make an epistemological contribution to the existing body of theory around teacher education.

1.5 Giving voice to student teachers

An important aspect of my constructivist stance is the concept of 'giving voice' to student teachers and representing their views. These issues are well-represented in the literature (MacLure, 2009; Byrne, 2015; Ollerenshaw and Creswell, 2002; Rhodes, 2000; Guttorm, 2012 and Pillow, 2003) and are not unproblematic. Byrne (2015, p. 4) suggests that in the process of telling a participant's story, a new story is created that reflects something of the researcher's own experience and, therefore, distorts the original meaning. In agreement with Byrne (2015), I believe that the influence of the researcher is unavoidable but, like Ollerenshaw and Creswell (2002, p. 332), I also believe that the researcher can situate a participant's story and provide a contextual layer of meaning that may be absent from the original. I might add that as an insider researcher, this aspect is strengthened further by my own knowledge and insight into educational issues. In a sense, my voice becomes a part of the story of the students that participated (Rhodes, 2000). Rather than making claims to represent a student's reality, the narrative aims to, as Byrne (2015, p. 4) says, 'tell the story of the research, to analyse and interpret in order to seek and convey its significant messages.'

1.6 The structure of the thesis

Each chapter of the thesis draws upon relevant literature that emerged as the research developed. Chapter 2 contextualises the research with a description of the practice-based elements of ITE and a discussion of the current, prevailing discourses in teacher education with an emphasis on the concept of 'partnership' between schools and higher education institutions (HEIs). The chapter goes on to discuss the nature of university-based aspects of ITE and attempts to unpick the 'theory' that applies to child learning (pedagogy) and those theories that apply to the ways in which the adult students learn about theory themselves (andragogy). The chapter concludes by proposing that there is a significant, epistemological gap between the theoretical and the practical elements of the primary PGCE.

Chapter 3 describes the nature of the maths that is currently taught in primary schools and therefore, also the maths curriculum that the students experience when they are on teaching practice. The chapter describes the principles and practices that characterise 'the mastery curriculum' in terms of how it is taught, why is taught in that way, how the children learn and what they learn. It discusses how the Cockcroft Report's recommendations were taken on by so-called 'Pacific Rim' jurisdictions in the 1970s and 1980s and effectively ignored in the UK and how this has created a highly political motivation for children in the UK to out-perform children in places like Shanghai and Singapore. While it makes claims to sound, constructivist roots, Chapter 3 finds that aspects of the mastery curriculum are actually at odds with the tenets of constructivism and that the way in which mathematics is taught can constrain rather than enable the children's cognitive development. The chapter concludes by suggesting that maths education is currently undergoing rapid and significant change. This means that PGCE students with an interest in mathematics are subject to very different experiences at the different schools in which they are placed as the schools themselves attempt to 'get to grips' with the new and ever-changing requirements.

Chapter 4 provides a detailed insight into the methodological approach taken to address each research question. It provides an overview of the study's ontological stance and presents the case for 'mixed method research' and describes the sorts of quantitative and qualitative data that were collected. The chapter goes on to describe and explain my approach to the collection of data through questionnaire and semi-structured interview design. In particular, it provides a rationale for my use of telephone interviews with the students and makes the contribution to the case for using telephone interviews in educational research.

Chapter 5 makes use of a reading frame to analyse the theoretical content of the texts from the mathematics subject strength PGCE module. It provides a sense of the sorts of texts that were chosen for the students to engage with. The chapter continues by outlining the theoretical content of each text and makes reference to the different ways in which the seminal works of constructivist theory are presented to the students through the literature and their fidelity to the original works. The most well-used text from the reading list, Askew's (2012) *Transforming Primary Mathematics*, is analysed and the ways in which the works for Vygotsky, Piaget and Bruner are presented to the students are discussed. The chapter develops the concept of second order textual interpretation and suggests that, through texts about theory (rather than the original texts themselves), students only ever receive a snapshot of an original thinker's subjective reality.

In Chapter 6, I present the quantitative data that was collected from the questionnaire given to the students. As well as providing straightforward, descriptive statistics with regard to the frequency of responses to each question, a Friedman Test of differences was conducted on those questions where students were asked to rank statements about educational theories. When the Friedman Test rendered a significant result, a *post-hoc* Nemenyi Test (AKA the Wilcoxon-Nemenyi-McDonald-Thomson Test) was conducted to highlight which pairwise groups of questions had a significant difference based on their rank means. This enabled a more stark, polarised view of the students' perceptions of theory to emerge. Generalised statements about the practices of the PGCE students are presented with the aim of contextualising the data collected from the interviews with the sample of selected students. The chapter finds that students with more classroom experience were better able to cognitively assimilate theoretical ideas into their existing understanding.

Chapter 7 serves as a preface to the data presentation and thematic analysis that follows in Chapters 8 and 9. The chapter begins by explaining my approach to coding the interview data and how I arrived at the five, key themes. The chapter also introduces the reader to some of the key findings from the interviews. Namely, the impact of what I have called 'the matryoshka effect' and the finding that some pedagogy actually seemed to describe the way in which the students (as well as the children) learned. The chapter concludes with the presentation of vignettes of each of the students interviewed for the thesis. Their aim is to retain their individual contributions so that they are not lost in the thematic analysis that follows. Each vignette concludes with a short statement that sums up each student's approach to using educational theories within a three-fold typology.

Chapters 8 and 9 address the five themes that frame my analysis. Chapter 8 presents an analysis of the two themes that derived from intrinsic factors: students' perceptions of the nature of educational theories and student teachers' motivations. The chapter draws upon the qualitative data gained from interviews with eight student teachers and draws upon literature relevant to their responses. The chapter finds that students have difficulties in seeing educational theories as relevant to their mathematics teaching and that the very nature of being a student inhibits their use of them. Specifically, the chapter draws upon Piaget's concept of 'perturbation' to discuss way in which the students approached their written assignment and the impact of this on their theoretical understanding. Chapter 9 continues the analysis and presents data from the three themes that derived from extrinsic factors: the quality of mentoring, the impact of time and the nature of ‘the gap’ between theory and practice. As in Chapter 8, Chapter 9 draws upon the qualitative data gained from the interviews with eight student teachers. The chapter finds that the study of educational theory was not seen as central to the students’ development as mathematics teachers and that practical, classroom experience took precedence over the engagement with theory. The constructivist concept of ‘viability’ is used to explain that the nature of individual placement schools and, more specifically, the quality of school-based mentors was of critical importance in the students’ ability to make use of the theories that they had learned. While each of the five themes is discussed separately in Chapters 8 and 9 they are, in practice, intricately related. The narrative is structured to accommodate this intricacy and the discussion of each theme concurrently considers the others where relevant.

Chapter 10 addresses the research questions and discusses the findings and recommendations made by the thesis as a whole. It takes a reflexive approach and aims to present a bifurcated view of ITE and maths education. It draws out the contributions made to professional practice and suggests that PGCE students pursuing a strength in mathematics ought to be placed in schools with a suitably qualified, maths specialist teacher. It also suggests that the PGCE could be restructured to allow for planned opportunities for guided reflection on aspects of teaching and learning again, with a suitably qualified maths specialist teacher from outside of the school and the university. Chapter 11 draws out the contributions that the thesis makes to scholarship, the existing body of theory and the practice of initial teacher education. In terms of contributions to theory, the thesis finds that pedagogy can be gainfully applied as a theory to describe adult learning within an educational context and that the so called ‘matryoshka effect’ prevents students from seeing children’s learning at the heart of their endeavours as student teachers. Additionally, the thesis makes methodological contributions by promoting the value of an insider stance and telephone interviews to educational research.

As the narrative unfolds, a number of key themes emerge. One such theme resonates throughout the thesis and concerns the nature of being a student teacher. More specifically, it emerged that student teachers used educational theories in a very specific way that appeared to impede their intrinsic benefit. My conclusions offer an alternative pedagogy that describes the specific way in which student teachers learn and draws out potential areas for further research.

<u>Chapter 2 – The context of Initial Teacher Education – theory and practice</u>

I try to implement theory and it just doesn't work in practice sometimes. As much as the literature suggests it does….
(Conversation with Emily, p. 21)

This chapter explores the nature of Initial Teacher Education (ITE) both in terms of its theory-based and practice-based elements. It begins with a discussion of the epistemological roots of educational theory and moves on to discuss practice through partnership between schools and HEIs. The chapter concludes by discussing the nature of the gap between theory and practice as understood by the thesis.

2.1 *What is theory?*

Throughout this thesis, I will draw on the theoretical works of Jerome Bruner. It therefore seems apt to begin with his own definition of what a theory should be. According to Bruner (1960, p. 25), 'A good theory is the vehicle not only for understanding a phenomenon now but also for remembering it tomorrow.' He goes on to say that,

> To understand something as a specific instance of a more general case – which is what understanding a more fundamental principle or structure means – is to have learned not only a specific thing but also a model for understanding other things like it that one may encounter. (Bruner, 1960, p. 25)

In short, Bruner presents theories as models for understanding broad, educational phenomena that teachers are likely to encounter each time they step into the classroom. Theories supposedly take a teacher from the specific to the general and give them the ability to adapt their practice to new and challenging situations. As models for thinking, theories require a context and as I will discuss throughout this thesis, this is precisely what student teachers do not yet have. In this sense, they are somewhat disadvantaged from the outset. The quality and relevance of the theory that student teachers learn is therefore of great importance although the literature suggests that negative attitudes toward theory are prevalent in education. Indeed, McIntyre (1993, p. 39) suggests that theory has become a 'dirty word' in relation to ITE and Higgins (2010, p. 448) suggests that all too often,

‘...what passes for theory in educational discourse is the mere recitation of the names of theorists...’. The irony of this is not lost on Higgins (2010) who remains very concerned that this results in anti-intellectualism among the very people learning to promote and nurture intellectualism among children. Lambert and Pachler (2002, p.225) paint a similarly negative picture of theory in educational discourse when they refer to the ‘smattering of theoretically informed debate’ taken from the fields of history, sociology, philosophy and psychology that in their view, underpins ITE programmes. Alexander (1984) seems to agree and suggests that in educational terms, theory is not a single entity but a mixture of ideas taken from the field of psychology and that theoretical content (knowing about and understanding seminal works of theory by significant, high-profile thinkers) is that which is ‘popularly unpopular’. Rather than emphasising theoretical content, he suggests that theory should, ‘… concentrate less on what the student should know, [and] more on how he might think’ (Alexander, 1984, p. 145). Part of the problem, Alexander (1984) suggests, is that theory is too readily presented as having prescriptive implications for practice. Far better, he proposes, if the theory used in teacher education incorporates ‘…speculative theory, the findings of empirical research [and] the craft knowledge of practising teachers…’ (Alexander, 1984, p. 146). Forrest and Peterson (2006, p. 115) are careful to emphasise that whether describing the learning of children or of adults, theories are not teaching techniques but ‘the philosophy that a teacher looks to for guidance’. In his overview of theory in mathematics education, Cottrill (2003) draws a clear distinction between these constituent parts. Specifically, he separates educational theories from the conceptual frameworks used to interrogate them. The difference, he suggests, is that educational theories endeavour to explain the complex factors that contribute to an individual’s growth in knowledge, skills and understanding whereas there are certain epistemological frameworks that support the researcher as they investigate these aspects of learning. Eraut (1994) extends this and suggests that knowledge about teaching can be classified in three different ways. Firstly, through discipline-based theories with their roots in bodies of knowledge. Secondly, through the practical principles derived from the professional field and, finally, through specific, case-based examples of practice. In Chapter 5 of the thesis, I explore this concept and draw a distinction between educational theories and models for teaching although as I will discuss, both are often deemed to be ‘theory’ by student teachers. Rudduck (1991) suggests that dispensing with the word ‘theory’ altogether might be beneficial because it would remove the stigma attached to it and simultaneously accommodate a greater focus on critical refection among teachers. There seems to be a case here for realigning popular perceptions of theory and demystifying it somewhat. Rather than an all-knowing, unattainable and infallible entity to be studied, both Alexander (1984) and Rudduck (1991) are united in their desire to dispel the myths to make theory both more useful and more readily sought.

There are some distinctly negative attitudes toward theory in the literature and, as the thesis will discuss, there are also some negative perceptions of theory among students and teachers alike. These will be discussed in detail in Chapter 8, but central to this study will be defining what is meant by ‘theory’ within the context of the non-practice-based elements of a mathematics strength PGCE module. The broad field of ‘Educational Theory’ has a number of components that will be useful to this research and theories that pertain both to children’s learning and adult learning are relevant. Thomas (2011, p. 3) provides a succinct summary of theory and concludes that all theories relate to ‘thinking, abstraction and generalizing’. In addition to this, he acknowledges five general areas of theory. Arguably the most relevant of these to this study is defined as ‘the thinking side of practice’ (Thomas, 2011, p. 2). It is suggested that in practical disciplines such as teaching, practical theorising is what constitutes the most effective professional development. Significantly, Thomas (2011) goes on to question whether theory should be the outcome of our endeavours (*a ‘product’*) or whether it should be simply *‘a tool’* for explaining observable phenomena.

Popkewitz (cited in Biesta et al 2014, p. 13) seems to suggest the latter and concludes that despite a ‘mantra of educational talk’ concerned with the usefulness of research to practice, ‘[theories] order what is seen, thought about, and acted on’. Popkewitz (2014) continues to define theory in an educational context by suggesting that theories are styles of reasoning that create ‘cultural theses about who the child is and should be’ Popkewitz (cited in Biesta et al 2014, p. 13). Empirical content is seen as of the utmost importance and Popkewitz (cited in Biesta et al 2014, p. 16) states that ‘theories are an empirical fact of educational practices’. Biesta et. al. (2014, p. 6) are a little more cautious; whilst they acknowledge the potential of theory to re-describe concepts and even function as hypotheses (and therefore the basis for an empirical study), they do not have to be considered as claims to the truth but rather, 'They can also be seen as possible interpretations of what might be the case – interpretations that can inform teachers' perceptions, judgements and actions by opening up possibilities for seeing things in new and different ways'.

On the contribution to empirical research, Biesta et. al. (2014, p. 6) appear to agree with Thomas' (2011, p. 3) notion of theory as both 'product' and 'tool' by suggesting that theory can support the analysis of empirical data, but that it also plays an important role in the beginnings of research and in particular, in the formulation of *what* to research.

For the purposes of my research and when discussing *what* student teachers learn, 'educational theories' are defined as conceptual frameworks that describe how information is absorbed, processed and retained when children are learning. In this thesis, 'educational theory' refers to the broadly cognitivist works of those such as Dewey, Vygotsky, Piaget and Bruner. It also includes the more contemporary works of Skemp and Askew that relate directly to mathematics. I have chosen to use the term 'educational theories' rather than learning theories because this thesis is concerned with students' perceptions of what theories are, what theories are for and how they are used. As such, I do not want to assume they are only related to learning by referring to them as 'learning theories' or 'theories of learning' (as much of the literature on the subject does). In effect, this would equate to deciding this in advance and I am keen to leave the term open to interpretation. For me, the term 'educational theories' achieves this and refers to the broad area of education without restricting its use to ideas associated with teaching or learning in particular.

2.2.1 *Theories of child learning (Pedagogies)*

Pedagogy is a very familiar concept to student teachers as it encompasses theories of learning that relate to children. Within the broad umbrella of pedagogy, there are a number of theoretical perspectives and high-profile thinkers. Even a cursory glance thorough course overviews from a handful of UK universities reveal some commonalities; in particular, the seminal works of Vygotsky, Piaget and

Bruner are popular among teacher educators so it seems appropriate to include a brief discussion of them here. All three thinkers are bound by a broadly cognitivist stance. This suggests that information is processed in the mind of individuals by seeking the relationships that exist between what is new and what is already known. Cognitivist theory comprises of a number of distinctive areas of thought such as constructivism, social constructivism and socioculturalism that are actually considered to be theories in their own right (Bates, 2016). Vygotsky, Piaget and Bruner have thought and written extensively about children's learning and development in general terms but significantly, all three have also written specifically about mathematics education.

2.2.2 Lev Vygotsky (1896-1934)

The work of Vygotsky (1978) has given rise to a sociocultural theory of teaching. Vygotsky believed that there is a recognisable body of mathematical knowledge that derives from the work of mathematicians. It is this knowledge, he argues, that children need to be taught in order to become competent mathematicians. This theory suggests that the role of the teacher is to influence children's thinking in order to move them towards more conceptual, scientific understanding. The emphasis is very much on the skill of the teacher and their ability to impart knowledge to the children.

A key component of Vygotsky's ideas about teaching is that children learn best when they are operating in the 'Zone of Proximal Development'. Often referred to as the ZPD, Vygotsky (1978, p. 86) describes this as 'the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers.'

The teacher's role in the learning process is deemed crucial. As a *more knowledgeable other*, they are responsible for supporting children to work at a level beyond which they could independently. This is a well-accepted concept in primary schools and is represented in numerous guises in classrooms. Currently popular is Pardoe's (2009) concept of 'Purple Learning'. The model describes tasks that the children are capable of achieving independently as working in their *comfort zone*. Beyond the comfort zone lies the *challenge zone* where learning is more challenging but attainable through perseverance and support. Finally, the *danger zone* describes learning that is beyond the current capabilities of the child. This model is often presented diagrammatically as concentric circles where the challenge zone is coloured purple (hence the name). Children are deemed to be 'purple learners' if, with the support of their teachers, they move beyond tasks that are easily attainable and engage with tasks that they find appropriately challenging. Returning to Eraut's (1994) classification of knowledge about teaching provides a useful lens through which to view this because Pardoe (2009) has used Vygotsky's tentative, discipline-based theory and with the support of her professional status, developed a practical principle – a way of 'doing' the theory - that can become part of the practice of individual schools and teachers. In a similar way, at my own school, variation theory (Gu et. al. 2004) has become the 'Do it', Twist it', 'Solve it' approach to deepening conceptual understanding in mathematics.

Despite this, Ogunnaike (2015) observes that the ZPD does not adequately explain the process of cognitive development and Zhou (2020) suggests that the ZPD is limited because it ignores the role played by motivational influences in children's learning. While these claims could be made about any number of tentative, theoretical constructs, the work of Smagorinsky (2018) provides a critique of Vygotsky's work that is more relevant to this study. Smagorinsky (2018, p. 70) argues that there has been significant trivialization of Vygotsky's work and that it has been reduced 'to a briefly-mentioned pedagogical idea [that results in] the neglect of his more important project of generating a comprehensive cultural-historical-social theory of mediated human development'. Smagorinsky (2018) blames, in part, the conflation of Vygotsky's concept of the ZPD with the notion of scaffolding which is more accurately attributed to Wood, Bruner and Ross (1976). He argues that this shifts the emphasis from long-term human development (as Vygotsky may have intended) toward short-term, quick fixes that support children's understanding of isolated concepts (Smagorinsky, 2018, p. 71). By way of remedy, Smagorinsky (2018, p. 74) proposes a retranslation of the ZPD to the ZND, the Zone of *Next* Development. 'Proximal', he suggests, is misleading as it implies adjacency of concepts to be learned, whereas 'next' captures the longer-term, developmental meaning behind Vygotsky's construct. Claxton (2021, p. 87) warns against ‘trying to draw out quick implications for teaching from the scientific study of learning.’ However, as I shall discuss through the thesis, Vygotsky’s ideas (and theories in general) are seen in terms of providing understanding of isolated mathematical concepts rather than the long-term development and understanding of the children.

2.2.3 Jean Piaget (1896-1980)

A further theoretical perspective that differs from Vygotsky’s (1978) ideas can be loosely defined as ‘constructivist’. Constructivist theories of education are based on the belief that children construct their own knowledge and understanding of concepts through their own activities rather than through the actions of a teacher. The seminal work of Piaget is the foundation of much constructivist thought. There are a number of similarities between the work of Vygotsky and Piaget, but in relation to mathematics, Piaget (1977) suggests that the teacher’s role is not (as Vygotsky [1978] may have suggested) to give children access to a wealth of objective, mathematical knowledge, but to establish an environment where children are able to ask questions, explore and construct their own understanding of concepts for themselves. Unlike Vygotsky, Piaget emphasised the role of children’s peers in their development and not, as Vygotsky may have, their *more capable* peers or adults (Lourenço, 2016, p. 130). In addition to this, Piaget (1977) proposed four stages to cognitive development that he defined as ‘sensorimotor’, ‘preoperational’, ‘concrete operational’, and ‘formal operational’. Piaget’s work is not without opposition and is now well-accepted that children do not, in fact, develop through qualitatively different stages of learning (Askew, 2012) although as Goswami (2001) points out, the education system in the United Kingdom is espoused to the stages theory. In agreement with this, the mathematics that student teachers learn to teach does seem to be bound to the concept of staged development. For example, from my own experience, it is common for schools to have a ‘calculation policy’ which prescribes the nature of addition, subtraction, multiplication and division to be taught in different year groups and the use of practical equipment is far more prevalent in the Early Years and Key Stage One than it is in Key Stage Two. As such, students are almost certain to encounter the concept of staged development at school whether or not it is discussed in explicit, Piagetian terms. I believe that, in an ideal scenario, students would be made aware of the theoretical bases of the approaches to teaching that they encounter. However, if students experience the intrinsic benefit of theories without explicit reference to the theories themselves, then I support incidental encounters with them in the way that I have described.

Lourenço, (2016, p. 125) sees Piaget's development stages as highly controversial if they are applied rigidly, but he admits that they are useful heuristics for describing developmental change over time. He suggests that the notion of staged development should remain abstract and that problems arise when developmental stages are reified and interpreted as concrete ways of thinking or doing (Lourenço, 2016, p. 127). Arribas-Ayllon and Walkerdine (2017, p. 144) agree and suggest that, in child-centred pedagogies, there is a need to 'deconstruct the tendency of reducing problems of learning to psychological explanations of normative, rational development.'

Ojose (2008) explains that the age of the children being taught by the students in this study could give rise to a stark shift from the 'preoperational' to the 'concrete operational' stages of development that may manifest itself as 'remarkable cognitive growth' (Ojose, 2008, p. 27). Ojose (2008) cites the example of a child who 'understands that adding four to five yields nine cannot yet perform the reverse operation of taking four from nine' (Ojose, 2008, p. 27) who by the 'concrete operational stage', will have developed the skills of 'seriation' and 'classification' to allow them to order objects and numbers, group them according to common characteristics and see the intrinsic links between calculations. Primary student teachers are likely to see such development unfolding in their own mathematics lessons and in those of other teachers. Rather than merely seeing and being pleased by the children's progress, pedagogy gives students a way of understanding it in order that they might promote it again. This is a crucial thread of the thesis and as I suggest in Chapter 9, the absence of pedagogical awareness while they are on teaching practice can prevent student teachers from engaging fully with how children learn.

Piaget is perhaps best known for his theory of genetic epistemology. Although this concept in itself is hardly unorthodox or even particularly inventive (I suspect that all teachers, including student teachers, recognise the developmental nature of children's learning), this is often the only level at which students encounter the work of Piaget. I am in the privileged position to be able to draw upon Piaget at a deeper level than the students and his concept of knowledge is both more interesting to me and more relevant to this study. For Piaget, knowledge is not concerned solely with empiricist notions of the *object* or with rationalist ideas of the *subject*. Rather, it emphasises the importance of the context in which the knowledge is gained and the effect of this on the quality of the learning that takes place. Knowledge is continuously invented and reinvented as a learner develops and interacts with their environment. Piaget's ideas about representational thinking are of particular interest since they can be used to describe the way in which theories are presented to students, but also the ways in which mathematical concepts are presented to children. As I discuss in Chapter 3, there is now a significant emphasis on representations of mathematics education. Piaget (1952, p. 68) himself used the term 'representation' in two different senses; the 'wide' and the 'narrow' sense. In the wide sense, he argues, 'representation is identical with thought' and not simply based on perceptions. I think it likely that student teachers may learn about theory in this way. However, his description of the 'narrow sense of representation' is reminiscent of the sorts of representation used in the mathematics education of children. Piaget suggested that, 'In a narrow sense, representation can be limited to the mental image or to the memory-image, that is, to the symbolic evocation of absent realities.' (Piaget, 1952, p. 68). From my own professional experience, I have found that such representations are emphasised with young children while representations in the 'wide sense' are overlooked. Despite Piaget's distinction, representations are too readily imposed on children and their ability to think operatively and intelligently is often dismissed. For example, I once observed a mathematics lesson in which the teacher had concluded that a Year 1 child had not understood the concept of commutativity (and they had duly marked their work with an orange traffic light to indicate that they needed additional support the next day). Having taught the child the previous year and knowing that mathematics was an area of strength for them, I was surprised that they had not understood and after speaking to them about their work, I realised that they actually did have a good understanding of commutativity and that their failure to 'understand' was merely a failure to represent commutative relationships in the part/whole diagrams (see Figure 1 below) prescribed by the teacher.

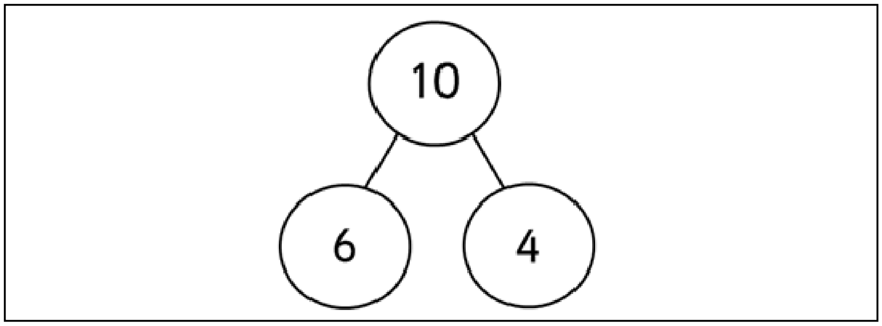


Figure 1: A 'part/whole' diagram used in Key Stage 1.

Claxton (2021, p. 89) points out that, 'constructivism is about what people do with what they're told' and that it does not assume that an individual's cognitive constructs (either a child of their teacher's) is more valuable than any other. He argues that '…knowledge tends to get glued quite tightly to the narrow circumstances of its initial acquisition' which almost suggests that teachers can become a part of children's cognitive constructs. Certainly, a mathematics lesson could be deemed a 'narrow circumstance', so Claxton proposes that teaching children how to make connections and build understanding needs to take place to help them to 'make the connections that they otherwise might not make' (Claxton, 2021, p. 132). This suggests that an individual's cognitive constructs can only be part of learning since children need guidance to make sense of their own ideas.

2.2.4 Jerome Bruner (1915-2016)

Like Piaget, Bruner's epistemology also attributed cognitive development to a learner's ability to create internal representations of their experiences and their ability to organize these representations so that learning can be recalled and used (Furth, 1968). Also, like Piaget, Bruner takes a child-centred stance and sees the teachers' role not as the giver of objective knowledge, but as a facilitator of learning. If anything, Bruner further defines the teacher as the *designer* of learning who must craft lessons that engage children and allow them to solve problems for themselves. Rather than providing them with a model for doing so, Bruner argues that providing children with the essential information needed to solve a problem and then allowing them to discover links for themselves enables a depth of understanding that surpasses any superficial 'spoon feeding' of information. He argues that *discovery learning* occurs through carefully-planned lessons that allow children to make links between different pieces of information (Bruner, 1960, p. 20). This suggests that, for Bruner, the teacher's role is to provide a carefully-planned, scaffolded discovery that reveals concepts to children as though they had discovered them for themselves.

Claxton (2021) provides a useful critique of discovery learning and direct instruction; the former, he argues, represents a progressive and the latter, a traditional view of education. While he robustly challenges the orthodoxy of direct instruction, Claxton does not seek to determine whether direct instruction or discovery learning is the more valuable pedagogy. Indeed, he suggests that no one approach has universal validity since education has many aims and that different pedagogical approaches lend themselves to different outcomes (Claxton, 2021, p. 141). Rather, he proposes the concept of 'guided discovery' in which the teacher actively structures learning and guides children toward a given outcome while the children are, simultaneously, able to explore, experiment and discuss the intended learning (Claxton, 2021, p. 135). Simamora et. al. (2019, p. 65) endorse this approach and suggest that the teacher's guidance is essential in order to anticipate misconceptions and avoid cognitive overload and that discovery learning without assistance is of no benefit to children at all.

In addition to Bruner's *discovery learning*, his concept of the *modes of representation* provides a further theoretical lens that is of use to this study in two ways. Firstly, it provides an insight into how the representation of concepts affects children's learning of them. Secondly, it forms the basis of much of the current thinking around primary mathematics education and the mastery curriculum.

Bruner suggests that there are different stages that occur in a child's development of conceptual representation. They begin with enactive representations that are characterised by basic, habitual actions. With time, iconic representations are added to a child's scope of understanding and it allows them to use imagery without action. Finally, children draw upon their ability to interpret and use symbolic representations. As a contemporary of Piaget and fellow purveyor of the constructivist stance, it is perhaps of little surprise that Bruner's concept of *enactive, iconic and symbolic representation* bears some resemblance to Piaget's stages theory. The difference seems to be that Piaget believed that children's development through different stages was sequential and progressive whereas Bruner suggests that different ways of representation are simply more prevalent at different ages. He therefore does not discount a child's (or presumably, an adult's) ability to think symbolically before thinking iconically, simply that their natural propensity for choosing one form of representation over another may change as they grow older. He also maintained that a child's induction into activities through different representations is more important than the Piagetian concept of staged development (Bruner, 1960, p. 39). This theme will be explored in greater detail in Chapter 3.

2.2.5 Pedagogy conclusion

In my experience, pedagogy is rarely discussed in explicit terms in schools. Despite this, it clearly remains a powerful voice in primary education albeit through the modern, re-branding of the work of Vygotsky and Bruner in particular. If theory really is a 'dirty word' (McIntyre, 1993), then reproducing them in a colourful, user-friendly, diagrammatic form (as Pardoe, 2009 has done) or turning them into an *approach* to teaching makes the theory seem more accessible and, as 'Purple Learning' is, more widely used. This is a recurring theme throughout the thesis and the gap between theory and practice seems to be concerned with how theories are presented rather than the content of them.

2.3.1 Theories of adult learning

There are a number of theoretical perspectives that describe the learning of adults. These are relevant to this study because those completing the PGCE are adult learners. Adult learning theories may provide some insight into the ways in which they assimilate knowledge both about education as a 'subject' in its own right and about their classroom teaching skills. The following section provides a discussion of self-directed learning, Socratic learning, reflective practice, experiential learning, situated learning and andragogy. All are different perspectives that give some insight into the ways in which student teachers learn.

2.3.2 Self-directed learning

The term ‘self-directed learning’ has been used for some time (Rogers, 1969, Knowles, 1975) and takes a collaborative constructivist stance. Garrison (1997) argues that the term gives rise to both social and cognitive issues concerned with ‘self-direction’ and ‘learning’ respectively. He argues that, for too long, the focus has been on the social aspect of directing one’s own learning rather than the cognitive processes involved in adult learning. He therefore proposes a model for self-directed learning in which metacognitive awareness of the learning itself is as important as a learner’s control of the task. In fact, Garrison’s (1997) model comprises three dimensions: self-management (task control), self-monitoring (cognitive responsibility) and motivation (entering the task).

When viewed through the context of ITE, some problems with the model emerge. To begin with, ‘self management’ implies that learners are able to diagnose their own learning needs and exercise control over their learning decisions. Both at school and at university, student teachers may be able to diagnose their learning needs but more frequently, they are dictated to them (by their school-based mentors while on teaching practice and their university tutors when it comes to their academic studies). It also seems unlikely that students will be able to exercise control over their learning decisions – this too is set out by the requirements of the practice-based and taught elements of their course. In a similar way, student teachers can, at best, have only some control over ‘self-monitoring’. Again, the monitoring of student teachers tends to come in the form of feedback following observations of their teaching. At best, this involves a scaffolded reflection process where both the student and their mentor reflect on the teaching and learning that has taken place although in my experience, this is often a more unilateral process where the mentor reports on the strengths and areas to develop that emerged. Within an educational environment, Garrison acknowledges that self-monitoring may be dependent on both internal and external feedback:

> The challenge for the learner is to integrate this external feedback with his or her own internal meaning assessment. To be aware of this internal feedback and external input, and to use it to construct meaning and shape strategies is to self-monitor learning cognitively and metacognitively. (Garrison, 1997, p. 25)

This suggests that, for student teachers, cognitive responsibility for their learning is shared with their school-based mentors and university link tutors. This also suggests that their own perceptions of their teaching must combine with the feedback they receive from others to generate meaning and to make progress. 'Internal feedback' also suggests that a level of reflection is required from learners. Reflection is the basis for many of the adult learning theories that I will go on to discuss.

It seems to me that the final aspect of self-directed learning is the only area over which the students are able to exercise full control. Without a level of self-motivation, it seems unlikely that students would be able to complete a teaching qualification. While extrinsic factors (such as achieving good grades or enjoying positive relationships with the children and teachers at their placement schools) might affect their levels of motivation, the motivation to learn must come from within.

2.3.3 Socratic learning

While students may be unable to make objective decisions about their learning, they are readily able to reflect upon it. Indeed, they are encouraged to do so. Reflection as a means through which learning occurs is not a recent idea and was described, to some extent, by Socrates in the 5th century BCE. This gave rise to the theory of Socratic Learning that is underpinned by the premise that thinking is driven by questioning and, as Socrates held, questioning is the only defensible form of teaching (Denman, 2003). Socrates advocated rigorous questioning in the discussion of moral issues and while moral perspectives abound in the broad study of education, they are possibly less pertinent to the individual lessons taught by student teachers who are, in my experience, more concerned with demonstrating their competence against the teaching standards.

Rather like a coaching model, Socratic Learning, requires a teacher or mentor to persistently question learners to challenge their preconceived ideas. Through the Socratic dialogue that ensues, a student is made aware of their errors and weaknesses. As in other adult learning theories, the role of the Socratic teacher is not to be a purveyor of knowledge but the leader of an interactive dialogue however, like other models of coaching, Socratic questioning does assume that learners will understand their own lack of answers and that they will learn from that. For those with limited classroom experience, this may not yet be the case. According to Denman (2003), Socratic learning demands a learning environment that is characterised by ‘productive discomfort’. This suggests that in order to improve, students need to be open recipients of criticism. The concept of ‘productive discomfort’ could be applied to the main way in which student teachers’ learning is promulgated while on teaching practice. Typically, one lesson each week is formally observed by a mentor or university link tutor and following the lesson, students receive feedback that is akin to a Socratic dialogue. While having one’s teaching analysed and even criticised is not always a pleasant experience, it is one that is essential in the development of skills and expertise.

2.3.4 Reflective practice

More recently, Schön (1983) defined *reflective practice* as either reflection *on* action or reflection *in* action*.* These are defined simply as reflecting on events after they have occurred as a summative exercise or reflecting upon events as they are unfolding in a formative sense. Schön maintains that there is value in both and that teachers frequently evaluate episodes of teaching summatively (reflection *on* action) with a view to improving them. As discussed, student teachers will be familiar with this process as lesson observations and feedback on them are the backbone of the way in which they are assessed and they way in which their learning is structured. That said, Schön argues that reflection *in* action is what underpins a teacher’s craft as it involves making decisions about enhancing learning and understanding in the children during lessons.

It seems to me that reflection *in* action is the more complex skill to develop in student teachers. As a teacher, I must continuously make decisions during lessons to reflect the way in which the children are responding to the teaching. One of the professional standards for teachers prescribes that teachers much be accountable for children’s learning and progress and as a mentor, I have, on many occasions pointed this out as an area for students to develop. For the students, this often means being prepared to deviate from the lesson plan to explore the children’s responses as they arrive. Sometimes, this is as straightforward as allowing a little more time than planned for children to complete a task or pausing to explore a misconception that has emerged. These small decisions may seem to be of little consequence to an outsider, but they can be the difference between a successful teaching session and one in which learning is limited. Such adjustments to the planned course of action are undoubtedly the result of reflection *in* action, but during the rigours of a lesson, there is not time to pause and discuss them with a mentor, they are internal decisions that become automated with time. In agreement with Schön, reflection *in* action (and acting upon these reflections) is a large part of the craft of teachers, but I have observed that for student teachers, making their tacit actions explicit can only happen when they reflect *on* action and this often happens during post-lesson discussions.

2.3.5 Experiential learning theory (ELT)

Kolb's (2015) theory of 'experiential learning' (ELT) is pertinent to the discussion of the ways in which student teachers learn because it links education, work and personal development. As I discuss in detail in Chapter 8, I believe that these three aspects converge and generate a triadic identity that is unique to teacher education. ELT suggests that students need to engage with active participation in their chosen field and, as the name of the theory suggests, learn from experience. In a sense, Kolb's work draws on that of Piaget because the learner is at the centre of activity although Kolb asserts that learning only occurs when experience is reflected upon. However, ELT is often misunderstood as merely providing learners with experiences from which they can learn. Kolb and Kolb (2005) seek to dispel this by describing it as a philosophy of education that is based on what Dewey (1938) called a 'theory of experience'. It describes a process whereby concrete experience is reflected upon. This is followed by abstract conceptualization of the experience, then active experimentation with it.

Learning from experience characterises the practice-based elements of the PGCE and even theory-based elements are deemed to bear fruit in the students' practical, teaching skills. This cycle is very much like that of a student teaching a lesson, reflecting upon it, analysing their reflection then putting into practice the results of that conceptualisation in their next lesson. ELT does go some way to describe the learning of student teachers although typically, students undergo this process with support from mentors in school. Kolb and Kolb (2005) themselves make reference to this and draw upon the work of Kegan (1994) who uses the image of a learner being 'held' by a blend of challenge and support. From my own experience of both observing students teaching and being observed myself, it is common to focus on areas for development. Particularly in the early stages of the PGCE, areas for development are likely to be numerous and frequently cover a broad range of areas like behaviour management, subject knowledge, pace and differentiation. This can be overwhelming for students and it does rely on a skilled mentor to create the 'ingenious blend of challenge and support' described by Kegan (1994, p. 42) that carefully meters targets for development alongside positive aspects and support. It is interesting to note the parallel between Kegan's notion of challenge and support and Vygotsky's ZPD (discussed earlier in this chapter). This suggests that there are some intrinsic similarities between theories that describe adult learning and theories that describe the learning of children.

2.3.6 Situated learning

Lave and Wenger seem to be less sure that active participation in learning opportunities is possible when learners are novices in their field. Instead, they propose a process that they call 'legitimate peripheral participation' (Lave and Wenger, 2011). This begins when, as novices, learners join a community of practitioners. Referred to as a 'community of practice', the community comprises of learners at all stages of development. As the knowledge, skills and understanding of the 'newcomers' develop, they gradually move toward fuller participation in the community and they become a source of expertise for the new novices that join the community over time. This sociocultural perspective actually describes primary schools rather well. From my own experience, schools frequently comprise a mixture of experienced and newly qualified teachers. Indeed, I joined my current school at the beginning of my fourth year of teaching and I am now (13 years later) a deputy head teacher and have been given responsibility for supporting those teachers who are earlier in their careers. It seems feasible then that student teachers could also become part of the 'community of practice' at their placement school. If individual classrooms can be considered a 'community of practice', this works on a small scale where student teachers gradually improve their skills and take more and more responsibility for teaching the class.

However, the communities of practice approach is not without its limitations and Wenger et. al. (2002, p. 141) themselves make reference to the ‘downside’ of communities of practice. Roberts (2006) offers a useful critique of the approach and from her work, I have drawn out the three factors that I see as most pertinent to my research: these relate to power, trust and belonging.

As I shall discuss in Chapter 9, student teachers have insufficient power to influence practices in such a short space of time at their placement schools and as Roberts (2006, p. 627) suggests, peripheral participants (such as the students) may only ever remain on the periphery and unable to make a contribution to meaning. As peripheral members of the community, students may not trust, or be trusted, by other members of the community and as Roberts (2006, p. 628) points out, ‘Without trust, members of the community of practice may be reluctant to share knowledge.’ As gaining knowledge from others in the workplace is arguably at the heart of a student’s teaching practice, this is indeed a significant issue with the concept. Finally, individuals may belong to a number of communities of practice and their development in any of them might be hindered by ‘spreading themselves too thinly’. Indeed, the very nature of the PGCE affects the extent to which the students are able to participate in a community of practice in at all. Students are frequently only in each school for a single term and could be in three different schools within their training year. After learning from the community of practice, they must move on to an entirely different setting. This represents a more transient form of legitimate peripheral participation and suggests that the approach may be better suited to school-based, employment routes (like the School Direct salaried route) where students remain in their schools for longer and are often employed by their training school once qualified. In this way, they not only learn from their community of practice, but they also make a contribution to it. Similarly, the nature of student teachership (and what I have called the triadic identity of student teachers) means that students may belong to communities of practice that are linked to their student, teacher *and* self identities that may mean that development in any of them may be hindered by the sheer volume of learning to negotiate.

2.3.7 Adult learning theory conclusion

It is my view that there is no single adult learning theory that adequately describes the nature of learning on the PGCE because none can fully incorporate both the theoretical and the practice-based aspects of learning that underpin the PGCE. In describing the learning of those students involved in this study, I have chosen to focus initially on the precepts of andragogy because it relates specifically to adult learners, but it is epistemologically aligned with pedagogy. Later, I will show how I challenge the need for different learning theories dependent on the age of the learner.

2.4 The Pedagogy/Andragogy debate

There is much debate surrounding the differences between pedagogy and andragogy but the essence of the difference lies in the assumption that adults learn in an inherently different way to children. As a theory, andragogy was originally publicised by Malcolm Knowles (1970) who persuasively argued that there needs to be a separate theory to apply to the ways in which adults learn since, he claims, andragogy is learner-focused whereas pedagogy is teacher-focused. This suggests that adults are more aware of their own learning than children are and that the responsibility for the children's learning lies firmly in the hands of the teacher. The benefit of pedagogy must come to children through an effective teacher whereas andragogy can be accessed directly by the adult learner. Inenaga et. al. (2007) elaborates on this and suggests that the main principle that underlies pedagogy is the socialisation and pastoral care of children, whereas andragogy is underpinned by an emphasis on the acquisition of relevant knowledge and skills. I suspect that primary teachers (myself included) may take exception to this distinction as it does not reflect the fullness of what primary education involves. To begin with, a primary teacher's effectiveness is measured not by the social skills and pastoral development of the children in their class, but on the children's ability to read, write and do mathematics competently. Furthermore, the distinction fails to mention the place of creativity and thinking skills that are central to the professional endeavours of all teachers.

Forrest and Peterson (2006) define pedagogy as an ‘archaic term’ when it is applied to adult learning and strongly advocate the use of andragogy to describe the learning of adults. They go further in their attempt to define what characterises andragogy and suggest that there are four key assumptions regarding learning that underpin it: 1) a self-directing self-concept, 2) use of experience, 3) a readiness to learn and 4) a performance-centred orientation to learning. It seems apt to address each of these in turn and consider the ways in which they may be applied to the learning of adults and children alike. 1) To begin with, a self-directing self-concept does seem to be rather more applicable to adults than it does to children; children’s sense of self develops as they mature and unlike adults, the children have no choice when it comes to being educated, so their ability to self-direct is limited. 2) Being older, adults are likely to have more lived experience than children although Forrest and Peterson’s (2006) assumption seems to be that adults are better able to make use of their previous experiences when faced with new areas of learning. I do not think that this is necessarily the case. Indeed, children’s more limited prior experience may make it easier for them to draw upon specific instances of it when they are faced with new concepts. This is particularly true when applied to mathematics education where concepts are returned to and overtly built upon each time they are revisited. 3) ‘Readiness to learn’ is a highly subjective perspective that is difficult to measure and therefore compare. Having chosen to remain in education, it could be argued that adult learners are demonstrating a *desire* to learn although whether or not this constitutes *readiness* remains questionable. It is possible that, with experience comes preconceived ideas about what learning ought to look like and that having learning structures imposed on adults may generate conflict that is less prevalent in children. From my own experience, the vast majority of children are ready and willing to learn and despite the didactic nature of their school experience, children are, in the most part willing recipients of teaching. 4) Adults undoubtedly embark upon learning opportunities with a clear sense of what they are working toward whether this be the acquisition of a new skill (learning another language, for example) or a qualification (like completing a degree or postgraduate programme such as the PGCE) so they do posses a ‘performance-centred orientation to learning’. In the early stages of their education, children are arguably less focussed on long-term goals although it would be to do them a disservice to suggest that they too are not concerned with their ‘performance’. Children in Year

6 (their final year of primary school) are acutely aware (some may say too aware) of the levels of attainment that are expected of them in the end of Key Stage Two Standard Attainment Tasks (SATs). Even in the years leading up to this, children are subject to shorter-term, academic performance goals that contribute to their levels of motivation and determination.

I suggest that, while each of Forrest and Peterson's (2006) attributes of andragogy could be applied to the ways in which adults learn, they could be similarly applied to the ways in which at least some primary-aged children learn and that the distinction between the learning of children and of adults is less clear than they suggest. Indeed, the work of Knowles (1970) is not without opposition and the pedagogy/andragogy debate remains active. Mohring (1990) seems concerned by the etymological roots of the term 'andragogy' and suggests that there need not be separate terms to explain the learning of adults or of children. Etymology aside, Knowles' rationale does seem rather simplistic when it is applied specifically to student teachers. According to Knowles (1988), a defining feature of andragogy is that intrinsic motivation is more prevalent than extrinsic motivation and that learning in adults is most valuable when it is problem-based and collaborative rather than imposed and inherently didactic. Like all postgraduate students, PGCE students are undoubtedly adult learners. However, as they are also studying education and working toward a teaching qualification, they are simultaneously both teacher and learner. Indeed, the very nature of my research poses an interesting issue that requires attention from the outset. Namely, student teachers are taught (as adults) about the teaching of children. In a sense, they are taught about teaching, they learn about learning and they theorise about theory. I have likened this complexity to that of the layers of a Russian doll and a detailed discussion of what I have called 'the matryoshka effect' follows in Chapter 7. Furthermore, while student teachers are, presumably, bound by the intrinsic motivation to become teachers, they are also subject to extrinsic motivation and pressures (in the same way that children are) imposed upon them by their university tutors and having to read and write at masters level. My own experience of administering and marking School Direct trainees' assignments is that they revealed little about their wider and deeper abilities and understanding.

Andragogy is situated within the theoretical framework of humanism which suggests that learners are self-determining and can make autonomous learning decisions. This stance seems to be directly at odds with the nature of the PGCE. As a taught postgraduate programme, the PGCE invariably imposes on student teachers a level of prescribed direction comparable to that of children at school where the tenets of cognitivism are the more prevalent discourse since the learning of PGCE students occurs predominantly through their exposure to logically delivered information. That said, student teachers do possess valuable life experiences and an awareness of the goal of their endeavours. With this in mind, it seems likely that student teachers are subject to a more intricate relationship between pedagogy and andragogy than the literature suggests. Indeed later, I argue that there is room for an educational theory that pertains specifically to the ways in which student teachers learn that accommodates their status as adult learners but simultaneously acknowledges what and how they learn.

2.5 What is practice?

Attending university to be taught in a formal sense in only part of a student teacher's educational experience. Whether following an undergraduate, postgraduate or employment-based route to QTS, students must complete a mandatory period of time in school. This is not merely a case of implementing their learning from university in a real-life classroom environment, but the students must develop interpersonal and relational skills, behaviour management and organisational skills that cannot be simply taught in a seminar at university. As well as the practical skills of a teacher's trade, teaching practice marks the commencement of the students' professional socialisation.

Students' initial experience in school is one of observation. They observe the children and their class teacher and are encouraged to observe other teachers at the school in action. Their first steps toward assuming the role of the class teacher involve what Britzman (1991, p. 4) calls 'custodial moments' such as taking the register, reading a story to the class or escorting the children to and from the playground. On the whole, these early experiences are managerial rather than pedagogical in nature. McNally (2006, p. 80) supports this and found that early school experiences are ‘largely informal with strong emotional and relational dimensions associated with identity formation’. This suggests that the development of a professional, teacher’s persona can legitimately take precedence over pedagogy in the early stages of teacher education. Students’ first experiences of actual teaching tend to be highly structured, prescribed tasks with small groups of children. These tasks are typically designed by the university to give the students an opportunity to interact with children. Within their first term, students are required to progress from this to carry out a percentage of whole-class teaching (typically around 40%). As well as the hands-on teaching, students are required to plan and evaluate each lesson and to prepare any resources required for their lesson. Over the year, the percentage of teaching responsibility increases with, it is hoped, the students’ classroom competence.

Much of the literature concerning the practice-based element of ITE focuses on the concept of partnership between schools and HEIs. Indeed, according to Furlong et. al (2006, p. 32), ‘...it is the concept and practice of partnership that is the distinguishing feature of initial teacher education in England today’. HEI’s throughout the UK work in collaboration with local primary schools that are prepared to host student teachers for the practice-based elements of their course. Participation in the partnership is voluntary, but it is common for schools to receive a nominal payment from their services (this is mainly to cover any additional costs that hosting a student may incur). The term ‘partnership’ does carry implications for the nature of the collaboration between HEIs and schools but it clearly implies a shared responsibility for the preparation of new teachers. At a practical level, universities cannot provide opportunities for their students to practise their teaching without schools and schools are unable to award academic qualifications or make recommendations for QTS without universities. The collaboration between schools and universities and the nature of their respective contribution to teacher education and training is crucial to understanding the gap between theory and practice as experienced by student teachers.

Furlong et. al. (2006) suggest that within partnership, there are deep-rooted epistemological and pedagogical assumptions. This means that the very nature of schools and HEIs makes them fundamentally different institutions that provide student teachers with different forms of professional knowledge that is delivered in different ways:

> Universities gave access to knowledge based on theory, on research and, most importantly of all, on the synthesis of a broad range of 'indirect' practical experience encapsulated in professional literature and in the experience of higher education lecturers themselves. Schools, on the other hand, gave access to knowledge based on direct practical experience itself. (Furlong et. al., 2006, p. 33).

While this describes the general principles of partnership, I might add a further assumption regarding the consistency of students' experience. While all students receive a more consistent content and style of teaching at university, students may be subject to very different experiences when they are placed in different schools for their teaching practice. While all schools are surely united in their aim to provide the best possible educational experience for their children, they can differ significantly in their capacity to support students. The relationship between HEIs and individual schools is therefore of great importance; HEIs need to know their partnership schools as individual institutions very well. Cameron-Jones and O'Hara (1994, p. 140) suggest that what trainees learn in school is 'contextualized' whilst learning at a HEI can be more easily 'generalised'. They suggest that partnership is simply a question of deciding what trainees can best learn from HEIs and from schools respectively. Again, this neglects the variation that exists between the offers from different placement schools. To remedy this, Cameron-Jones' (1995, p. 25) uses the concept of 'complementarity' between HEIs and schools to suggest an optimum model for partnership that acknowledges the specific nature of each school and what they are able to offer. Koetsier et. al. (1997) recognise this and highlight that the quality of schools chosen for students' placements was of the utmost importance for connecting theory and practice. They suggest that, 'Co-operating teachers need to be able to point out the relevance of theoretical notions for the student teachers whenever this arises. They must also be able to refer to the student teachers' campus activities' (Koetsier et. al.,1997, p. 128). This has some clear implications for those supporting students in schools: first, they should be in possession of theoretical knowledge that is equal to (if not exceeding) that of the students in their care and second, they should know both what students have learned at university before their school placement and what they will be learning after it. My research seeks to determine the extent to which this is the case.

In their discussion of the 1992 Modes of Teacher Education (MOTE) project, Furlong et. al. (2000) identified three models of partnership that have characterised ITE in recent years: complementary partnerships, collaborative partnerships and HEI led partnerships. In models of complementary partnership, HEIs and schools have separate yet related responsibilities that complement each other. At the heart of a collaborative model, they suggest, lies a commitment to exposing trainees to a range of educational knowledge and understanding, some of which comes from HEIs and some (equally legitimate) knowledge comes from practising teachers. However, Furlong, et al. (2000) suggest that the most common model used during the 1990s was HEI-led. They argue that this model was fundamentally different from the collaborative or the complementary model in that it was led by those in HEIs and reflected the pressures under which they worked. Conversely, in a report on partnership between HEIs and schools in Scotland, Elder and Kwiatkowski (1993, p. 9) suggested that the prevailing discourse in ITE is a ‘simple apprenticeship model’. Far from HEI-led, apprenticeship implies that students learn from the workplace and that schools are in control. Smith, Brisard, and Menter (2006, p. 21) also found a preference toward an ‘apprenticeship model’ whereby trainees learn teaching skills from the teachers at their host school and university tutors are ‘driven into an assessment oriented role’ (Smith, Brisard, and Menter, 2006, p. 21). John (1997, p. 29) also found that link tutors from universities took on more of a managerial role with responsibilities for the assessment for students and the moderation of outcomes and far less of an enabling, pedagogical role. This seems to denigrate the contribution made by university tutors (and by association, HEIs) in apprenticeship models and seems a little premature when Elder and Kwiatkowski (1993, p. 9) suggest that improvements could be made to apprenticeship models by incorporating a ‘theory-led reflection process’ into programmes. As former teachers themselves, university tutors are in possession of both theoretical knowledge *and* practical, classroom experience. Arguably, they are best-placed to provide theory-led reflection that is rooted firmly in pedagogy rather than a simple ‘assessment oriented role’.

Within the context of this study, HEIs provide the majority of the initial pedagogical subject knowledge and continue to provide schools with handbooks and mentor training. This essentially directs the specific *content* of the PGCE that must be covered in school. In one sense, this fulfils the description of a HEI-led partnership although the nature of *how* the content is provided, remains in the hands of individual schools and suggests the precepts of a collaborative model. Smith (2016, p. 19) suggests that partnership can be characterised as a 'space' where theory and practice meet. Zeichner (2010, p. 82) defines this as a 'third space' where students and their experiences should be at the core of ITE programmes. This has major implications for the delivery of such programmes and leads me to question the extent to which ITE of this kind could be planned for if learning is based on what each student happens to experience at their placement school.

So far, the literature suggests that little has changed in partnership discourse over the last 30 years or so. More recently, Farrell (2021) argues that there remains a good deal of ambiguity surrounding what is meant by partnership. While she accepts that partnership involves bridging a divide between theory and practice and researchers and practitioners, she maintains that operationalising the principle of partnership can be esoteric (Farrell, 2021, p. 2). Even where there is a universally accepted understanding of the contribution that HEIs and partner schools make it ITE, Farrell (2021) argues that there is still a requirement to acknowledge that contextual differences abound at different schools and that this creates a range of practices. From my own experience, formal partnership agreements go some way to achieving equivalence between schools and HEIs (Koetsier et. al., 1997) by assigning pre-defined responsibilities to both schools and universities. However, having hosted students at my school from a number of universities, these agreements have always been provided by the university and have been generic documents that have not reflected the distinctive, contextual features of the school. Smith (2016, p. 20) agrees that this provides some of the ambiguity and suggests that, to have any meaning, partnership needs to go beyond rhetoric.

To conclude this section, partnership is not simply a case of students 'doing' theory at university and 'doing' practice at school. There is a single desired outcome to the PGCE that is shared by both HEIs and schools: to prepare individuals to be competent, qualified teachers. To this end, the outcome must be the sum of its individual parts (both theory and practice) that are provided by genuine collaboration between schools and HEIs. This relies on both parties having an in-depth understanding of what the other can offer.

2.6.1 What is the gap between theory and practice?

Bruner (1960, p. 74) suggests that the gap between theory and practice in education is often perceived as ‘a yawning one’. He attributes this to popular perceptions of the value of thought and those who think. While education is valued and few would disagree that children deserve a high-quality education, he argues that curriculum content and approaches to teaching are rarely considered. In his view, ‘doing has been taken as the mark of effectiveness in thinking’ and the value of thought has been reduced to celebrating the ‘arcane wizardry’ of those who theorise.

As Bruner suggests, much of the gap between theory and practice seems to derive from perceptions of theory in particular. As discussed earlier in this chapter, theory seems to attract negative connotations that create a dichotomous, even oppositional relationship to practice. From my experience, negative attitudes to theory abound both among student teachers and qualified teachers alike. For example, in my research diary, I noted that a mathematics specialist teacher leading a piece of training for student teachers openly apologised for including references to theory in his presentation (Research diary entry, 14th October 2016). Similarly, in one of my interviews with a student, they described learning about theory as ‘… a bit of a drag and a bit boring’ and saw it as something to ‘get through’ (Conversation with Owen, p. 9). I will draw upon more examples of the student’s thoughts to illustrate my developing argument throughout the thesis.

In their study of trainee teachers’ perceptions before beginning their ITE programmes, Hobson et. al. (2006, p. 65) found that theoretical aspects of training were not considered of much importance: of the fourteen areas of knowledge and skill identified, ‘ability to bring about pupil learning’ and ‘ability to maintain discipline in the classroom’ ranked of the highest and second highest importance respectively. At the other end of the scale, ‘awareness of research findings about effective teaching methods', 'knowledge/understanding of the philosophy of education' and 'knowledge and understanding of the history of education' ranked twelfth, thirteenth and fourteenth respectively. Significantly, this study does not reveal whether those aspects of teacher education that were not rated highly were actually of use to the students or not. This is a significant omission and one that my research seeks to address.

The significance of students' attitudes to theory is echoed by Jackson and Eady (2008) who suggest that to bridge the gap between theory and practice, 'it is essential that student teachers do not divorce the one from the other' or see the theoretical aspects of their course as an ' irrelevant 'bolt-on'' (Jackson and Eady, 2008, p. 8).

The question of the efficacy of theory in ITE is by no means a new one. In his 1904 publication 'The Relation of Theory to Practice in Education', Dewey berates teacher education programmes that lend teachers 'immediate skill... at the cost of the power to keep on growing' (Dewey, 1904, p. 320). The 'power to keep on growing' could lie in an individual's own attitude, but I suspect that Dewey is referring to a solid foundation of theoretical understanding. Yet the literature on the subject of theory in teacher training is awash with arguments for and against it in abundance, although most agree that there is a place for both theory and practical experience in the preparation of new teachers.

In an investigation into perceptions of theory in teacher training, Hill (1997) found there was great support among head teachers for a significant theoretical content to ITE programmes and many felt that this was best provided for by HEIs. HEIs undeniably have access to the theory generated by educational research and Hagger and McIntyre (2000) propose a four-fold benefit to educational research in teacher education. Firstly, they make the distinction between research that provides an understanding of what is seen in the classroom and research that seeks to offer suggestions of new approaches. Secondly, they offer a further distinction that either type of research could be used to enhance the teaching and learning of children, but more interestingly, they also suggest that, 'Research which helped to solve the problem of making teacher education more effective and reliable would indeed be useful' (Hagger and McIntyre, 2000, p. 484).That said, they also acknowledge the generalist nature of research and they point out that, paradoxically, at the core of 'expert practice' lies the ability to make subtle judgements that are often based only loosely on the generalisations that research provides (Hagger and McIntyre, 2000, p. 487).

In support of this, Counsel et. al. (2000, p. 469) acknowledge that the primary aim of any teacher education programme has to be that students become 'competent classroom practitioners' and that ideas gained from research are only useful of they are directly relevant to achieving that aim. While from the outset, they persuasively argue that educational research can play an integral role in the learning of student teachers, they also describe ten key principles that ought to be adhered to if research is to be useful to trainees' practice. Most notably though, Counsel et. al. (2000), acknowledge that no theory has universal validity and they suggest an informed, careful and critical approach to its use. They also suggest that choices made by HEIs about which theories and research to include in their curricula need to be highly inclusive and regardless of what discipline the research comes from, its value should be measurable by its relevance to teachers' practice. In support of this, Husbands and Pendry (2000) found that trainee history teachers struggled to internalise or accept knowledge that did not provide answers or whose knowledge did not support their day-to-day classroom practice.

2.6.2 Praxis, not practice

It is at this point that the concept of praxis becomes useful. It is a concept that I came to late in my studies and after many attempts to define what appeared to be an empty void between theory and practice. On the contrary, my research defines praxis as the process by which theory and practice converge and develop meaning. As I shall discuss, it is praxis that makes theories useful to student teachers.

For Torres and Mercado (2004), praxis offers more than practice or theory are able to offer in isolation. In their view,

> Considering the teaching profession as one of instrumental problem solving reduces any decision about the appropriateness of a given educational

> theory or method to empirical tests, whose results become time and context free prescriptive principles of practice. (Torres and Mercado, 2004, p. 60)

However, in their description, praxis provides a self-sustaining process that not only improves teachers’ practices but that also enhances their understanding of those practices and makes explicit the impact of their improvements.

Arnold and Mundy (2020, p. 9) argue the case for a ‘praxis pedagogy’ in ITE. They suggest that immersing student teachers in their school experience is most fruitful when combined with a ‘praxis enquiry model of learning’ because it enables them to make explicit links between theory and practice. They suggest that a praxis in ITE should begin by questioning and then describing practice. Only then is existing theory introduced with the students seeking to explain their practice using the theories of other people. Following this, the students attempt to theorise their own practice before finally modifying it and making improvements. This strikes me as significant in two ways. Firstly, is implies an inductive approach where theory is applied to practice. As I shall discuss later, this does not reflect the way in which the students in this study used theory. Later in the thesis, I also propose that educational theories are more readily consumed when they are neatly packaged as ways of doing and not as frameworks for thinking. I argue that this represents a reductionistic approach to using theory that may not meet the needs of all students or even be possible in different school environments. In a similar way, as Arnold and Mundy’s (2020) model essentially provides a way of ‘doing’ praxis, I suggest that it too may have limited scope. However, the ‘matryopraxis’ that I describe in Chapter 7 takes account of the nature of student teachership and, rather than presenting a model for enhancing the learning of student teachers, it provides a broader way a understanding the issues that they face.

2.6.3 Conclusion to ‘the gap between theory and practice’

Eraut (2007, p. 419) describes how learning occurs in the workplace and concludes that, ‘Formal learning contributes most when it is both relevant and well-timed, but still needs further workplace learning before it can be used to best effect.’ In short, both formal (theoretical) and workplace (practical) learning make a valuable contribution to ITE. Despite this, theory and practice are often presented as a dichotomy. According to Britzman (1991, p. 2), they are better expressed as dialogic as, ‘they are shaped as they shape each other in the process of coming to know.’ In this sense, while they are often considered as opposite, even opposing concepts, they are duly bound in a symbiotic relationship. In ITE, theoretical learning needs to be activated in a school environment before it becomes truly useful and practical experience must be reflected up and theorised in order to remain useful.

This chapter has described the general context of theory and practice in ITE. The following chapter addresses the second aspect of the bifurcated discussion and provides an insight into current discourses in mathematics education and specifically, the nature of mastery in mathematics.

Chapter 3: Mastery in Mathematics

... with the new national curriculum, the broadening as opposed to that surface knowledge, I suppose that schools are a little bit shy at the moment of what mastery really means and why to do it and what are the benefits …
(Conversation with Tara, p. 5)

3.1 Introduction

This chapter explores the current climate of primary mathematics and in particular, the nature of the mastery curriculum. While it reflects the practice of the period during which the research was undertaken (2015-2019), the tenets of the mastery curriculum remain high-profile in schools in 2021-22. The chapter begins with a brief history of mathematics education before focussing on the precepts and content of the mastery curriculum. The chapter goes on to explore the theoretical basis of mastery before concluding with a discussion of the effects of a mastery curriculum.

3.2 Mathematics education is subject to political intervention

The National Curriculum for England was introduced in 1988 by the then Secretary of State for Education Kenneth Baker. The document set out the statutory programmes of study for pupils in Key Stages One and Two (KS1 and KS2) in all subjects. In most primary schools, there is a dedicated, daily mathematics lesson as well as an English lesson. This often (although not exclusively) takes place in the morning and in KS1 and KS2, often lasts for around one hour. Whilst this dedicated and lengthy mathematics session could indicate individual schools' priorities with regard to mathematics education and the importance that they place upon children becoming competent mathematicians, it could also indicate continued adherence to a formalised, government-driven attempt to raise standards in numeracy among primary-aged children. Initially launched in 1998, the National Numeracy Strategy prescribed a daily 'numeracy hour' that advocated a fixed lesson structure to allow time for a 'mental and oral starter', whole class teaching, differentiated activities and a plenary. Naming the framework for teaching the *numeracy* strategy could indicate something of the Department for Education's (DfE) priorities with regard to mathematics. Specifically, fears over levels of adult illiteracy and innumeracy may have been behind a move to improve children's numeracy. As a contraction of 'numerical literacy', the term numeracy suggests confidence and fluency when it comes to handling numbers and calculating. However, in 2006, a new framework of The Primary National Strategy was launched in which programmes for teaching literacy and *mathematics* were put forward. *Mathematics* suggests a much broader skill set than *numeracy*. After all, the work of mathematicians is to solve problems and communicate ideas and being numerate is arguably the most basic prerequisite of this. This shift in terminology hinted toward a desire to develop children's broader skills of reasoning and problem solving as well as continuing to develop their calculation proficiency. The political context of education is significant and the intervention of politicians has a huge impact on what happens in the classroom. Importantly, mathematics is considered useful to business and employers and politicians are bound to target mathematics in schools to ensure an ongoing supply of skilled mathematicians for the workplace.

Along with English and science, mathematics is deemed to be a 'core subject'. This means that it is widely acknowledged to include fundamental knowledge, skills and understanding without which, the children would be disadvantaged both at school and in their lives as adults. As such, the standards that children achieve in mathematics are closely monitored by Ofsted and are therefore of high priority in all schools. Each year, schools' attainment data are published to allow for comparisons to be made between schools and league tables to be compiled. This is currently called the Inspection Data Summary Report (IDSR). The IDSR is constantly monitored by Ofsted and a drop in standards can trigger an inspection. My own recent experience as a mathematics subject leader during an Ofsted inspection of my school (June 2018) was an interesting one. As well as an interrogation of my school's standards in mathematics (that happened to be 'good' in Ofsted's terms), inspectors also scrutinised mathematics lessons and work in children's books. Additionally, inspectors questioned me (for some time) about my priorities for the subject the pedagogical roots of our chosen approach to mathematics.

While obtaining the primary PGCE enables individuals to teach all subjects in the primary curriculum, the students involved in this study chose mathematics as their particular area of core subject expertise. The knowledge, skills and understanding that the students gain through their studies lay the foundations for them to take on the role of mathematics subject leader later in their careers.

While the National Curriculum itself is revised infrequently, new approaches to mathematics arise frequently and primary mathematics has become an ever-changing entity. An understanding of current trends and high-profile approaches are crucial to this thesis because they are at the centre of the students' experiences of mathematics teaching while they are training.

3.3 Mathematics education has undergone rapid change recently

In September 2014, a new National Curriculum for primary schools became statutory and the expectations of this third incarnation (1989, 1999, 2014) are continuing to provide challenges for experienced teachers and student teachers alike. One of the greatest changes was in mathematics where the methods that children use to carry out calculations gained particular prominence; indeed, the only appendix to the entire mathematics curriculum document is a collection of written calculation methods that the Department for Education (DfE) promotes. The aims of the curriculum are to promote 'fluency', 'reasoning' and 'problem solving' and as with any educational reform, schools are under pressure to deliver the new curriculum whilst still maintaining and improving standards of attainment. As well as new curriculum *content* (the things that children must be taught), there is also now a huge emphasis on curriculum *design* (the ways in which these things are taught). This has significant implications for the use of theory in teaching mathematics because the work of constructivist, social constructivist and socio-cultural thinkers can help to provide a framework for the ways in which children are taught and therefore also what student teachers must learn about.

3.4 The 2014 curriculum is a 'mastery' curriculum

'Mastery' is a relatively recent addition to the nomenclature of primary education yet as an educational concept, it has actually existed for some time among scholars. 'Mastery Learning' was described by Benjamin Bloom in 1971 and was defined simply as mastering a concept before moving on and learning another. At this stage, it is important to emphasise that there is no single, universally understood definition of mastery and that different schools have interpreted it in different ways. Initially, there was some confusion surrounding its precise meaning. To begin with, the ‘mastery standard’ was one of four attainment indicators set out by DfE (2014) in a draft document and was used to describe children’s performance that exceeded age-related expectations. However by the time that the DfE’s Interim Assessment Framework was published in September 2016, the term had already disappeared and was replaced by the ‘greater depth standard’. Whilst the reasons for this rapid reinvention of the term are unclear, it is now widely accepted that mastery is an approach to teaching and learning rather than simply a description of performance or a level of attainment. Naturally, the term attracted (and continues to attract) a significant amount of attention from mathematics subject leaders who hurried to define what exactly was meant by mastery and what it might look like in their schools. This triggered an abundance of CPD, training courses, books and teacher research groups on the subject that were designed to support schools in their implementation of a mastery curriculum. Similarly, student teachers have received guidance from their ITE providers to ensure that they too have an understanding of mastery.

3.5 What is mastery?

Mastery draws on the practices and educational principles from some high-performing jurisdictions in east and Southeast Asia – namely Shanghai and Singapore. Recently, much has been written about the so-called ‘mastery curriculum’, but it is generally accepted that mastery of mathematics involves teaching one set of mathematical concepts to all children and that it moves beyond the memorisation and regurgitation of facts (Drury, 2015). Additionally, it involves a deep, conceptual understanding that allows children to apply their knowledge to new and unfamiliar contexts. The National Centre for the Excellence of Teaching Mathematics (NCETM) describes mastery as a set of principles that include the belief that through good teaching, resources and pedagogy, all children can achieve in maths. In support of this, Trundley et. al. (2016, p. 7) describe ‘teaching for mastery’ as ‘teaching for understanding’ and as they point out, it is not a new concept at all, but more a new name for what might be described by some as simply good teaching. The 2014 curriculum suggests that children should only move on to new material when they have a deep, conceptual understanding and that they should then be provided with ‘rich and sophisticated problems before any acceleration through new content.’ (DfE, 2013). This key tenet of the mastery curriculum seems to be fundamentally at odds with the precepts of general intelligence theory. Originally proposed by Charles Spearman, general intelligence (or the *g factor*) suggests that children’s performance across seemingly unrelated subjects were positively correlated. Spearman (1904) attributed this to the existence of an underlying, mental ability that permeates children’s performance in all subjects. General intelligence might suggest that only those children with a high level of attainment in other areas would achieve at a high level in mathematics. As I shall discuss later in this chapter, this opposes current trends in the description of a child’s mathematical ability.

Running alongside the issue of children’s mathematical ability is the question of teachers’ (and therefore also student teachers’) mathematical ability. From 2000-2019, all student teachers needed to pass a statutory skills test in English and mathematics before QTS could be awarded. Indeed, from 2012, it became an entrance requirement for ITE courses. In addition to this, the majority of teacher training courses (BEd. PGCE and School Direct) require prospective students to pass an English and mathematics test at interview. In my role as Training Manager for the ‘School Direct’ teacher training programme, I have been responsible for the administration and marking of such tests. The tests are taken very seriously by prospective students and those interviewing them alike and the outcomes of them form a significant discussion point among the selection panel. The following excerpt from my research diary captures such a discussion:

> *When discussing the candidates post interview, Anne [one of the head teachers involved in the selection process] looked through one of the completed maths tests; the candidate had* scored *only 9 out of 30. She immediately said, ‘No, not in my school. I couldn’t have her teaching my children.* (Research Diary, Thursday 7th January 2016)

This struck me as a very interesting insight for two reasons. Firstly, the head teacher involved was happy to disregard a prospective student purely on the basis of her low score in a mathematics test and secondly, because the mathematics test was only a reflection of the candidate’s personal mathematical ability, not her ability to explain concepts to children, reason mathematically or explain her thinking despite these being the very skills that the new 2014 curriculum aims to promote in the children. In this instance, mathematical ability was considered more important than the ability to theorise and conceptualise. This is reminiscent of George Bernard Shaw's well-known adage*, 'Those who can, do; those who can't, teach'* and it raises some important questions. Did the head teacher in question know about the new curriculum and the principles of mastery and has she always thought in that way?

As Trundley et. al. (2016) suggest, many teachers will be familiar with the principles of mastery without labelling it as such but a mastery curriculum has a number of facets that have implications for the way that mathematics is taught in primary schools, many of which challenge the prevalent trends in mathematics education of recent times. These will now be explored in more detail.

3.6 Mastery means taking your time

One of the key facets of a mastery curriculum is the time that is allocated to learning different concepts. After all, to truly master a concept or skill takes time. Bloom (1968, p. 7) emphasised this when he commented that

> We believe that each student should be allowed the time he needs to learn a subject. And, the time he needs to learn the subject is likely to be affected by the student's aptitudes, his verbal ability, the quality of instruction he receives in class, and the quality of the help he receives outside of class. The task of a strategy for mastery learning is to find ways of altering the time individual students need for learning as well as to find ways of providing whatever time is needed by each student.

This view seems to be contradicted by the 2014 curriculum which states that, 'The expectation is that the majority of pupils will move through the programmes of study at broadly the same pace' (DfE, 2013, p. 99). This is in stark contrast to the previous curriculum that acknowledged that teachers may need to slow or hasten the children's progress through the programmes of study in order to meet their needs. Using Bloom's (1968) description, it seems strange that the 2014 curriculum has been described as a 'mastery curriculum'. Indeed, the phrase 'linger longer' has been coined in some schools as one of their approaches to mastery. The National Association of Mathematics Advisors (NAMA, 2015) has also argued that the 2014 curriculum is not compatible with a mastery approach because it has far too much content to allow teachers to spend lots of time exploring concepts before moving on. The NCETM (2014) describes effective mastery curricula as those that use small steps to be mastered before new ones are introduced. Bloom (1968) also suggested that only a state of ‘mastery’ or ‘non-mastery’ could ever exist in a learner and that alongside ‘non-mastery’ had to come a prescription of what a learner needed to achieve to attain mastery.

3.7 Does mastery mean no differentiation?

At the heart of the mastery curriculum lies the concept of inclusion (Drury, 2015, p. 57). This means that all children, regardless of their ability, are taught about the same concepts and included in the same learning opportunities. In recent years, including all children in mathematics learning opportunities has been interpreted as differentiation by lesson content (indeed, the ability to differentiate is one of the DfE’s (2012) Standards for Teachers in England). This has aimed to ensure that children who find concepts difficult are given different tasks and resources to slow the pace and reinforce their learning while higher-attaining children are accelerated through curriculum content, often from subsequent year groups. With an incessant focus on narrowing or even closing ‘the gap’ between the attainment of different groups of children, there is research evidence that suggests that differentiation may actually increase the achievement gap between higher attaining and lower attaining children (Stevenson and Stigler, 1992, Parsons et. al. 2014). The age-related curriculum that is now in place in England is designed to avoid gaps in children’s understanding from emerging in the first place. The new curriculum requires that all children should meet the expectations set out for their year group and that higher attaining children should be challenged through problems of greater depth and complexity, rather than through their introduction to new concepts. Arguably, providing more complex problems for more able children *is* differentiation and the extent to which keeping all children working on the same ideas is actually possible is something that requires further investigation. Drury (2015, p. 26) suggests that, ‘the concepts and skills that are taught earliest are not ‘the easiest’, but the ones that will be most foundational for future learning.’ Few teachers would dispute this and would join Drury (2015) in emphasising the importance of early mathematics, but some may question the wisdom of restricting high-attaining children to practising the same skills until all are ready to progress. Indeed, a cynical observer may describe this as an attempt to suppress the progress of the most able to allow lower attaining children to catch up, but I am not convinced that this is really the case because the raised expectations of the 2014 curriculum dictate that the most able children need to be challenged further to meet even the expected standards. Despite this, I do think that mastery oversimplifies the reality of the range of attainment in mainstream primary schools yet according to the NCETM, the mastery approach is underpinned by the belief that *all* children are capable of both understanding and doing mathematics. Stripp (2015) provides a useful insight into how this might look (in practical terms) in a classroom as he discusses ways of meeting the specific needs of all pupils without differentiation of lesson content. Stripp (2015) also promotes rapid, 'same day intervention' as a means to achieving mastery without differentiating lesson content. In some primary schools, this has been interpreted as assessing the children's understanding of the daily teaching then offering additional support to those who have not understood at another point during the day (often outside of the mathematics lesson). One colleague from another school has even named their intervention the 'scoop group' because it 'scoops up' children who have not yet understood and supports them until they do. The underlying principle of this approach is sound and involves extra input to enable some children to catch up with their peers but it does beg the question of what happens to the children who still don't understand after intervention? What do they do the following day when the rest of the class has moved on to the next concept? There are also concerns about the broadness of the school experience that some children will receive if they continually find themselves in the 'scoop group' as this excerpt from my research diary suggests:

> *When discussing 'same day intervention' with a Y2 colleague, she said. 'What about the kids who are always going to be in that afternoon (rapid intervention) group? They'll never do anything but English and maths and will miss out on all the other subjects like art and music – that they're probably quite good at!* (Research diary entry, Tuesday 24th January 2017)

My colleague's concern is a valid one and suggests that 'same day intervention' may only become a practical reality when either we are able to teach a narrower curriculum with fewer areas to cover or when a more holistic education can develop many more aspects of children's learning and understanding.

3.8 Mastery requires a 'growth mindset'

Up until now, I have focussed on how curriculum design contributes to a mastery curriculum but Carol Dweck (2006, 2016) has written extensively about the importance of an individual's mindset in their mathematics and science achievement. Indeed, she suggests that 'mastery goal orientation' is dependent on a growth mindset and *not* on curriculum content or design. The basis of a growth mindset lies in the belief that intellectual abilities are not fixed and that they can be nurtured and developed (Dweck, 2006). Historically, schools have referred to children's levels of attainment, however recently, terms such as 'rapid graspers' or 'previously high attainers' have become prevalent in the nomenclature of primary teachers to describe pupils who previously may have been described as simply 'good at maths'. In order to preserve children's self-esteem and to promote the belief that all can achieve mathematically, less able children often referred to as 'previously low attainers'. The principle here is that a child who found, for example, addition challenging may engage perfectly well in subsequent units of work on fractions or shape. In mastery terms, prior low attainment does not mean that children will find all areas of mathematics challenging although from a general intelligence stance (that I discussed earlier in this chapter), this seems to be a somewhat idealistic assumption. This shift in terminology hints toward a belief that all children are able to be successful with new content even if historically, their attainment has been low. This has significant implications for the student teachers because if they are to enable all children to succeed, they must become expert mathematics teachers with an in-depth knowledge and understanding of theory and practice. In recent years, the concept of growth mindsets has been questioned and the likelihood of positive attitudes contributing to successful learning has been challenged. Sisk et. al. (2018) and Effron (2018) have both shown concern toward the efficacy of the concept itself, and the methods used to arrive at its claims. Sisk et. al. (2018) carried out an empirical study to ascertain the relationship between mindset and achievement and found that correlation between the two was weak. Similarly, Effron (2018) is concerned that, although the term 'growth mindset' is used casually, there is no way to measure mindsets in a meaningful way. Despite the critique, it would be difficult to argue against positivity and self-belief when it comes to learning mathematics and as a teacher of young children myself, I would never consider ‘fixing’ their mathematical ability or giving them the impression that they were not capable mathematicians.

Jo Boaler has also written extensively about mindsets in mathematics and she argues that mathematics education has been characterised by negative mindsets for a number of years. She cites a negative attitude to mathematics as a significantly damaging factor that prevents progress. Significantly, she argues that children’s anxieties and difficulties with mathematics are due, in part, to teachers’ own mindsets. As the content of this chapter has already implied, this is not new thinking and the Cockcroft Report (1982, p. 62) recognised the importance of parents’ mindsets, attitudes and low expectations and suggests enlisting the help of parents by explaining approaches to maths that they may not have undertaken themselves whilst at school. In a study entitled ‘Transforming pedagogical practice in mathematics: Moving from telling to listening’, Suurtamm and Vézina (2010) found that teachers’ ideas about how best to teach concepts were based on long-held, well-ingrained views that were difficult to change or move away from. Whilst a shift in mindset and attitude may be required to keep up with the ‘revolution’ that Boaler describes, there seems to exist something of a pedagogical trap; teachers know that they need to allow children to explore concepts and think mathematically, but they are similarly bound by a straitjacket of prescribed calculation methods, outcomes and testing. Suurtamm and Vézina (2010, p. 3) allude to this conflict when they say that,

> It takes time for teachers to see the importance of posing problems, providing opportunities for students to explore the problems, and listening to their solutions. Even when they are convinced of the importance of these practices, it takes time for teachers to learn to incorporate them.

Incorporating these practices is certainly a significant challenge when the success of a school (and indeed of individual teachers) is not measured by the ability of children to think mathematically, but by their ability to pass tests. This apparent conflict between performance and understanding was fuelled in Janaury 2016 when the UK government announced a statutory multiplication tables test for children in Year 4 of primary school that formally assesses their recall of multiplication facts. Boaler (2016, p. 35) shows great concern over what she calls ‘passive approaches’ where children copy methods demonstrated by the teacher, because they do not require any thought. Interestingly, just seven years prior to the announcement of a new times tables test, Ofsted (2009, p. 3) released guidance stating that, '… it is of vital importance for pupils of all abilities to shift teaching and learning away from a narrow emphasis on disparate skills towards a focus on pupils' mathematical understanding.' While the government is seemingly unable to heed its own advice with regard to a 'narrow emphasis on disparate skills' and teachers and their pupils remain subject to the rigours of a culture of testing, schools are invariably bound to spend more time promoting rapid recall than teaching for mastery.

3.9.1 What is the theoretical basis of mastery?

The mastery curriculum has triggered something of a resurgence of interest in educational theories. In considering mastery, teachers have, to some extent also had to consider theory. Naturally, this has brought theory to the forefront of serving teachers minds when for many, it was something that they *did* whilst they were training to teach and then abandoned altogether. In the previous chapter, I gave an overview of Bruner's concept of the *modes of representation* and suggested that it has had a significant impact on teaching for mastery. Indeed, I believe that Bruner's description of *enactive, iconic and symbolic* representations is responsible for rekindling an interest in theory among both students and qualified teachers alike albeit in its re-branded guise as the 'Concrete, Pictorial, Abstract' (CPA) approach. CPA is now familiar concept in most schools and forms the basis for the way in which teachers present mathematical concepts to children within a mastery curriculum.

As with Bruner's original idea, the concept of CPA suggests that different forms of representation can be used as children's understanding of a concept develops. They begin with concrete representations (Bruner's *enactive* mode of representation) of mathematical concepts. If learning about addition, for example, the children typically explore additive relationships and the concept of equality using practical apparatus. Primary schools tend to be awash with equipment such as counters, interlocking cubes, 'tens frames', Cuisenaire rods and 'Base 10'. Indeed, the renewed emphasis on concrete resources has, from my experience, caused schools to invest in large quantities of practical equipment (some of which had been owned by the school, had fallen out of fashion and been disposed of years previously). In the following example, I illustrate how a child may explore the concepts of addition and equality in ‘concrete’ terms with plastic, ‘Unifix’ cubes:

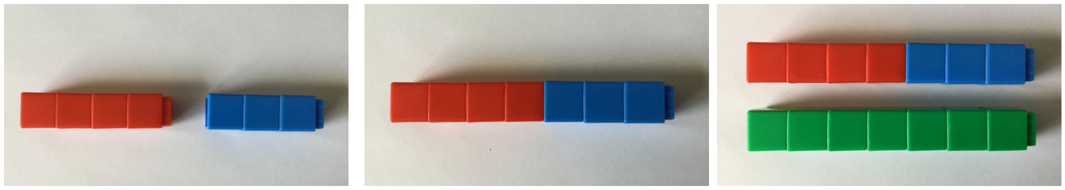


Figure 2: A ‘concrete’ representation of addition.

In this example, the child gains a tangible experience of addition by combining a tower of 4 cubes to a tower of 3 cubes. They will recognise that the tower made from 4 cubes is taller than the tower made from 3 cubes and this will reinforce their concept of 4 being greater than 3. Finally, they are able to count the total number of cubes in their tower, compare their tower to the tower of 7 cubes and recognise that 4 + 3 is equal to 7.

Following the concrete phase comes the ‘pictorial’ phase (Bruner’s *iconic* mode of representation). As the name suggests, the child no longer relies on a concrete representation and is able to interpret images that represent the concept that is being taught. Below is an example of a pictorial representation of the calculation above:

Figure 3: A ‘pictorial’ representation of addition.

In this example, the child is shown the additive relationship between 4, 3 and 7 in this diagrammatic form. No longer do they need to handle towers of cubes to recognise that 4 is greater than 3 and that when they are combined, they are equal to 7. This pictorial representation is generally referred to as a ‘bar model’ and it is a representation used frequently in Shanghai and Singapore and that has accompanied the mastery curriculum in becoming commonplace in UK classrooms. The 4 and the 3 are now aligned horizontally in preparation for the more standard written form with which adults are familiar and the numerals have been added to each part of the bar model.

When the children are familiar with concrete and pictorial representations of calculations, they are exposed to the 'abstract' phase (Bruner's *symbolic* mode of representation). Within the example of calculation that I have presented, this involves the children engaging with standard, written calculations that use mathematical symbols (4 + 3 = 7 in this example).

In its own right, the CPA approach is a working model for developing children's understanding but when viewed alongside Bruner's original concept, a number of inconsistencies emerge. To begin with, Bruner's enactive mode of representation suggests that we come to know how to do things through a 'habitual pattern of action we have mastered' (Bruner et. al. 1966, p. 6). It suggests that actions become automated until they are easily accomplished. Conversely, concrete representations are rather more to do with practical, tangible exploration of concepts that invariably deepen the child's understanding of the concept, but not to a point where the skills (of addition in my example) have been mastered. The 'pictorial' phase does appear to mirror Bruner's *iconic* mode of representation. It is important to emphasise that the bar model is not a method of calculation, but rather a tool for expressing and understanding numerical relationships. This aligns with Bruner's original idea that, 'to have a picture before one (or in one's head) is not necessarily to be able to execute the act it represents' and that 'a picture is a selective analogue of what it stands for' (Bruner et al, 1966, p. 6). In my chosen example, the bar model is a good example of Bruner's 'selective resemblance' (p. 7) and for the child, is essentially a picture of the towers of cubes that they encountered it the concrete phase. Finally, the 'abstract' phase of the CPA approach does draw upon Bruner's idea of symbolism because it makes use of mathematical symbols, but in my view, that is where the similarity ends. By symbolic representation, Bruner refers predominantly to the use of language to represent phenomena and in this example, mathematical language such has 'greater than', 'less than', 'plus', 'added to' and 'equal to' have already been used by the children to express the addition process in both the concrete and pictorial phases of representation. I propose that traditional, written calculations are not truly symbolic in the way that Bruner describes. Rather, they are a further iconic representation of the relationship between numbers that happen to use mathematical symbols.

A further discrepancy arises in the way in which the CPA approach is used when it is compared to the way that Bruner suggests that enactive, iconic and symbolic representations are used. He suggests that, in time, the modes of representation are *added* to the previous, most prevalent form of representation. This subtle use of language is easily missed but is of significant importance in our understanding of how the modes of representation were intended to be used. Being added to does not imply 'is replaced by' and yet the CPA approach implies a sequential progression from one form of representation to the next and that as a child develops 'mastery' of concepts, previous forms of representation are no longer needed. This is a common misunderstanding among teachers that, I believe, has been promulgated by the rigidity of the CPA approach and has led to many KS2 teachers that I have spoken to feeling that their children are too old for concrete representations. Indeed, in a conversation with a subject leader from another school, it was suggested that she would not be using concrete resources in her Year 6 class because the children are not allowed to use them in SATs tests so that there was not point in teaching them to use them or worse, to develop a reliance on them. The focus of this teaching was clearly not on the depth of understanding that mastery suggests, but on the procedural competency that can help the children to be successful in statutory assessments. As I will describe later in the thesis, this posed a problem to the student teachers when they tried to use concrete representations with older children in their classes.

The epistemological roots of the CPA approach are therefore questionable. Concrete and pictorial representations are chosen by teachers and presented to the children, some of whom may not derive inherent meaning from them. I believe that by being made into a rigid approach to teaching, Bruner's tentative, flexible, constructivist concept is no longer truly constructivist because as the CPA approach, it imposes a way of representing that is more akin to a socioculturalist approach where the teacher becomes the giver of objective, predefined knowledge. While the representations that are chosen mean something to the teacher, they are not a construct of the children themselves so could be meaningless or, worse still, damage the children's existing cognitive constructs. It is my belief that the CPA approach is typical of the formulae that adults like to measure the children's learning by. However useful it is as a teaching tool, it does not necessarily do anything to help teachers to examine the children's levels of understanding. This could indicate that Bruner's ideas have been moulded to fit the CPA approach to give some weight and intellectual validity to the practices the methods that are now widely accepted as 'best practice'. This does lead me to question whether purveyors of the mastery curriculum are, to some extent, guilty of misrepresenting theory to support their ideas about effective mathematics teaching. The implication of this for student teachers is significant because it means that they may not gain a true appreciation of either theory or practice.

The mastery curriculum also draws upon Bruner's *spiral curriculum*. In order to achieve the depth of understanding demanded of a mastery curriculum, curriculum design is of the utmost importance. There are, arguably, a finite number of mathematical concepts that are retuned to and built upon throughout a child's time in school. Children encounter subtraction, for example, in their reception year at school and children in Year 6 are still taught about subtraction albeit at a deeper level. The mastery curriculum is therefore cyclical in nature and the way in which concepts are introduced and developed is reminiscent of Bruner's well-known concept of the *spiral curriculum* that achieves depth of understanding by revisiting and building upon those concepts that have already been learned. Depth of understanding is also achieved through multiple representations of concepts (both in concrete and pictorial terms). Askew (2012, p. 126) suggests that multiple representations of concepts as 'work in progress' not only negate the issue of single, contrived representations by teachers, but also celebrate the very process of mathematics rather than simply the correct answers.

3.9.2 Variation theory

Rather than an approach to teaching mathematics in general terms (like the CPA approach), variation theory (Marton et. al., 2004) attends to aspects of specific, mathematical content. Variation theory acknowledges the intent of learning and that episodes of teaching always have a specific learning objective in mind. According to Askew (2012, p. 62), variation theory 'provides a framework for thinking about how to maximise the likelihood of the object of learning being brought into existence.' It is about making deliberate attempts to reveal mathematical concepts to children through carefully crafted representations of concepts and problems for the children to solve. Lo, Chik and Pang (2006, p. 3) suggest that variation theory is based on the view that '... when certain aspects of a phenomenon vary while its other aspects are kept constant, those aspects that vary are discerned'. This mirrors Dienes' (1960) 'systematic variation' where the same concepts are presented to learners in different ways in order that they develop a deeper understanding of them. In tangible terms, this includes presenting mathematical concepts to children both in terms of what they are and what they are not. For example, it suggests that an in-depth understanding of the base ten system cannot be achieved without also understanding number systems with other bases (Lo, 2012).

There are two distinct types of variation in mathematics teaching: conceptual and procedural variation (Gu et. al. 2004). Conceptual variation aims to present children with mathematical concepts from a number of different perspectives whilst procedural variation supports the progressive formation of concepts in which children experience solving problems in a number of ways. Gu et. al. (2004) suggest that procedural variation is derived from three forms of problem solving: by varying the problem itself, by varying the processes of problem solving (and therefore the methods that are used to solve them) and finally, by applying the same method to a group of similar problems. This seems to suggest that there is a gap between theory (conceptual variation) and practice (procedural variation) and I do wonder whether separating concepts and procedures in mathematics is actually possible. For example, when introducing the concept of addition to children as combining two quantities, it would not be possible (or indeed desirable) to avoid the process of adding one set of objects to another and finding the combined total. In my view, variation theory relies on pedagogical understanding on the part of the teacher to determine precisely what could be varied and when.

From variation theory comes the concept of 'intelligent practice'. Gu et. al. (2004) suggest the avoidance of 'mechanical practice' and recommends that when learning, practice should be limited. After all, if children are able to complete, say, six calculations accurately, is there any need for them to complete twenty such examples? Whilst it certainly seems 'intelligent' to limit the amount of time spent on practice (especially within the confines of a broad and arguably overcrowded curriculum) Merttens (2015) points out that intelligent practice may not be entirely compatible with a mastery curriculum and suggests that, ‘Mastery of an algorithm or skill requires that it, or parts of it become, to a greater or lesser extent, automated. To get things onto ‘automatic pilot’ takes repetition and practice’ (Merttens, 2015, p. 8). In other words, Merttens (2015) suggests that a more exhaustive approach to practising key skills may be required in order for children to truly ‘master’ them. Drury (2015, p. 8) seems to support this and suggests that a mathematical concept or procedure has been mastered when ‘a person can represent it in multiple ways, has the mathematical language to be able to communicate related ideas … [and can] … apply it to a totally new problem in an unfamiliar situation.’ This description of mastery is unlikely to become a reality without time for children to develop and embed skills and it does give rise to an interesting and relevant perspective: ‘mastery’ seems to suggest that there is no gap between theory and practice for children and that they can all achieve the same levels of attainment. Mastery suggests that if a child has an in-depth understanding of mathematical concepts, they ought to be able to apply them in a range of differing contexts while in reality, the two facets may not be so intrinsically linked. This is, to an extent, reflected in the way that ITE courses are being delivered. Non-specialist PGCE students focus on practical classroom teaching and only those that are pursuing a particular strength in mathematics explicitly engage with theory. The assumption here is that the most important part of being an effective mathematics teacher is the knowledge of what to teach children whilst the deep, conceptual understandings (that can be gained through critical engagement with theory) are merely a desirable extra. This clearly has huge implications for an imbalance in teaching approaches between those pursuing a strength in mathematics and those who are not.

3.9.3 Connectionist theory

While not reported to be one of the theoretical frameworks behind the mastery curriculum, Askew’s (2012) connectionist theory provides a useful lens through which to view the CPA approach and the concept of multiple representations. Askew et. al. (1997) define connectionist theory as the extent to which connections are made between different mathematical concepts (identifying the links that exist between division, fractions and decimals, for example) and between different representations of them. Secondly, it describes the way in which connections between the children's own methods and those being taught are made. They argue that the best mathematics teachers are 'connectionist teachers' and that the ability to make connections between concepts and methods outweighs the standard of a teacher's qualifications, their style of teaching or their organisation of the children.

3.10 Why mastery now?

In 2012, the Organisation for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA) survey placed England's children in twenty seventh position for mathematics (OECD, 2012) whilst children in Shanghai and Singapore achieved first and second places respectively. Using the PISA results, this suggests that the mathematics attainment of children in England is between two and three years behind their counterparts in Shanghai which, despite not being a country, were ranked in first position (Drury, 2015, p. 4). Both Shanghai and Singapore teach a mastery curriculum and it may be for this reason that the National College for Teaching and Leadership (NCTL) has endorsed the teaching methods used there as recommended approaches to teaching and learning. Implementing a curriculum that is successful in other countries could be viewed as a political decision with the aim of creating a 'quick fix' to the issue of perceived educational inadequacy while the reasons behind the problem are likely to be complex and multifaceted. Askew (2012) proposes one such reason and suggests that the number naming system used in Korea and China lends itself to a better understanding of place value. He concludes that, 'Asian children are not innately 'brighter' mathematically, but the structuring of the activities that they engage in may make them appear so' (Askew, 2012, p. 59).

Whilst the mastery curriculum has become prominent in English primary schools, it does not set out teaching sequences or suggest ideas for planning. It is therefore commonplace for schools to choose to buy schemes of work that are often produced in response to new government initiatives and curriculum reforms. As well as exemplifying the new requirements, they also provide teachers with planning and resources to use with the children. One such scheme, *Inspire Maths*, has been developed by Dr. Fong Ho Kheong and has been adapted from a scheme called *My Pals Are Here!* (2001) that was originally designed for use in Singapore's schools. As well as responding to the needs of teachers in England amid the wake of the new curriculum, *Inspire Maths* also brings Singapore's interpretation of mastery in mathematics to the United Kingdom at a time when the overriding sense is that there are many lessons to be learned from the Shanghai and Singapore approach to teaching mathematics.

3.11 Why has mastery been embraced in the Pacific Rim whilst it has not been in the UK?

During the 1960s, so-called Pacific Rim countries were not doing at all well in the teaching of mathematics (Field, 2015). What followed was a large-scale examination of their curricula with a huge emphasis on the work of educational theorists such as Vygotsky, Bruner, Dienes and Skemp – the same seminal works that have been at the centre of much educational thinking for the past 50 years in the UK (Field, 2015). As discussed in Chapter 2, theories have been the preserve of HEIs for a number of years and have not been actively promoted as worthwhile tools to qualified teachers, many of whom have not encountered seminal works of learning theory since they were at university themselves. Despite their enduring inclusion in HEI programmes of study, the extent to which theory actually forms the basis of how and what they teach remains questionable (hence the rational for the thesis). Its quality aside, Field (2015, p. 16) proposes that the '... more random, ad hoc approach to embedding theory into our practice' might go some way to explaining the apparent disparity between current levels of mathematics achievement in the UK and areas of South East Asia. Morris and Williamson (1998 cited in Cheng at. al. 2012) agree and suggest that Confucian heritage cultures such as those in China, Japan and Taiwan emphasise ITE curricula that are based on academic content knowledge while the curricula in Anglo-Celtic cultures like the UK, USA and Australia emphasise practice-based competences. This could go some way to explaining why the theoretical underpinnings of the maths curriculum in Shanghai and Singapore are so clear. Interestingly, China actually does less well than the UK in international tests when it comes to aspects of problem solving with number (Cai, 2001) and in the 2011 Trends in International Mathematics and

Science Study (TIMSS) tests, English ten year olds actually do well when compared to their South East Asian counterparts.

Despite the lack of clarity around levels of attainment, Fong et. al. (2015) state that educational theories are the basis for the approach to mathematics education in Singapore and it is therefore not surprising that he chooses to dedicate the majority of the *Inspire Maths* teachers' handbook to an explanation of the theoretical underpinnings of the scheme. According to Fong et. al. (2015, p. iv), Inspire Maths is based on 'well-established constructivist ideas of learning' and the ideas of Bruner, Piaget, Vygotsky, Skemp and Ausubel. Whilst these seminal works of theory are still a prevalent feature of the mathematics strength PGCE module, referring to ideas as 'well-established' is, in itself, misleading. Teachers in the UK may be surprised by the prevalence of learning theory when the last time that they encountered it was likely to be when they were training to be teachers themselves so arguably, the ideas are not well-established at all. He even argues that constructivism is at the very centre of the scheme's approach to the teaching of mathematical concepts. Fong et. al's (2015) assertions are strong and references to well-published intellectual and theoretical works adds weight to claims and undoubtedly instils some confidence among those schools choosing Inspire Maths. However, one will never know whether the programme is truly derived from (and therefore grounded in) theory or whether it just happens to reflect some of its constituents. It is interesting to note that Fong has a British PhD (gained from Kings College, London) so may have been subject to the same overview of educational theory that those training to teach are now and that for him, constructivist learning theory is 'well established' whilst for others, it may simply be something that they encountered while training to become a teacher.

The possibility exists that theorists have been used to decorate and give authority to the programme and this is something of concern to von Glasersfeld:

> If research programmes and schools announce that they have adopted the 'constructivist paradigm', innocent people are led to believe that there has been a breakthrough and that the adoption of constructivism will rescue education from whatever crisis it is thought to be in. (von Glasersfeld, 2002, p. 176)

For von Glasersfeld, this is not only misleading, but it is ‘counter-productive’ because constructivism remains a tentative and situational concept that takes time to develop and is not simply a set of principles that can be used and applied to a given context. This insight also offers a degree of personal pertinence both on a national and local scale. Firstly, it is a fitting description of the way in which the mastery curriculum was introduced. Mathematics education in the UK was indeed deemed to be in a crisis because of its unfavourable performance when compared to countries like China and Singapore. The mastery curriculum (and therefore its constructivist roots) were seen by the Government as a solution to the problem because a similar approach had proved to be successful elsewhere. Secondly, my own school chose to adopt the Inspire Maths scheme in response to the need to implement a ‘mastery curriculum’ quickly. Crucially, this came at a time when mastery remained a new and mysterious concept and there was a degree of panic surrounding the need to follow (or be seen by Ofsted to follow) a mastery approach. While Inspire Maths was not selected solely on the basis of its theoretical principles, it is fair to say that they provided some confidence and validity to our choice of scheme.

The theoretical bases of the mastery curriculum lead me to question whether students who have been taught theory handle mastery better. Whilst a full investigation of this is beyond the realms of this thesis, evidence from my research diary suggests that this may be the case, or at least that this is the perception among teachers. The following insight came from a discussion that I had with two NQTs at my school – one of whom had recently pursued a mathematics strength for her PGCE and the other of whom had chosen to specialise in English:

> *I was talking to Mary (a mathematics specialist) and Beth (an English specialist PGCE) about the issues they were having with teaching money to reception. Mary suggested using real coins and cited the CPA approach. Beth said, ‘See you get how to do these things!’ Mary replied, ‘Well, this stuff is based on a lot of the ideas from uni last year.’* (Research diary entry, 18th April 2016)

Whether or not Mary handled an issue with teaching for mastery well because she had engaged with theory at university or not is unclear, but in her referencing a concept such as the ‘Concrete, Pictorial, Abstract’ approach, her response reveals that she was willing to seek an answer in theory rather than from her own, classroom experience.

3.12 What are the effects of a mastery curriculum?

The seeming English obsession with the teaching methods employed in Shanghai and Singapore gained momentum in 2013 when the DfE, in collaboration with the NCETM, funded the creation of thirty-four 'Maths Hubs' to enable high-achieving schools to lead local improvements in mathematics education. In 2014, the Maths Hubs led three, national projects; two of which were concerned with the teaching methods used in Shanghai and Singapore. Firstly, the Maths Hubs coordinated an exchange programme between UK and Shanghai teachers that focussed on mathematics teaching and secondly, the 'High Quality Textbook Project' (Field, 2015) that set out to investigate the usefulness of the pupils' textbooks that are used in Singapore.

As well as programmes for teaching, the Shanghai and Singapore models for teaching have brought their own methods. Namely, the 'Singapore Bar Model' is a means through which children can visualise calculations with the aim of developing a deep, conceptual understanding of problems rather than simply knowing a method with which to solve them. Whilst it is the choice of individual schools whether they use such a model, the exemplification materials for the Key Stage One National Curriculum assessments feature the 'Singapore Bar Model' as an example of children's methodology, but only in the exemplification of 'working at greater depth within the expected standard' which could suggest that the Singapore curriculum is the preserve of the most able pupils.

It is also significant that the new primary curriculum bears perceptible resemblance to the nature of the PISA/TIMSS tests. Whether or not this represents teaching to the test on a massive, international scale remains open to debate, but it is clear that education cannot escape political intervention and that trends in education and so-called 'best practice' are part of a wider, political agenda. Many governmental priorities filter down into primary schools and where the UK is seen to fall short of the educational standards, the government tends to intervene. Similarly, mathematics is seen as a subject that is useful to business and the economy so mathematics education, even at the earliest stages, is always under scrutiny.

3.13 The Cockcroft Report

As well as being rooted in learning theory, much of the Shanghai and Singapore models for mathematics teaching are said to be based upon the Cockcroft Report so here I will now discuss and analyse some of the ways in which both learning theories and the Cockcroft Report have influenced teaching in the UK and in Shanghai and Singapore.

In 1982, the UK government commissioned a report into mathematics education called, 'Mathematics Counts – a report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr W H Cockcroft'. Now more readily referred to as the Cockcroft Report, the paper's 'Foundation List' of mathematics basics that children should have *mastered* by the time they were sixteen fed directly into the first 1988 curriculum; despite this, many of the report's recommendations were never implemented in the UK. Whilst an in-depth analysis of the report is not necessary for the purposes of this thesis, Cockcroft made a number of recommendations, that are useful to this study and a summary of their key points will provide a useful lens through which to view the current climate of mathematics education.

From the outset, the report defines itself as very pro mathematics and also pro mathematics teaching. It emphasises the importance of learning maths skills for both everyday life and for employment. This is an attitude that is still prevalent today and arguably the reason for such significant political intervention in education. Recently, this has manifested itself through the financial incentives that have been offered to science and mathematics graduates who train to be teachers.

The report goes on to suggest that an appreciation and enjoyment of mathematics should be instilled in children from the earliest stages of their education and that both children and parents alike should understand that mathematics requires hard work and much practice in order to be successful. This is now a facet of the mastery curriculum that has gained much attention recently and as I have already discussed, the work of Boaler and Dweck suggests that negative attitudes to mathematics among both adults and children have a damaging effect on the children's progress.

3.14 The conflict between Cockcroft and mastery

For me, the most useful insight offered by Cockcroft is the belief that teachers should not expect pupils to commit things to memory without also understanding them. This is certainly in keeping with the underlying principles of a mastery curriculum and Cockcroft emphasises the point by suggesting that an excessive focus on arithmetic will not aid children's understanding.

Despite Cockcroft's detailed analysis, and the relevance to the 2014 curriculum, many of the report's recommendations have not been heeded in the UK. As already discussed, the multiplication tables check that was introduced into Year 4 seems to counter Cockcroft's recommendation and in 2016, the DfE introduced a specific arithmetic test to be used at the end of KS1. This invariably shines a spotlight on children's arithmetic skills from the very early stages of their schooling so teachers remain in the difficult position of trying to provide a rich and varied mathematics curriculum while focussing on arithmetic and the memorisation of facts to enable their children to pass the test. Furthermore, Cockcroft states that it is not desirable or indeed possible to dictate a definitive style for the teaching of mathematics. The very concept of a mastery curriculum seems to directly contradict this recommendation as it prescribes a way of teaching and learning *for all* that does not take account of the situational nature of teaching and learning. The Cockcroft Report also advocated the importance of practical work in developing children's understanding of mathematical concepts. This initially saw an increase in UK schools but again fell out of favour (Brown, 2014) whilst it is clearly a central precept of the, now revered, Singapore curriculum. Conversely, the report also suggested that, 'pupils should possess some reliable method (however unconventional) of carrying out calculations ...' (Cockroft, 1982, PARA 458) when some of the draft test materials for the new Standard Assessment Tasks (SATs) even referred to children using *the* correct written method.

3.15 Conclusion to Chapter 3

In September 2019, Ofsted produced a new inspection handbook for use in the inspection of primary schools. For some, it presented something of a U-turn in emphasis because it now included a much greater focus on interrogating foundation subjects (such as computing, art, history and music). Despite a focus on foundation subjects, the core subjects (English, mathematics and science) remain high-profile areas and standards in them are of critical importance to how effective a school is judged to be. As if to remind teachers of this, in June 2020, the DfE produced mathematics guidance for each of the primary year groups that exemplifies the national curriculum and sets out guidance on progression. Many of the examples included in the documents promote depth of learning through multiple representations and an emphasis on conceptual understanding over procedural competence. Despite being an arbitrary and somewhat confusing term, this is a strong indication that mastery in mathematics remains at the core of primary education and this makes the findings of this thesis all the more important.

Having established the context of theory and practice in ITE in Chapter 2 and the current discourses in mathematics education in this chapter, Chapter 4 sets out the methodological approach used to gather data.

Chapter 4: Methodology and ethics

You know, this [interview] is like a full on reflection, counselling kind of session!
(Conversation with Eve, p. 20)

This chapter discusses the methods that were selected to address my research questions. It begins by re-defining the aims of the research and discussing its theoretical and philosophical underpinnings. Following this, the chapter will discuss and describe the methods that were used for addressing each one as well as the reasons for my choices. The chapter will conclude with a discussion of the ethical issues to which this research was subject and the ways in which they were addressed.

This research is concerned with the theory that is accessed in course literature by primary teaching students pursuing a strength in mathematics for their Postgraduate Certificate in Education (PGCE). It aims to explore the effectiveness of the use of theories in the mathematics education and training of primary school teachers. It is intended to contribute to the understanding of the enabling and constraining factors that affect student teachers as they use theories in their classroom teaching practice while they are training. I hope to achieve a greater sense of what, if anything, students gain from the study of educational theory.

In order to ensure that the aims of the research were met, I identified five research questions (RQs) that are set out below:

1. How does the mathematics course literature accessed by primary PGCE students compare with the original sources of learning theory to which it relates?
2. In what ways and to what extent do primary PGCE students draw upon theories of learning in the planning, delivery and evaluation of their mathematics lessons?
3. What are the enabling and constraining factors that primary PGCE students face when using educational theories in their mathematics teaching?
4. What are the implications for the continued role of universities in the education of primary mathematics teachers?

5. Is there a need for adult learning theory to describe the learning of primary PGCE students?

The research questions were addressed by means of three, distinct yet interrelated methods: textual analysis, questionnaire and interview. This chapter will discuss what each method offered my study and of equal importance, what they could not offer it. While each approach was used separately, no one approach is tied solely to any one research question. Rather, it is their combined entity as a methodological package that provided the insight necessary to answer the research questions. As a classroom practitioner, school leader and teacher educator, I am constantly reflecting on my practice and its effect on the children that I teach. My research diary captured some of these reflections as well as recording other relevant conversations and experiences. Before I begin the discussion of each method, I shall affirm the broader theoretical and personal basis for my chosen approach.

4.1 Ontology and Epistemology

This research is situated firmly within the interpretivist paradigm since it is a study of social action and interaction. It is based on the constructivist assumption that the reality of learning to teach is not concrete or factual, but that it is highly subject to the interpretation of those involved. Schwandt (2003) suggests that what defines social action and interaction (indeed, he cites teaching as an example of this) is that human action is ‘inherently meaningful’ (Schwandt, 2003, p. 296). He goes on to suggest that interpreting what different actions mean requires research in the interpretivist paradigm. As Thomas (2011) suggests, interpretative research assumes that there is no objective social world (or at least, that there is one but that we are all likely to see it differently) and that it is ‘constructed differently by each person in each situation they face’ (Thomas, 2011, p. 51). Thomas’ (2011) description fits this research particularly well as its aim is to discover what situations individual students face and their reactions to them.

The broad, ontological position adopted by this study is that of constructivism. It assumes that knowledge about teaching and learning does not exist independently but rather, that it is created in the minds of individual student teachers. As well as being grounded in constructivist assumptions itself, the thesis is also a study of how students make use of constructivist theory. This is because in this thesis, constructivism is both the object of study and the means through which I have chosen to study it. In this sense, it is a constructivist study of constructivism and the interpretivist epistemology denies the existence of objective, pre-existing truths in teacher education.

This gives rise to particular data collection methods and both textual analysis and qualitative interviewing are rooted within the epistemological framework of interpretivism. That said, the data obtained from both the textual analysis and the qualitative interviews was counted (and therefore treated quantitatively) as part of my analysis. Numerical analysis of the questionnaire data followed and whilst this may hint toward a positivist epistemology, this was not a positivist study since the phenomena under investigation were subjectively defined and a matter of my own interpretation (and that of the participants in the study) and not material facts. The numerical data were useful because it involved a broader sample of students that helped to establish whether the findings from qualitative interview could be reflective of a larger sample.

4.2 Mixed method research

Much has been written surrounding this conflict between paradigms (Crotty, 1998 and Harrington, 2005), but it is generally accepted that a cautious approach is appropriate when categorising a study on the basis of the type of data that it aims to generate (be that either quantitative or qualitative or both). Crotty (1998) suggests that, ‘Quantification is by no means ruled out within non-positivist research ...’ and advises that, ‘Whatever research we engage in, it is possible for either quantitative methods or qualitative methods, or both, to serve our purposes’ (Crotty, 1998, p. 15). Sparkes (2014) seems to agree and suggests that borrowing a quantitative data collection technique does not make a study positivist as positivism and interpretivism are based on very different philosophical assumptions. Indeed, my study is based upon the assumption that there is no objective reality when it comes to the ways in which students read and interpret learning theories and that their meaning is contingent. However, a positivist study might assume that there is a fixed and wholly discoverable reality among student teachers and the ways in which they use educational theories in mathematics. To address this, there is a growing body of research (Cameron, 2011, Venkatesh et. al., 2013 for example) that promotes the use of ‘mixed methods’ for developing ‘Rich insights into various phenomena of interest that cannot be fully understood using only a quantitative or a qualitative method’ (Venkatesh et. al., 2013, p. 21). Johnson and Christensen (2014) have also written extensively about mixed methods research and while they define ‘mixed methods’ as a paradigm in its own right, they helpfully put forward ‘The Research Continuum’ (Johnson and Christensen, 2014, p. 495) as a means to describe it. At one end of their continuum lies ‘monomethod’ research that is set within a single paradigm and at the other sits ‘fully mixed research’ where both paradigms are given equal weighting. As this research is situated within the interpretivist paradigm and merely borrows some facets of methodology that are normally associated with positivism, my study is most accurately (although ineloquently) described as employing ‘partially mixed methods’.

4.3 Insider/outsider research conflict

Thomas (2011, p. 77) might describe this study as a ‘local knowledge case’ since it is something within my personal experience about which I want to discover more. Indeed, as a mathematics subject leader in an infant school and having some responsibility for the Initial Teacher Education (ITE) of students, this study is a form of ‘participant observation’ or ethnographic methodology. Uldam and McCurdy (2013) provide a very rich discussion of this methodology and some of the issues surrounding it. Specifically, they propose varying degrees of participant observation that centre around the roles of ‘insider’ and ‘outsider’ and of being a ‘participant’ or ‘observer’. Part of the problem, they argue, is that these roles are not always clearly defined. Indeed, while I was an ‘outsider’ in terms of my relationship to those students involved in the study, as a teacher, I also had some understanding of the issues that they face and of the context in which they work, so could also have been described as an ‘insider’. Similarly, by *observing* and discussing their practice, I was, in effect, *participating* in it. Uldam and McCurdy (2013) allude to this directly as they suggest that, ‘The participant observer’s familiarity with the research setting and its practices may make her blind to some of the experiences that an outsider would find significant. While an outsider may take for granted fewer practices, she faces the challenge of becoming empirically literate in the field' (Uldam and McCurdy, 2013, p. 945). Cohen et. al. (2011) also allude to the complexity of participant research. While they conclude that, 'Both complete participation and complete detachment are as limiting as each other' (Cohen et. al., 2011, p. 465), they also suggest that a stance of either complete subjectivity or objectivity is difficult to attain.

This research is not characterised by a simple 'insider/outsider' dichotomy and its position on an 'insider/outsider' continuum was, in part, dictated by my own positioning and range of job titles and roles. Put simply, as a qualified teacher, deputy head teacher, training manager and researcher, I was positioned as an 'outsider' because I was not a student teacher like the participants in the study. However, being within the education system myself, I am very much an 'insider': as a teacher, I have been through the training process and as a training manager, I have an understanding of the process of training to teach. As a deputy head teacher, I am perhaps more removed from the direct experiences of the students and as a researcher, I am firmly on the 'outside'. As such, defining my own, precise location is challenging and while ascribing a name to it may not have been necessary, an awareness of it was important as I planned and carried out the interviews. It is at this point that the question of reflexivity and its impact on my research became important.

4.4 Axiological Stance

It is also important to consider my own axiological stance and how this may have biased the research either consciously or unintentionally. By this, I am referring to the values that I invariably hold toward the themes that I have encountered and discussed. Being a practising teacher, I acknowledge that I am naturally concerned with good quality teaching and learning and therefore, promoting high-quality teacher training is also important to me. As well as this, my responsibilities for students following the 'School Direct' route to QTS drives my strong feelings towards their right to the best possible education and training. Whilst my own position has impelled me to study in this area, this was not detrimental to the participants in the research. As this study adopts a form of participant observer research, it relies upon my own knowledge and experience of the areas under investigation but I have endeavoured to present these in a neutral, unbiased way.

4.5 Reflexivity

Reflexivity is defined as the extent to which a researcher's own position influences the research and the participants in it (Schultze and Avital, 2011). As such, the concept of reflexivity is particularly apposite to the research, and gained particular relevance through the interview process. As discussed above, my insider/outsider stance inevitably permeates and strengthens my discussion and this was supported by a research diary that I kept throughout this research process. While it was not a data collection method per se, my research diary was a key part of my approach to data collection. Whilst it may not capture the precise nuances of each conversation, it was recorded soon after each event to remain as true as possible to the actual events as possible. As it is my own, personal account, it includes names and contexts to aid my own memory of the events but where excerpts of the diary appear in the text, names and situations that would otherwise identify individuals have been removed. Where appropriate, and to maintain the flow of the narrative, pseudonyms have been used.

4.6 Reflective Practice

'Reflective practice' is underpinned by the notion that action and thought are complementary (Schön, 1983); action (practice) promotes thinking and thinking (reflection) extends our actions and their results. Whilst reflective practice is not a research method in its own right, I will now discuss how it was an essential aspect of my research methodology and how it enhanced my semi-structured interviews with the student teachers.

For the student teachers involved in this study, both reflection and practice are essential elements of achieving QTS. Their PGCE requires both successful classroom practice (assessed through their block teaching practices in schools) and the ability to read and write about teaching (assessed through to two, masters' level assignments that they must write). At the university attended by the students in this study, the 'core strength' assignment requires them to teach a series of lessons and reflect upon the quality of their teaching alongside the children's learning. The students developing a strength in mathematics, who are the focus of this research, must reflect on their mathematics teaching through the lens of a theory that they choose themselves.

Orton (2014) describes 'reflective practice' as being dependent on two, key relationships: firstly, the relationship between communication and reflection and secondly, the relationship between experiential learning and reflective practice. The implications of the first (that Orton, 2014, p. 27 describes as a 'symbiotic relationship') are significant for teachers and those training to teach because it implies that for reflection to be meaningful, teachers have to be able to communicate it clearly. Teaching is invariably concerned with the communication of ideas and concepts so it could be assumed that effective teachers and student teachers ought to be able to communicate their own thoughts on their teaching clearly. Orton (2014) emphasises that this is often not the case she suggests that,

> ... too often the level of reflection is superficial and little genuine learning takes place. In part this is because there is a reluctance in applying reflection ... with a lack of time being given as a justification for not taking it further. (Orton, 2014, p. 27)

From my own experience as a teacher, this certainly rings true. After all, am I not far too busy with actual teaching to spend time thinking about it? As a mentor and training manager, I am also guilty of providing trainees with feedback following formal lesson observations that focuses on 'what went well' and 'action points for next time' without any critical reflection on *why* and *how* things in the lesson unfolded in the way they did. Often there is a twenty-minute window at break time in which to provide feedback before a trainee is teaching again. More often than not, trainees are most concerned with how the lesson was graded and whether it was an improvement on last time.

'Reflective practice' is important to this research for two reasons. Firstly, because I encouraged students to become reflective practitioners as they discussed their mathematics teaching with me and secondly, because this study is part of my own reflective practice as a class teacher, mentor, training manager and doctoral student. 'Reflective practice' was used as a lens through which students could view their teaching during interviews (and crucially, one that both they and I were familiar with) and it was used again (as my role as an insider researcher) in my analysis of the students' responses to my questions.

I will now explore the three methods that were used to collect data.

4.7 Textual analysis

Textual analysis was used to compare the ways in which books from the reading list presented educational theories to the students (RQ1). On initial inspection, the textual analysis may not seem to fit with the qualitative data collected by the questionnaire and interviews. Essentially a desk study, the textual analysis formed an essential undercurrent as it enabled me to gain a personal insight into the materials that were available to PGCE students. This was important for two reasons. Firstly, it allowed me to discuss them with some prior knowledge during interviews with students; it was hoped that knowing what they had had to study would enhance the engagement and the trust of the students that I interviewed. Secondly, it aided my understanding of the ways in which theories are presented to students at the outset before I delved into the ways in which students take and use theories for themselves. Initially, it had been intended to explore all course literature that students use: textbooks, journals and lecture notes. However, it quickly became apparent that this would be a huge undertaking and beyond the scope of this thesis. As such, the decision was taken to focus solely on textbooks from the reading list given to students although it is acknowledged that this is a limiting factor because students may get a very different experience of theories from, say, their lecture notes and the content of their seminars.

Textual analysis was used to carry out a critical literature comparison in which the reading list given to PGCE students pursuing a strength in mathematics was scrutinised. Books were read and analysed in terms of their fidelity to the original sources of learning theory that they refer to and the ways in which student teachers could have applied them to their teaching of mathematics. A 'reading frame' (Stanley and Wise, 2007) enhanced consistency and ensured that all texts were subject to the same critique as others. The reading frame was a key feature of the textual analysis, so a full discussion of its design and application follows in Chapter 5.

Before embarking upon a discussion of textual analysis, defining what is meant by ‘a text’ is appropriate. McKee (2003) has written extensively about textual analysis and he cites ‘films, television programmes, magazines, advertisements, clothes and graffiti’ as examples of texts (McKee, 2003, p. 1). His examples suggest that a text is simply a means through which meaning is conveyed and that this can either be visually or audibly. In keeping with everyday nomenclature and for the purposes of this research, ‘a text’ is defined simply as a piece of writing that can be read. With this established, McKee (2003, p. 2) points out that ‘academics who do ‘textual analysis’ actually practise a huge range of methodologies – many of which are mutually contradictory and incompatible’. McKee’s (2003) observation is particularly apposite to this study as I have used the method in two different ways. Firstly, a very literal analysis and comparison of the books that students were required to read and secondly, using McKee’s (2003) description, the transcripts from the qualitative interviews became written texts in their own right so many of the features of textual analysis also become useful when seeking patterns and commonalities in the interview data.

Balnaves and Caputi (2001) discuss the ‘first and second order’ interpretation of texts and they argue that, through their very creation, data within published texts have already undergone significant interpretation. They suggest that, ‘The job of anyone working in the human sciences is to interpret the interpretations that people have already made [of a text]’ (Balnaves and Caputi, 2001, p. 5). This is a useful distinction to make and one that I return to through the thesis; the texts that were created from interview transcripts (to be discussed later in the chapter) were subject to ‘first order interpretation’ as patterns and significant themes were sought directly from the raw data. So-called ‘second order’ interpretation came to the fore when addressing research question one as it involved interpreting the content of texts (in the form of books) that have, according to Balnaves and Caputi’s (2001) description, already been subject to their author’s analysis and their decisions about what to include and emphasise. Indeed, McKee (2003) describes texts as ‘The material traces that are left of the practice of sense-making – the only empirical evidence we have of how other people make sense of the world’ (McKee, 2003, p. 15). This insight suggests that texts are such a deeply embedded and condensed expression of their author’s own experiences and perceptions that any number of interpretations is possible from them. In fact, McKee's (2003, p. 27) suggestion that 'textual analysis is about making educated guesses about how audiences interpret texts' is rather apt and whilst his reference to guesswork could be perceived as a superficial or even unscientific pursuit toward the truth, the method is based on the assumption that the way in which individuals interpret and respond to them can vary enormously. As such, textual analysis can be as simple as 'an attempt to understand the likely interpretations of texts made by people who consume them' (McKee, 2003, p. 2). Indeed, McKee (2003) is very interested in the ways in which different cultural groups interpret texts.

In his discussion of cultural anthropology, McKee (2003) argues that, 'A national culture isn't made up of millions of identical people who all make sense of the world in exactly the same way. Rather, it consists of a mixture of many overlapping subcultures' (McKee, 2003, p. 13). Within the context of this research, books that contain educational theory are clearly aimed at educationalists (teachers, teaching assistants, mentors, lecturers and students, for example), but McKee's (2003) description raises the question of whether student teachers represent their own 'subculture' within the wider cultural group of educationalists and whether they would interpret texts in a different way to, say, qualified teachers, or their university tutors? Indeed, qualified teachers are likely to read educational texts within the context of their own experiences in the classroom whereas student teachers, with limited or no experience of teaching independently, may interpret texts more literally. McKee (2003, p. 9) suggests that this is almost certainly the case and that student teachers will actually read texts differently because they are students. Bourdieu's theoretical concept of 'fields' may also go some way to explain the reasons for this difference in interpretation. Bourdieu (1993) proposes that all social formations are comprised of hierarchically arranged fields – structured spaces with their own rules of functioning and relations of force. While each field is autonomous, each is structurally homologous with the others. Within an educational field, students occupy their own structured space that has its own rules and procedures for functioning that are neither purely 'student' or yet, purely 'teacher'. The concept of the specific identify of student teachers is discussed in more detail in Chapter 8.

Whilst delving further into this was beyond the scope of this study, it would certainly be of great interest to ascertain whether qualified teachers and those training to teach interpret educational texts differently. In the concluding chapter of the thesis, I identify this as a potential area of further research. It was important to bear in mind that in my attempt to understand how student teachers ‘consume texts’, I also had to ‘consume’ them myself and as a qualified teacher and research student, I invariably interpreted texts differently to student teachers. That said, consistency was enhanced by the fact that I analysed all texts myself and as McKee (2003) points out, textual analysis should not attempt to judge which texts offer the most accurate representation of reality but moreover, it should attempt to make sense of the different ways in which individuals *could* interpret them.

Interestingly, McKee (2003) points out that textual analysis can go beyond reading and comparing texts; he suggests that it can also involve carrying out interviews, surveys and questionnaires about texts and the ways in which participants have interpreted them. Through my interviews, I spoke to students about the books that they have read and the ways in which it had impacted on their practice, yet this does suggest that the version of textual analysis that I employed was both small-scale and narrowly focussed and that it was unrealistic to expect to exploit the full potential of the method in my own study.

4.8 Questionnaire: questions and statistics

Munn and Drever (2004) praise the use of the questionnaire as an effective means to including large numbers of participants in a study, ensuring their anonymity and eliminating bias by standardising questions. However, they also cite the time taken to prepare an effective questionnaire as a significant downfall of the strategy. Opie (2005) states that when carefully designed, questionnaires can be very effective when gathering information. However, Bell (1999, p. 95) warns that, ‘Causal relationships can rarely if ever be proved by a questionnaire [and that] the main emphasis is on fact-finding’. Whilst it is acknowledged that this small-scale study is unlikely to prove any causal relationships, questionnaires certainly seemed like the most appropriate method of ascertaining which theories students had been taught.

The first consideration in the questionnaire design was to identify the group to be sampled. Munn and Drever (2004) strongly advocate 'random sampling' when including the whole of a population as a sample. Within the context of my study, this could mean choosing a percentage of PGCE students pursuing a strength in mathematics randomly from their student numbers as a representation of the cohort as a whole. Initially, it was intended that questionnaires would be circulated among all primary PGCE students studying within a given, academic year. They were to be designed to establish which theories students had been taught and which they had actually engaged with when planning and teaching their mathematics lessons. However, a truly random sample of primary PGCE students in schools would likely include students who had and had not been taught about theories of learning whereas a sample of say, students who like teaching mathematics could in Munn and Drever's view '... bias the sampling [by] imposing on it your own notions about the very things you are trying to find out' (2004, p. 13). Munn and Drever (2004, p. 13) suggest that members of the sample population ought to be identifiable by 'operational definitions' and that a good test of this definition is whether others are able to 'apply your rules and agree with you about who is eligible for inclusion'. Consequently, it was decided that questionnaires would be issued to all primary PGCE students completing the mathematics strength module. Crucially, this group of students were all taught about significant theories of learning during lectures and seminars, so the questionnaires were (at the very least) able to ascertain which theories the students were able to remember being taught.

With the sample group decided on, the next consideration was the questions themselves. Munn and Drever (2004) discuss the use of standardised questions as a way of '… strictly controlling the stimulus presented to all respondents' but they advise caution because '… you cannot control the way in which respondents interpret the questions' (2004, p. 4). Whilst this is presented as a disadvantage of the technique, one could argue that the respondent's own interpretation of the impact of educational theories on their practice is exactly what is required of the method. The fact that through questionnaires, respondents are unable to seek clarification about terminology is an advantage as it is their interpretation of the terminology that is important to this study.

The questionnaire began with contextual information about each student (their age group, gender and undergraduate degree subject) and it asked them for their own definition of educational theory. Following this, the questionnaire asked students to numerically rank statements based on their preferences, then to tick groups of statements that were applicable to them. This was to ascertain factual information about how and when students had used theories. After this, a 7-point Likert-style ‘rating scale’ format was used alongside a range of statements about learning theories for participants to either agree or disagree with. This enabled me to gather data on the importance that individual students placed on the use of the selected theories in their practice and this helped me to understand how theories were perceived and understood by them. The questionnaire concluded with a copy of the students’ reading list (see Appendix 1, p. 254) and asked them to indicate which texts they had made use of. Appendix 2 (on p. 255) contains a copy of the questionnaire.

A draft of the questionnaire was circulated among five ‘critical friends’ – students following the School Direct programme (and not the standard PGCE) who were known to me (and therefore who would not be participating in the study) who first completed the questionnaire and then offered their suggestions about how to improve it. Improvements included grouping the question types so that different ways of responding were confined to their own area of the questionnaire as there was, initially, some confusion between questions that asked respondents to rank statements and those that asked them to tick all applicable statements. It was decided to use a ‘convenience sample’ (Etikan et. al. 2016) of students with whom I had regular contact for this as it meant that I could easily have informal discussions with them about the questions themselves and in particular whether the questions were interpreted in similar ways and whether they were easy to understand.

Prior to the interviews, I circulated a questionnaire among all of the primary PGCE students developing a strength in mathematics; this sample comprised a total of 34 students. To ensure a good return rate, I asked the primary PGCE mathematics course leader if questionnaires could be circulated following the students’ final seminar session at the university. The students were taught in two groups and I happened to be providing input in my role as a mathematics subject leader to the first group. 18 of the students were present for my presentation (I have called this the *engagement* group) and the remaining 16 were part of the group that were meeting the following day (I have called this the *proxy* group because my questionnaires were presented to them by their university tutor on my behalf). This presented a significant, methodological issue that I will discuss in detail below. All students returned a questionnaire although one student in the proxy group completed only the first page, so I recorded a return rate of 97.06%.

Questionnaire data were subject to different layers of statistical analysis but before this was undertaken, they were grouped into three categories, based on the type of question from which the data were gleaned: ranked questions (with the 1-5 ranking criteria); agreement questions (with the seven-point, Likert-style agreement scale); and multiple choice (where the students ticked however many options applied to them). Using an Excel spreadsheet, basic frequency tables (numbers and percentages) were created and, for the ranked and agreement questions, some analysis of mean responses was carried out (based on a conversion to a 1-5 numerical scale for rankings, or a 1-7 scale for the agreement questions).

I chose to make use of a 7-point, Likert scale to enable the students to convey varying degrees of agreement or disagreement with a number of statements. The seven options for the students were:

- 'I am certain that I disagree'
- 'I mostly disagree'
- 'I mildly disagree'
- 'I have no opinion/I don't know'
- 'I mildly agree'
- 'I mostly agree'
- 'I am certain that I disagree'

The extent to which the students agreed or disagreed provided a useful layer of analysis. This was particularly the case when all of the variation of opinions was not between agreement or disagreement, but rather in the intensity of the agreement or disagreement. However, in the analysis of data in Chapter 6, I have chosen, at points, to reduce the 7-point, Likert scale to 3 points to depict either agreement, disagreement or neutrality. This is to enable to me to draw out simple claims to knowledge and general trends in responses. While simple, descriptive statistics (in the form of numbers or percentages of students) has been used to aid the flow of the narrative, the 7-point scale remained important in the significance testing of the data described below.

As well as the descriptive statistics that are based on frequency and mean responses, the questionnaire data were subject to significance testing using a Friedman Test of differences. Where a significant Chi-square value was returned, a post-hoc Nemenyi Test (AKA the Wilcoxon-Nemenyi-McDonald-Thomson Test) was conducted to highlight which pair-wise groups of questions had a significant difference based on their rank means. This was relevant as it provided a more polarised view of the students' actions. Making generalisations based on the most prevalent courses of action was valuable in itself, but when viewed alongside the corresponding least likely course of action, it provided a rather more stark sense of the students' reasons for responding in the ways that they did. In addition to the Friedman test and the Nemenyi Tests, T-tests were conducted to compare the average rank given by age-band (those aged over 26 *versus* those aged under 26), by gender and by prior exposure to educational theories (exposure *versus* non-exposure / uncertainty around exposure).

As well as providing data for addressing research questions 2 and 3, the questionnaire was the way in which I invited students to be interviewed. The final question in the questionnaire asked students if they would be prepared to be interviewed by me. Significantly, 14 students (77.77%) from the engagement group were willing while only 1 student from the proxy group (6.25%) was. From a methodological viewpoint, this suggests that the insider stance I had established with the group of students that I had met made them more willing to be interviewed and conversely, I was viewed as an outsider by the proxy group (for whom the questionnaire was delivered on my behalf) who were then less willing to participate. Willing participants were asked to supply an email address that I could use to make initial contact with them should they be selected for interview.

As well as providing raw data themselves, the insights gained from the questionnaires enabled triangulation with the data collected from the semi-structured interviews (that are discussed in the following section). Specifically, they revealed whether those students interviewed shared a similar experience to the broader sample who participated in the questionnaire and it provided greater confidence in my findings.

4.9 Interviews

The interviews were rooted firmly in the interpretative paradigm as they were based on the assumption that meaning is contingent and that there is no direct relationship between the meaning in an educational theory and the way that a student will behave when they apply it to their teaching. Semi-structured interviews took place with eight PGCE students following their study of theory in their mathematics lectures and seminars. They were used to ascertain the ways in which students used educational theories (RQ2) and to gain an insight into some of the challenges they faced when they attempted to use selected theories in the planning, teaching and evaluation of their mathematics teaching (RQ3).

Before embarking upon a discussion of the use and relevance of the method, King and Horrocks (2010, p. 17) make a crucial point: that qualitative interviewing assumes that there is accurate information there to be discovered and that knowledge can actually be obtained. From my interviews, I gained an insight into specific instances of students using theories in their classroom mathematics teaching and talked to them about their perceptions of its relevance and use. As I was interested in participants recalling actual events (such as referring to lessons that they had taught or plans that they had written), I was able to glean accurate and useful information using this method.

I had initially decided to use unstructured interviews (that are also used in disciplines such as psychotherapy) because I wanted to encourage participants to speak freely about their classroom experiences while I extracted the details of how theories may have informed their practice from what they said. As well has having arguably less control over the outcome of the interview, Brewer (2000, p. 66) also suggests that as a novice researcher, carrying out unstructured interviews may require greater skill and insight than I had. Conversely, Opie (2005) warns against ill-planned or overly prescriptive interviews because in his view, they can result in narrowly-focussed answers that, while useful for fact finding, do not truly access the participant's perceptions, motives or feelings. As student teacher's perceptions of the usefulness of theory in their mathematics teaching were of the utmost importance, it was vital that the type of interview that I designed reflected this. It therefore seemed reasonable to position my own interview style somewhere between those that are completely structured and those that are unstructured. O'Reilly (2012) might suggest that 'semi-structured' interviews were the most appropriate interview format for me to use to attain a balance between answering my questions and allowing participants the freedom to elaborate on answers. With this in mind, an interview style that was positioned more toward the structured end of the continuum seemed appropriate as I needed to be certain that, from the short time I will had with the students, I was able to access sufficient data. Similarly, I was keen that the students were not overly restricted by a rigid interview schedule. By way of a compromise, I decided to use semi-structured interviews by establishing a clear focus for the interview while encouraging the participants to engage in an informal discussion based around key areas that I had identified.

Of the 14 students who supplied me with an email address, I contacted (via the email address that they had supplied) eight students who, as a group, were representative of the whole mathematics strength PGCE cohort. This initial sample included the full age range of the cohort, a broad range of undergraduate degree subjects, those that had and had not encountered educational theories before and a mixture of male and female students that was broadly representative of the relative proportions of men and women in the group. Seven of the eight students responded positively to my request for an interview and one (male student) did not respond at all. I proceeded to contact another willing student from my initial list of contacts who was willing to take part, although this meant that the gender balance of my sample did not then reflect that of the whole cohort.

4.10 Telephone interviews

Initially, it had been decided that a face-to-face interview should be carried out with each student teacher that had agreed to take part. I had planned that these should take place in each student's placement school after the children had gone home for the day. As a teacher myself, I was aware that time after school is required for assessment and preparation for the next day and that teachers are tired by the end of a school day. This would leave a relatively short time in which to hold interviews with my participants (an hour at the very most). In spring 2017, I carried out a methodological pilot to assess the feasibility of this. Of the 19 students that identified themselves, as potential interviewees, only two were able to commit to a face-to-face meeting. Following this disappointing return rate, I decided that, for the main study, I would offer a telephone interview to add a more flexible dimension to my data collection strategy.

According to Oltmann (2016, p. 2) 'Most of the scholars who have examined telephone interviewing have been concerned whether it can 'stand in' for face-to-face interviewing, rather than explicitly recognising that telephone interviewing might have its own unique merits.' Indeed, Seidman (1998) suggests that the only valid use of a telephone in the interview process is to arrange a time and a place to meet face to face with interviewees. Part of the issue seems to be what Burke and Miller (2001, p. 4) call a 'scheduling quagmire' in which arranging a mutually convenient time and place to carry out an interview can take as long as the interview itself. They advocate the arrangement of interviews over the phone rather than via email but the way in which I selected students for interview (set out below) negates this issue. Similarly, Farooq and De Villiers (2017) report that traditionally, qualitative interviews have been carried out face-to-face because of the importance of building and maintaining rapport with interviewees. Again, I had arguably already established rapport with the students and had met the majority face-to-face prior to arranging interviews with them. Indeed, there is never a guarantee that an interviewer will establish a rapport with participants, particularly during what may only be a 45-minute interview. I would argue that building rapport with participants relies more heavily on shared understandings and common interests which, as an insider researcher, I had. Oltmann (2016) suggests that the decision about whether to use face-to-face or telephone interviews should be made following consideration of contextual details of the interview setting and process. My reflexive stance and insider position mean that I am well-placed to make judgement calls about the context of the study so it is important to establish from the outset that, while face-to-face interviews had initially been the intended data collection method, the use of telephone interviews was by no means a compromise because face-to-face interviews were not possible or presented significant challenges. In fact, telephone interviews presented a number of important, methodological advantages that, I believe, *strengthened* the quality of the data that were collected.

Oltmann (2016) offers a useful comparison between face-to-face and telephone interviews and provides seven areas for consideration. These are: time and financial costs, geographical distribution, sensitive or controversial topics, technology problems, interviewer safety, note taking and nonverbal language and cues. Oltmann's overview provides a useful means through which to discuss telephone interviews and helps to provide a rationale for my choice to use them. I will now examine each component in turn. For the purposes of this discussion, I have combined 'technology issues' with 'note taking' as the two features of the method are intrinsically linked in the context of my research.

4.10.1 Time and financial costs

In selecting telephone interviews, the financial cost of travelling to and from each participant's main placement school to interview them was negated and the main 'cost' was that of time. From my insider stance, I am well aware of the pressures of time both during and after the school day; teachers typically use the hours following the departure of the children to mark and assess work and to make preparations for the following day. Indeed, those tasks typically carried out by teachers after school may take student teachers longer to complete as they learn to do them independently and efficiently. Telephone interviews were carried out at a time suggested by the students themselves. Typically, these were weekday evenings when the students had returned from school and had had time to relax and reflect upon their day. In most cases, this also gave the students the freedom to speak to me for longer without infringing upon their valuable lesson preparation time for the following day. To negate any financial cost to the students, I asked students (via email) to supply me with a telephone number with which to contact them so that I incurred the cost of speaking to them.

4.10.2 Geographical distribution

Oltmann (2016) suggests that carrying out interviews over the telephone can extend the geographical range of interviewees. As the students that I selected for interview all attended the same university, they lived within the local area during term time. Had I chosen face to face interviews, I would have been restricted to carrying out interviews during term time only and I may also have had to avoid weekends because of those students that returned home. Additionally, one of the students involved in my study had carried out placements in a different part of the country and was only briefly returning to the university to hand work in later in the term. In this instance, the telephone interview not only extended the range, but it actually enabled a conversation (and valuable source of data) that would not have otherwise happened. Additionally, Oltmann (2016, p. 3) suggest that, 'The universal advice is to make the respondent comfortable by conducting the interview in a location of their choosing.' Through my decision to carry out telephone interviews, the students were able to choose where to speak to me.

4.10.3 Sensitive or controversial topics/ Freedom to respond

While the interview questions themselves were not contentious, when students were asked to explore some of the factors that constrain their use of educational theories on teaching practice, conversations concerning individual teachers, leaders and the school's ethos came to the fore. Such responses may have been uncomfortable or, worse still, impossible to discuss at the school or face-to-face so interviewing over the telephone helped remove this barrier to honest responses. Oltmann (2016) suggests that telephone interviews ameliorate the power imbalance between the interviewer and interviewee and make the experience less tense. Indeed, speaking to the students from the comfort of their own homes and outside of the rigours of a day at university or at school enabled me to talk freely to the students as student, teacher and individual and to glean better quality data as a result. As the telephone interviews allowed the students to talk more openly, this proved to be a balanced approach to delving into theory, the teaching of it and the students' understanding of it. Part of this is down to the relative anonymity that they are afforded. I certainly found this to be the case because some of the students with whom I spoke were not afraid to admit that they had forgotten key aspects of their course or that they had found things challenging. The telephone interviews encouraged them to disclose more details of their experiences and they felt less pressure to conform to social expectations or give what they perceived to be desirable answers to questions. This may not have been the case had I chosen to use an online meeting tool such as Skype or Zoom.

4.10.4 Technology issues and note taking

Clearly, carrying out telephone interviews introduced an added reliance on technology simply because, in addition to voice recording equipment, a telephone was also required. As it was still necessary to make audio recordings of each interview, I chose to use a ‘speaker phone and voice recorder method’ described by Burke and Miller (2001). Indeed, Burke and Miller (2001) recorded some issues with this method that centred around the reliability and quality of the speakerphone. Seventeen years on, this did not pose an issue to me as modern smart phones are now equipped with reliable, inbuilt speaker devices. When using any form of recording equipment, extraneous noise can be problematic but as I could speak to students from my own home, I could ensure that there was no additional noise to disturb the audio recording of our conversation. I did make notes to record key points or particularly interesting insights from each interview alongside the time that they arose so that I could refer back to them in the audio recording more easily. Burke and Miller (2001) suggest taking notes both as an additional source of evidence and as a failsafe should the worst happen and the recording equipment fail although had I experienced technological issues in reality, I would have more than likely simply contacted the students to rearrange the interview.

4.10.5 Interviewer safety

While I had not considered any aspect of my research to be unsafe, carrying out interviews from home ensured a level of comfort and security that may not have been so prevalent had I had to travel countywide to student’s individual schools. Students were also made aware in the information document (see Appendix 3, p. 262) that they could withdraw from the interview at any time without any question or recrimination. Part of the success of the interviews relied on my insider stance and my ability to establish a rapport with the students that I spoke to. To create this, each interview began with a ‘chat’ about how the students’ teaching practice was progressing and the employment market. In one interview, this lasted for over 10 minutes, but I believe that it was appropriate as it ensured that the student felt at ease and similarly, that they felt secure in my insider knowledge of their school experience.

4.10.6 Nonverbal language cues

One of the key criticisms of using telephone interviews over face-to-face interviews is that non-verbal communications (such as facial expressions and gestures) are not available to the interviewer so the richness of the data is diminished. This is certainly the case, but it is also important to note that not all non-verbal language cues are lost when the telephone is used. It is still possible to note pauses and hesitations over the telephone and tone of voice, emphasis and rushed responses are still readily available over the phone. Holt (2010) actually states that a narrower range of non-verbal cues could actually be advantageous because there are fewer non-verbal cues that could be ambiguous or misinterpreted. Opdenakker (2006) also shares the view that a lack of visual cues could be desirable as it sharpens the focus on what is actually said with fewer distractions.

The telephone interviews not only contributed to the quality of the data collected, but they actually enabled the data to be collected in the first place. The interview technique is often criticised because of the perceived distance that it creates between interviewee and interviewer (Farooq and De Villiers, 2017). This criticism rarely, if ever, includes reference to the distance between interviewee and their working environment. I suggest that the difficulties that student teachers have with juggling their student/teacher/self identities are accommodated by telephone interviews that are both away from the school environment and without the pressure of a face-to-face conversation with a fellow professional. As such, student teachers are able to leave their teacher persona at school and in reverting to their student (learner) and self identities, give honest and unbiased responses to questions about their professional learning.

4.10.7 The interview schedule

With the style and means of interview decided upon, the next consideration was the type of questions that I needed to ask. As Brewer (2000, p. 63) points out, interviews assume that a participant's verbal responses are reliable indicators of their behaviour. As obvious as this may seem, this was a significant factor and it is possible that with a study of this nature, participants may provide answers that they perceive to be desirable rather than simply being truthful. Whilst this was clearly a potential pitfall of the strategy, other than presenting a neutral stance myself, it was not something that I was able to control. Brewer (2000, p. 63) also points out that interviews assume that the questions asked are a reliable indicator of the subject of the research. This variable is arguably much easier to control although choosing the right questions or areas for discussion is clearly a significant skill and Coleman (2012, p. 260) suggests that word choice is of the utmost importance in generating interview questions and that 'avoiding ambiguity and leading questions' should be a major consideration.

With this in mind, I created an interview schedule (see Appendix 4, p. 264) that, rather than questions, featured a series of areas that I needed to cover. Coleman (2012, p. 252) refers to these as 'aide memoires' that allow the interviewer to ensure that the topics that they want to cover in the interview are discussed without restricting the interviewee's responses. Similarly, Thomas (2011, p. 163) suggests that structure can be given to an interview schedule by means of 'a list of issues' to be covered through the discussion. The advantages to my research of these forms over a fixed set of questions was that as the interviewer, I had the freedom to follow up lines of enquiry as they emerged and as each area of conversation did not need not be covered in order, many areas could be covered through a single aspect of the discussion and the questions used left room for the participants to expand. To enhance the interview schedule, both Thomas (2011) and Coleman (2012) suggest the use of 'probes' in order to encourage more in-depth responses to certain questions. They suggest that general probes such as 'could you explain that a little more?' are useful for encouraging more in-depth data, but the preparation of 'probes' that pre-empt and clarification that may be sought by participants may also be of value. For example, in each interview, I had prepared to provide participants with examples of the theorists (and their theories) that they may have learned about through their lectures, seminars and reading to help to initiate and prompt their verbal responses.

This suggests that qualitative interviewing is more than just a theoretical and analytic practice; moreover, it seems to be a very social process and being an ‘insider’ may either help or hinder this. It could be argued that professions are also subject to the various cultural nuances that exist within any community and ‘fitting in’ to them could be of importance as a researcher. Being a teacher myself, I am conversant in the language forms and jargon that are commonplace in the profession and it was anticipated that this knowledge would enable me to establish a rapport with participants and that interaction with them might have yielded richer data as a result. O’Reilly (2012, p. 118) alludes to this and suggests that a ‘collaborative rather than interrogative style’ may be beneficial to a study like mine; they also suggest an informal approach to interviews so that participants feel at ease.

The recordings were transcribed and after the addition of any notes describing significant pauses, sighs or changes in tone of voice, I began to analyse the data by coding it. Copies of the interview transcripts are not included as appendices, but they are available for perusal if required. Coffey and Atkinson (1996, p. 28) advocate coding as a means to organise, retrieve and interpret data and it was hoped that through highlighting the interview transcripts with codes that related to specific themes or references, it would aid the retrieval of every instance of a response so that significant patterns could come to the fore. Coffey and Atkinson (1996) go on to suggest that in reducing data to categories and ‘equivalence classes’ the researcher is, in fact, treating the data in a ‘quasi-quantitative way by (for example,) aggregating instances [and] mapping their incidence’ (Coffey and Atkinson, 1996, p. 28). That said, they go on to say that coding qualitative data is not ‘merely counting’ (as they argue quantitative coding is), but that it is a complex procedure of attaching meanings to data. This is a significant feature and suggests (as Coffey and Atkinson, 1996, p. 28 point out) that codes are, in fact, ‘heuristic devices’. Indeed, the codes that I used were all artificial constructs that assisted my exploration of the complex, qualitative data and I used them to provide a level of analytic clarity that helped me to compare the emerging themes in the different interview transcripts.

Following the coding of the data, various layers of analysis were applied to it in order to extract meaning from it. In the literature, qualitative analysis is often referred to as ‘progressive focussing’ and Sinkovics and Alfoldi (2012) provide a useful analysis of its application in business management research. Progressive focussing acknowledges that to begin with, qualitative data is complex and multifaceted and that it needs to be organised systematically and progressively before it can be engaged with analytically. Indeed, Sinkovics and Alfoldi (2012, p. 817) refer to qualitative research as a ‘messy’ process but they suggest that when published, data is still presented as ‘the result of a linear, predictable research process’. In order to make sense of the so-called ‘messy’ data, the first stage in progressive focussing was to categorise the data by splitting it up into large, simple categories. Rather than drawing on individual case studies, I chose to carry out a thematic analysis of interview data in order that my findings could be more easily generalised. A detailed discussion of my approach to coding and analysing the interview data is included in Chapter 7.

4.11 Research ethics

As Cohen et. al. (2011, p. 75) suggest, any study of this nature (that involves data collected from individuals) is laden with potential ethical issues to consider as the researcher negotiates the delicate balance between collecting data and ensuring that the rights and values of those that agreed to take part are not threatened. This research complies with the ethical guidance set out by the British Educational Research Association and the University of Gloucestershire’s Handbook of Principles and Procedures. Whilst I interviewed students during their teaching placements in schools, this was done outside of school hours and over the telephone, so did not involve any observation of or work with children. As I relied on the contributions of others, their right to confidentiality, anonymity and their right to withdraw from the study was ensured from the outset. All of the data collected was stored securely on encrypted electronic storage devices and my research diary was kept private.

According to Briggs et. al. (2012) areas of study can be sensitive if they involve power, relationships, and people’s perceptions of others (potentially both positive and negative). Hammersley and Traianou (2012) suggest that the first of five ethical principles to consider is concerned with minimising harm to participants and the BERA Code of Ethics (2011, p. 7) points to the responsibility among researchers to *'reduce the sense of intrusion'* felt by participants. As this study relied on the contributions of others, their anonymity was ensured from the outset and they were made aware of the study's aims and development throughout. References to individuals that are included in the rest of the thesis use pseudonyms to protect their identities; these bear no resemblance (either actual or implied) to their real name. Schools have been described loosely in terms of their type, size and class structure without any reference to their names or locations. In addition to this, whilst reference may be made to a student's 'experience', details of their academic abilities was not sought or written about. (UoG Research Ethics Handbook, Paragraph 2.5:1)

Conversations about participants' colleagues and tutors would feature heavily in interviews and individuals were discussed without their knowledge. It was important that they too came to no harm as a result of this so the names of colleagues of the interviewees have not been used nor have they been described in terms of their school or university role where that would easily identify them. (UoG Research Ethics Handbook, Paragraph 2.5:2)

Briggs et. al. (2012) suggest that interviews themselves are bound with ethical issues relating to the balance of power between interviewer and interviewee. Again, my use of telephone interviews went some way to negate this issue because each participant could take the call in a place of their own choosing.

The final ethical consideration involved my desire to make audio recordings of interviews to aid their accurate transcription and subsequent analysis. Coleman (2012, p. 262) advocates this method of data collection as a means to ensuring that 'all nuances of the answers can be retained and the richness of individual statements is not lost'. All interviewees were asked for their permission to record their voices before I met with them. To this, they agreed and were assured that on completion of the study, all recordings would be permanently destroyed. (UoG Research Ethics Handbook, Paragraph 2.3.2). The security of the interview data that I collected was of the utmost important both during and after the research. Audio recordings of interviews were stored electronically and erased on completion of the research. I have retained transcripts of original conversations for their potential value in post-doctoral research but these will be stored securely and remain confidential.

To conclude this chapter, it is important to emphasise the importance of the scale of the methods that I intended to use in my research. This was a small-scale research project primarily because of the time constraint involved in completing a PhD. As a novice researcher, it was also sensible to begin my work on a small-scale while my own abilities and preferences in the field were in their infancy. In addition to these personal reflections, the depth of insight and the rich data that I required to meet the aims of my research also lent itself to a small-scale inquiry of the type that I have engaged with.

Chapter 5 will now go on to discuss the design of the reading frame and present the data from the textual analysis of the critical literature comparison. This serves to establish a context for the quantitative analysis that follows in Chapter 6.

Chapter 5: Reading frame design and application

> *One of my salaried trainees approached me to ask whether they could have access to the library at the university because he wanted to 'get reading'.*
> *I asked what he wanted to read about.*
> *'Well, like theories and stuff', he replied.*
> *'What sort of theory are you interested in?', I asked.*
> *He replied, 'I don't know really. I wouldn't say I'm interested, it'll just make me feel like a real student again.'*
> (Excerpt from my research diary – 6th September 2016)

5.1 The structure of the chapter

This is the first chapter in which data are presented and discussed and it provides a sense of *which* significant theories were presented to trainees through key texts and the *ways* in which they were presented. It achieves this by providing an insight into the reading material with which the students engaged as part of their PGCE. The data for this chapter were collected in two ways: firstly, through part of a self-complete questionnaire that was issued to all primary PGCE students pursuing a strength in mathematics and secondly, through the deployment of a 'reading frame' (Stanley and Wise, 2007) that interrogated the theoretical content of the texts on the primary mathematics strength reading list. To illustrate something of the experience that students get from reading, the chapter concludes with a more detailed insight into one of the more widely used texts from the reading list: Askew's (2012) *Transforming Primary Mathematics*.

Whilst a general description of the primary PGCE can be found in Chapter 2, this chapter begins with a description of the specific mathematics strength module that the students in this thesis completed.

5.2 Description of the mathematics strength PGCE module

The primary PGCE is a 1-year postgraduate qualification that, as well as leading to a Postgraduate Certificate (a masters-level qualification equivalent to one third of a masters degree), it culminates in the award of Qualified Teacher Status (QTS). As well as a study of education in general terms (professional studies), the students are able to select an area of core subject expertise: this thesis concerns those students who chose to follow a specific mathematics module. It is interesting to note that the professional studies module is focussed on teaching and learning and addressing the Standards for Teachers (2012), whereas the subject specific modules are focussed on theory. This suggests that the priority lies in the general teaching skills and that theory is deemed a specialist, enhanced pursuit.

The mathematics module itself comprises eight taught sessions at the university from September to mid-January. These are focussed on developing the students' subject knowledge, their pedagogical subject knowledge, their understanding of barriers to children's mathematical learning and their understanding of theories that relate to mathematics education. The assignment is introduced in the first session and a range of educational theories are taught in the second session. According to the module handbook, the purpose of the assignment is to:

- Consider and compare theories of learning and identify how these relate to the practice in primary mathematics
- Consider how children learn within the core subject of maths and how the teacher can enhance and facilitate children's learning
- Draw on your own experience of teaching during placement one to reflect on your own role in enhancing children's learning.

In order to achieve this, the students were required to gather evidence of learning from two children over a series of four mathematics lessons. They were asked to reflect on and analyse their teaching in terms of two or three theories that they had selected to critique.

The module guide contains a suggested reading list of 14 key texts and a list of 13 texts for additional reading. As part of the quantitative data generated by the questionnaire, I presented the students with the recommended reading list from their mathematics module and asked them to indicate first which texts they recognised (i.e. which texts they had perhaps read or thought about reading) and secondly, which texts they had actively used and made reference to in their assignment. For the purposes of data collection, I assumed that those students who had used a text had also 'recognised' it. The number of students that purported to have recognised or used each text was counted and then expressed as a percentage of the total number of students. This was in order to gain a sense of the relative popularity and usefulness of each text before reading a selection of the texts myself to find out why.

The reading list and the percentage of students that made use of each text is detailed in the table below:

Percentage of students who recognised the text	Percentage of students who used the text	**Suggested reading list**
96.97%	81.82%	Askew, M. (2012) *Transforming Primary Mathematics*. Abingdon: Routledge
60.61%	27.27%	Briggs, M., and Davis, S. (2008) *Creative Teaching Mathematics*. London: Routledge
27.27%	15.15%	Carruthers, E. (2006) *Children's Mathematics: making marks, making meaning.* 2nd ed. London: Paul Chapman
75.76%	42.42%	Cockburn, A., Littler, G. (2008) *Mathematical Misconceptions*. London: Sage Publications
36.36%	18.18%	Donaldson, J., Field, J., Harries, D., Tope, C., and Taylor, H. (2012) *Becoming a Primary Mathematics Specialist Teacher*. Abingdon: Routledge
45.45%	15.15%	Grigg, R. (2010) *Becoming an Outstanding Primary School Teacher*. Harlow: Pearson Education Ltd.
27.27%	15.15%	Hansen, A & Vaukins, D. (2011) *Primary Mathematics Across the Curriculum* Exeter: Learning Matters
36.36%	15.15%	Lee, C. (2006) *Language for Learning Mathematics.* Maidenhead: OUP
54.55%	36.36%	Pound, L (2006) Supporting Mathematical Development in the Early Years. Maidenhead: Open University Press
39.39%	15.15%	McGregor, D. (2007) *Developing Thinking Developing Learning.* Maidenhead: OUP
39.39%	21.21%	Rowland, T. (2009) *Developing Primary Mathematics Teaching.* London: Sage
21.21%	3.03%	Ryan, J., Williams, J. (2007) *Children's mathematics 4-15*. Maidenhead: OUP
42.42%	24.24%	Thompson, I (2003) (ed) *Enhancing primary mathematics teaching and learning*. Buckingham: Open University Press
45.45%	24.24%	Turner, S. and McCullouch, J. (2004) *Making Connections in Primary Mathematics.* London: David Fulton

Table 1: The use made of each text by the students

5.3 Reading frame design

In order to gain an unbiased sense of the content of each text, I devised a reading frame (Stanley and Wise, 2007) to enable objective comparisons to be made. The reading frame was comprised of two parts that ensured that I engaged with each text in a similar way and applied the same principles to their analysis. In constructivist terms, each text invariably portrayed the author's own subjective reality so the reading frame concentrated purely on obtaining objective information about the content of the text rather than any hermeneutical analysis of the author's epistemological or indeed axiological stance. That said, I acknowledge that the choice of what to include in each text was still the authors and that that in itself must convey something of their own experience and subjective world to the reader.

Stanley and Wise (2007) suggest that creating a reading frame could be as straightforward as combing through texts and listing the most important points that are made. The key points can then be put in a logical order to create a set of criteria against which to evaluate further texts. Indeed, they even suggest that this process can be completed meaningfully for a single text. In keeping with this, my reading frame takes a bifurcated approach and features two distinctive parts that together, provide an insight into how educational theories are presented to the students through books. Firstly, a set of pre-defined criteria were applied to all texts from the module reading list to provide an overview and secondly, an in-depth analysis of one text in particular. This was in order to illustrate specifically how theories were presented in the text that the reading frame identified as the most successful in engaging students with theory. As my reading frame needed to evaluate and compare the way in which theories were presented and the fidelity of the presentation to original sources, it seemed appropriate to establish the criteria beforehand to ensure that all texts were subject to the same critique as others. In selecting the criteria, I aimed to remain as objective as possible so that each feature could be identified with some certainty and without introducing excessive bias. Stanley and Wise (2007, p. 223) suggest that researchers often select criteria that they disagree with and rewrite them as positive statements as, 'Often, the ideas that we disagree with can help us think better and more productively than those we agree with.' Essentially, I was searching texts for an absence of educational theory or a misinterpretation or dilution of original ideas, so in keeping with Stanley and Wise's (2007) suggestion, I converted my ideas about what a unsuccessful text might not include into positive statements about what, therefore, I felt that they should include.

The first part of the reading frame used in this research is a simple one which was comprised of six key questions that I asked as I read each text that were based upon my study of the field. The questions themselves are below and the bracketed content beneath each question provides a brief illustration of specifically what I hoped to gain from each of the criteria:

1) **Were educational theories obvious and easy to locate in either the contents or index pages?**
   (While 'obvious' and 'easy' are both highly subjective terms, this question aimed to find out whether students would be able to scan texts and locate information about the theories that they had learned about.)
2) **Was there any discussion of educational theories within the text?**
   (By discussion, I mean whether theories were referred to, drawn upon as examples or analysed in any way.)
3) **Were direct quotations from original sources of educational theory included in the text?**
   (This question aims to ascertain whether a theorist's own words are used within the text.)
4) **Did the author explicitly signpost the students toward reading original sources of educational theory?**
   (Some texts include a 'further' or 'recommended' reading list at the end of each chapter. Often, authors might suggest that their readers pursue a key theme by reading from the original sources themselves.)
5) **Did the author refer to any sources of educational theory in the bibliography?**
   (This involved scanning each bibliography for books written by significant, high-profile thinkers such as Vygotsky, Piaget, Bruner, Dienes and Ausubel.)
6) **Is any critique of educational theories offered or are they challenged?**
   (The final criterion in the reading frame concerns whether theories are promoted as representations of the truth or whether they are questioned or challenged in any way.)

A detailed version of this first part of the reading frame analysis can be found in Appendix 5 on p. 266, but a summary of it is presented in the table below:

Text	Educational theories appear in the contents or index	Educational theories are discussed in the text	Direct quotations from original sources are included	Original sources of theory are suggested as further reading	Original sources of theory appear in the bibliography	Critique or challenge to theories is offered
Askew, M. (2012) *Transforming Primary Mathematics*. Abingdon: Routledge						
Briggs, M., and Davis, S. (2008) *Creative Teaching Mathematics*. London: Routledge						
Carruthers, E. (2006) *Children's Mathematics: making marks, making meaning*. 2nd ed. London: Paul Chapman						
Cockburn, A., Littler, G. (2008) *Mathematical Misconceptions*. London: Sage Publications						
Donaldson, J., Field, J., Harries, D., Tope, C., and Taylor, H. (2012) *Becoming a Primary Mathematics Specialist Teacher*. Abingdon: Routledge						
Grigg, R. (2010) *Becoming an Outstanding Primary School Teacher*. Harlow: Pearson Education Ltd.						
Hansen, A & Vaukins, D. (2011) *Primary Mathematics Across the Curriculum* Exeter: Learning Matters						
Lee, C. (2006) *Language for Learning Mathematics.* Maidenhead: OUP						
Pound, L (2006) *Supporting Mathematical Development in the Early Years.* Maidenhead: Open University Press						
McGregor, D. (2007) *Developing Thinking Developing Learning.* Maidenhead: OUP						
Rowland, T. (2009) *Developing Primary Mathematics Teaching.* London: Sage						
Ryan, J., Williams, J. (2007) *Children's mathematics 4-15*. Maidenhead: OUP						
Thompson, I (2003) (ed) *Enhancing primary mathematics teaching and learning*. Buckingham: Open University Press						
Turner, S. and McCullouch, J. (2004) *Making Connections in Primary Mathematics.* London: David Fulton						

Table 2: Reading frame analysis summary

It is important to note that, despite an aim of the mathematics strength module being to 'consider and compare theories of learning', none of the texts on the suggested reading list (above) are overtly about theories or written by theorists such as Bruner, Piaget, Vygotsky or Dienes. Rather, they were secondary, not primary sources so already contained distilled knowledge. While there were two texts written by Skemp on the additional reading list, this strongly suggests that accessing theories in their original form is not expected or even desirable. Instead, each of texts on the reading list is a generalised guide to mathematics education although the majority of them (12 of the 14) do make reference to educational theories in some way. Two of the texts selected for the reading list are not written solely about mathematics education (Grigg's (2010) Becoming *an Outstanding Primary School Teacher* and McGregor's (2007) *Developing Thinking, Developing Learning* and significantly, they were among the least used texts on the list. While both contained a chapter on mathematics education, this does suggest that the students gravitated toward texts with a more explicit link to mathematics.

Those texts that did refer to educational theories provided a second-order interpretation of them. By this, I mean that the original theories had been read and interpreted by the authors of the texts before being delivered to the students. This means that, by the time the students encounter theories for the first time, they have already been condensed and potentially distorted. All but one of the texts referenced at least one source of original learning theory in the bibliography. This is unsurprising as authors are duty-bound to do so. One could reasonably expect an interested reader to identify and pursue further reading opportunities from the bibliography, but only two of the 14 texts included an explicit list of further reading that included original sources of theory. This does not make it easy for the students and there is a sense in which they need to 'go out of their way' in order to access educational theories in their original form.

Constructivism suggests that theories are representations of reality that only really exist in the mind of the theorist who proposed them. Piaget's own ideas and subjective reality invariably developed with time and students only really get a snapshot of this thinking. When they were originally written, his ideas were considered to represent radical thinking so they were adjusted somewhat to fit into the psychological tradition of scientific empirical knowing. This means that his work was (and, I believe, still is) widely misinterpreted. As I shall discuss in Chapters 8 and 9, such misinterpretations are the only version that the majority of students are able to access.

The reading frame analysis was useful because it allowed me to compare, in a predominantly objective, text-based way, the measurable features of each text that I identified. The analysis suggests that there is not a link between the amount of theoretical content in a text and its relative popularity since texts with both large and small theoretical emphases were widely used by the students. However, it is interesting to note that they only text to include each variable from the reading frame was also significantly more widely read by the students than any other text. 96.97% of the students recognised Mike Askew's (2012) *Transforming Primary Mathematics* and 81.82% of students purported to have used the text when writing their assignment. There could be a number of reasons for this and it is important to acknowledge those that relate both to its contents and the way in which the students access them. For example, for well-subscribed university programmes such as the PGCE, there is the possibility that the number of copies of each book that are available in the library at the time of writing an assignment may determine which texts a student uses. Similarly, a cynical observer might suggest that being alphabetically first on the reading list may have contributed to the frequency with which Askew (2012) was used. However, a more likely explanation for its apparent popularity is the knowledge that the PGCE actually promotes Askew's text and the module handbook encourages students to read from it during the early stages of the programme. Arguably, this in itself should have been a sufficient reason for Askew's popularity but as I shall discuss in Chapters 8 and 9, 4 of the 8 students interviewed made reference to and praised Askew's book. Both Sarah and Leanne commented on how accessible and easy to read it was – so much so that Leanne bought her own copy and continued to refer to it even after she had written her assignment. Owen also referred to Askew's book after he had completed his assignment and Molly always 'went to' Askew for ideas for how to improve her maths teaching (Interview with Molly, p. 20).

The second part of the reading frame delves into the reasons for this and involved a more detailed reading of Askew's (2012) *Transforming Primary Mathematics* and the next part of this chapter explores the theoretical content of the text in order to better understand specifically how seminal works of theory by Bruner, Vygotsky and Piaget are presented to the students through the text. The summary begins with an overview of the general perceptions of mathematics that Askew promotes.

5.4 A brief overview of Askew, M. (2012) Transforming Primary Mathematics. Abingdon: Routledge

5.4.1 The nature of teaching and learning in mathematics

As the title suggests, the underlying precept of Askew's book is that primary mathematics could be improved. Written and published in 2012, the text pre-dates the 2014 National Curriculum and yet Askew appears to promote many of the principles of a 'mastery' curriculum. While he doesn't use the word 'mastery' to describe an approach to teaching (indeed, the word doesn't even appear in the index), an astute student would recognise the characteristics of a mastery curriculum that they will have, almost certainly encountered at school, early on in the book. For example, Askew makes the case for mathematics teaching where children are '…active constructors of knowledge, not passive recipients of it' (Askew, 2012, p. 108). This constructivist stance suggests that children's knowledge should be deep and based on a genuine understanding rather than superficial, procedural competence. Askew also challenges the idea of mathematical 'ability' and suggests that successful mathematics is less to do with how well children perform and more to do with their relationship with the subject. Again, the students are likely to recognise this reference to the importance of 'growth mindsets' (Dweck, 2006) as one of the cornerstones of a mastery curriculum. This is likely to appeal to students as familiar and reflective of modern practices and attitudes to mathematics.

Early into his second chapter, Askew challenges the view of learning in mathematics as a solitary pursuit and that while a teacher's knowledge of individual children is important, there is a lot to be gained from attending to the learning of the whole class. PGCE students may read this and question why their assignment required them to focus on only two children's mathematical thinking when social constructivists like Vygotsky promote the importance of group work and discussion in mathematical development. To support this, Askew draws upon vignettes of classroom practice that he has either taught or observed himself throughout the text. In illustrating different approaches to teaching concepts to the children, he firmly grounds his arguments in classroom practice and, I suspect, increases his credibility among his student readers who, as the questionnaire data suggest, show greater regard for the ideas of classroom practitioners than they do for academics. Indeed, the exemplification of concepts is, as Leanne described in her interview (see Chapter 8) the bridge between theory and practice that the students required. As I shall discuss in my vignette of Leanne in Chapter 7, she placed great importance on reading Askew to prepare for writing her assignment.

At the end of his introduction, Askew (2012) makes explicit reference to his approach to theory and therefore, the ways in which he chose to present theory to the readers of his book. He admits to being ‘unashamedly selective’ (p. xxiii) in the aspects of theory that he chose to support his arguments and this struck me as significant in two ways. First, it mirrors, to some extent, the approach to literature that the students themselves took when writing their assignments (this is discussed in detail in Chapters 8 and 9). Secondly, this insight provides a further dimension to the concept of second order textual interpretation. Not only has Askew relayed theories in his own words, he has invariably introduced bias by selecting them to support his own arguments. This serves to exemplify my suggestion that the deployment of a reading frame can identify the imposition of an author’s subjective reality on the readers of their texts and that in some way, even their decisions about what and what not to include in their work communicates something of their attitudes toward theory. Indeed, Askew provides an explicit insight into his stance with regard to theory. In his view, ‘Any theoretical account of teaching and learning can only ever be a shadow of the ‘real thing’ and as such will never be able to capture the totality of teaching and learning mathematics.’ (Askew, 2012, p. xxiii). To some extent, Askew’s position may serve to demystify theories a little as it suggests that theories need not be viewed as complicated, academic pursuits but rather, a poor relation to practical, classroom experience. On initial reading, this stance could be construed as somewhat dismissive of theory, but applying the lens of my theoretical meta narrative suggests otherwise. From a constructivist standpoint, theories are not the actual act of teaching: indeed, they do not even represent it. Rather, they are representations of the theorist’s own experience and, as such, they only truly exist in the mind of the theorist themselves. The extent to which these representations can be conveyed to others through a text is questionable and the likelihood of them carrying an inherent meaning to the reader seems slim. I believe that acknowledging this from the outset is an important part of understanding and applying theories. Askew is similarly keen to promote theories among his readers as a means through which to view maths lessons in different ways so that ‘norms’ can be challenged and improvements made. He also does not shy away from the integrity of theories in their original forms and he concludes each chapter with suggestions of where to find more detailed accounts of them. In doing so, he acknowledges that his own accounts have been used in a specific way and that they may not be fully representative of the originals.

5.4.2 How the work of Vygotsky is presented to the students in Askew’s (2012) Transforming Primary Mathematics.

Askew makes frequent reference to the work of Vygotsky throughout the text. Specifically, he draws upon Vygotsky’s (1978) distinction between physical and psychological tools. While physical tools improve an individual’s capabilities to change the world around them (and literally become an extension of the body), they are, according to Vygotsky, limited in the sense that they do not change us as human beings. Psychological tools, on the other hand, not only allow us to make changes to our environment, but they also have a profound and lasting effect on ourselves. For ease of understanding, Askew uses an everyday example to simplify Vygotsky’s original explanation of physical tools:

> My hammer is not much use in my embroidery any more than my needle will help in putting up a cabinet. Similarly, a lot of hammering or fine sewing may improve some specific motor skills and hand-eye coordination, but these changes are mostly limited to these specific tool uses: the hand-eye coordination that I develop in learning to hammer accurately will not transfer to being able to embroider a delicate leaf, and vice versa. (Askew, 2012, p. 110)

Clearly, this analogy is Askew’s own construct and not specifically what Vygotsky said although arguably, this example allows easier access to the original idea. For students who are not familiar with Vygotsky’s work or indeed used to reading and interpreting tentative and subtle theoretical works, a simple analogy is likely to make a valuable contribution to their developing understanding. Askew adopts a similar way of presenting the idea of psychological tools. According to Vygotsky, the overarching psychological tool at our disposal is language. In itself, this could be considered rather an abstract concept but again, Askew draws upon an everyday example to make it easier to understand:

> Names and labels, in and of themselves, are not important, but they enable us to accomplish things. ‘Please pass the ketchup’ is much easier than ‘Please can you pass the thingy with the stuff the same colour as that other thing I’m pointing to’. Just like physical too, psychological tools enable action, but over and above that, they have a profound effect on who we are. (Askew, 2012, p. 110)

As well as being straightforward, Askew’s chosen example of how language can be considered a psychological tool is also humorous. I suspect that this goes a long way to breaking down the students’ perceptions of theory being the preserve of academics or difficult to understand.

Despite his attempts to demystify theories, Askew’s list of further reading for Chapter 3 directs his reader toward Harry Daniels’ Vygotsky and Pedagogy’ – an open reinterpretation of Vygotsky’s work. While he suggests that ‘... nothing can replace reading a good translation of Vygotsky directly’ (p. 18), he highlights how the historical and social context in which Vygotsky was writing can be neutralised and modernised for ease of understanding. This does present something of a dilemma for teacher educators and authors of texts used by student teachers. Do they attempt to remove historical and social contexts and present their own, second order interpretation or do they attempt to provide students with a sense of the all-important context that would enable them to understand Vygotsky in its original form? In my view, an understanding of the context in which any text is written is an important aspect of being a critical and discerning reader although I acknowledge that providing students with a genuine appreciation for the social, historical and political context of Vygotsky’s early twentieth century Russia may be beyond the scope of the PGCE. From my experience, I have found that all learning is situated and is dependent on the context in which it occurs. It could therefore be argued that a truly effective theory ought to be understandable beyond its original context. Perhaps the compromise for the students lies in at least acknowledging (as Askew does) the original context of the theories in order that they can be explored at greater depth should the student so wish or need to understand more.

Askew's reference to Vygotsky's notion of physical and psychological tools is rather pertinent to the way in which student teachers use theories. Theories themselves seem to fit Vygotsky's description of psychological tools and yet, as I shall discuss in detail in Chapter 8 students are more readily able to use them when they have a direct, physical application to their practice. In a sense, they attempt to use psychological tools physically. As I mentioned in Chapter 2, I believe that there is a difference between theories and models for teaching. A model for teaching suggests, or even prescribes a teaching sequence. This may incorporate suggested language and resources and is used with most prevalence in the planning of lessons. Conversely, a theory provides a much broader (and, I believe, a more versatile) conceptual framework through which to view practice and to reflect upon episodes of teaching. This is because theories are less bound by context so can be more readily applied to a range of situations than frameworks that have been designed to support specific instances of teaching.

5.4.3 How the work of Piaget is presented to the students in Askew's (2012) Transforming Primary Mathematics.

Askew makes frequent reference to Piagetian notions of staged child development throughout the text. He argues that much of the British education system is based on the ideas of clearly defined stages of development that, in turn, gives rise to the concept of readiness for subsequent stages of learning. However, Askew does not present Piaget's ideas as infallible – indeed, he suggests that to some extent, Piaget's idea of staged development is actually at odds with his own way of thinking. For example, he upholds the now commonly-held view that young children are capable of thinking in as many different ways adults. The issues do not lie in the nature of the mathematical thinking itself but rather, it is when teachers do not move beyond Piaget's 'abstract symbolic' presentation of ideas and fail to explore other modes of learning that young children are prevented from engaging with activities. Despite this, he does not criticise Piaget's work directly, but rather questions the way in which Piaget's influential ideas have been used by others. Specifically, he draws upon the influence of Piaget's work on the practice of 'discovery learning' and the way in which he does so is of interest:

> Thought, Piaget had argued, was a result of internalized activity (actually his argument was both broader and subtler than this but that was the gist

> used in teacher education) and so activity had to be at the heart of teaching. In fact it now seems that teachers were already using a lot of practical work and Piaget's theories were 'picked up' in order to justify these existing practices. (Askew, 2012, p. 5).

This insight suggests that, in Askew's view, Piaget's tentative ideas were used (or rather misused) to somehow validate and strengthen existing classroom practices with regard to mathematics teaching. It is significant that he refers directly to only a vague sense of Piaget's original ideas being adopted by teacher educators because it suggests that the way in which theories are presented to students (as this thesis explores) is by no means a new issue and that students often receive only a superficial version of theory.

Askew's support, indeed respect, for Piaget's work emerges once more in a discussion of Vygotsky's concept of physical and psychological tools. Piaget's ideas of accommodation and assimilation that describe how the brain adapts to external stimuli do, he argues, go some way to describe how use of physical tools can bridge the gap between external and internal development.

5.4.4 How the work of Bruner is presented to the students in Askew's (2012) Transforming Primary Mathematics.

Unlike the works of Piaget and Vygotsky, Askew's text includes direct quotations from original sources of Bruner's work. Indeed, even within the introduction, Askew quotes from Bruner (1979) to support his view that the aim, indeed joy, of mathematics is to 'bring order to a world of variation and uncertainty.' (Askew, 2012, p. xx) Having encountered the work of Bruner in only their second session at university, this is likely to have struck a chord with the students in my research and provided them with a sense of familiarity as well as some confidence that what they had learned at university had further-reaching validity. It suggests that theories really can provide a way of viewing mathematics that is attainable, easy to understand and relevant to modern practice.

Rather than a model for teaching or an insight into children's understanding, the example of Bruner's thought that Askew chooses represents a much broader, holistic view of mathematics education. It does suggest that mathematics that is challenging can be rewarding for children and it may challenge the students' perceptions of mathematical 'ability' and the appropriateness of different tasks for the children. Indeed, he makes this view more explicit later in the text and again, quotes directly from Bruner (1996) to reframe the issue of mathematical ability and the value of classrooms becoming mathematical communities of learners. Askew pervasively argues that there is great strength in seeing mathematics as a communal activity that looks beyond what individual children are able to achieve and that as in any community, diversity is an asset and not a weakness. A 'growth mindset' (Boaler, 2016) that has become a byword for a mastery curriculum would suggest that all children, regardless of their ability, can be capable mathematicians. Furthermore, the government's expectation that children will progress through mathematical learning at 'broadly the same pace' (DfE, 2013, p. 99) implies that a class of children should remain a homogenous, mathematical community rather than a collection of individuals with a common goal. This view is likely to be challenging for the students because, during the early stages of their training, they tend to develop their skills by focussing upon individual children and small groups. In fact, their assignment itself suggests a focus on just a few children. In brief, operationalising Askew's idea that draws upon Bruner's (1996) 'communities of learners' is probably not easy for a student teacher. Without overall responsibility for a class and being in a school for only a few months, they have neither the time nor the power to affect such cultural changes. As an experienced teacher and teacher educator, Askew is almost certainly aware of this but in this example, he makes use of theory to present a best case, pedagogical scenario that's based on attitudes rather than simply a model for teaching mathematics.

5.4.5 Other theoretical perspectives in Askew's (2012) Transforming Primary Mathematics.

In Chapter 4 of his book, Askew challenges the orthodoxy that learning occurs in a single lesson and promotes the view that teaching and developing understanding in the minds of children is a tentative pursuit. As ludicrous as it sounds within the context of a mastery curriculum, during my own teaching career, the learning of the children has been assessed (and indeed graded) following a single lesson observation where 'teaching' could only be deemed to be good if the children's 'learning' was also good. In addressing this, Askew draws upon Lave and

Wenger's (2011) theory of 'Situated Learning' and suggests that the children form 'communities of practice' when a strong mathematical ethos is created in the classroom. In Chapter 2, I draw upon Lave and Wenger's (2011) concept of 'communities of practice' as an example of an adult learning theory, however, it does seem feasible that this concept could also be gainfully applied to groups of children as they learn mathematics.

Askew openly promotes the children's depth of understanding over superficial, procedural competency. In doing so, he draws upon Langer's (1997) concept of 'conditionality' that enables children to explore mathematical variables and possibilities rather than simply digesting formulae.

Chapter 5 of Askew's book is explicitly concerned with theory and he presents maths (as Vygotsky does) as 'a cultural tool to do things with' (p. 34). He presents his own 'connectionist theory' (p. 35) and likens this to improvisation and the quality of effective teachers being able to take the children's ideas and effectively steer them toward a better understanding. This is reminiscent of the Aristotlian notion of associationism that is concerned with how contiguity, similarity and opposition promote associative memory and the process of knowledge acquisition (Buckingham, 2012, p. 268). Notably, when asked to name theories that they had encountered, Askew's connectionist theory was not mentioned by any of the students in the questionnaire data. This is a rather surprising omission since so many of the students purported to have read the book. It does lead me to question whether this was considered as theory by the students or whether theory has connotations for long-lived, time-honoured educational traditions that everybody is aware of. There is also a possibility, as I have suggested, that communal mathematical learning is simply too difficult for the students to achieve. The students' perceptions of the meaning of theory will be explored in greater detail in Chapter 6.

Askew devotes the whole of Chapter 7 to a discussion of variation theory (Marton, Tsui et. al. 2004) and a detailed discussion of variation theory can be found in Chapter 3. Askew promotes it as a means through which teachers make decisions and careful selections of specific content for learning. This section is heavily exemplified with practical suggestions for how concepts can be varied for the children and is instructional in nature. This strongly suggests that, for Askew, ‘variation theory’ is something that the students are able to *apply* directly to their practice rather than using it as a means to understanding teaching and learning.

5.5 Conclusion

It is perhaps of little surprise that Askew draws upon the work of thinkers such as Vygotsky, Piaget and Bruner since like them, his own ideas are broadly social-constructivist and child-centred. Constructivism, I believe, provides a realistic framework for considering teaching and learning because it acknowledges that concepts mean different things in the minds of different individuals – this is inevitably true of children, but must also be true of the students learning to teach them. With that said, Askew’s text can only really be about his own ideas regarding mathematics teaching and, as such, their usefulness to students could be questioned since their experiences of mathematics teaching (as novices) are likely to be very different to Askew’s who is, after all, an experienced teacher, teacher educator and professor of mathematics education. In a similar way, in my interview with Emily, she described Bruner as being difficult to read because it contained ‘quite a lot of jargon’ (Conversation with Emily, p. 14) and yet, as an experienced teacher and mathematics subject leader, I find Bruner’s ideas about mathematics accessible and straightforward to read. The concept of being ‘child-centred’ is also of interest because the extent to which a book written for adults could be centred on children is questionable because the benefit to the children can only be mobilised through a competent and understanding adult.

Theory runs as a narrative throughout Askew’s work. It does not direct his arguments, but it is used as a subtle backdrop to the narrative and is called upon, when relevant, and used as a lens through which to view his ideas. In a sense, it provides a fitting example for the way in which the students themselves should use theory. Significantly, it suggests a very different approach to the way in which the students are asked to use theory in their assignment. He defines maths as a never-ending journey of understanding and in doing so, very much aligns himself with the students themselves.

While he does present a simplified version of seminal works of theory, students are not misled into thinking that his interpretations of the original ideas are any more than a condensed version of the originals. Significantly, Askew actively points those reading his book toward original sources and suggests that they do read and interpret original sources for themselves.

While Askew does not ignore criticism toward the work of Vygotsky and Piaget in particular, he does, to some extent, defend their work by making it clear that their ideas are situated in a specific context. He presents theories both as models for learning and as ideal scenarios that have value either as tools or as conceptual lenses through which to view practice. This serves to make theories as useful and accessible as possible by broadening their scope and increasing the number of ways in which students can make use of them.

As well as providing an insight into the types of texts that the students engaged with, the questionnaire also yielded quantitative data about their opinions of educational theories and their experiences of teacher education both at university and in schools. Chapter 6 reports on these findings through descriptive statistics and statistical significance testing.

<u>**Chapter 6: Presentation of questionnaire data and quantitative analysis**</u>

I would just talk to a teacher and say, 'What do you think about this or this?' and 'Do you think this would make me better or do you think this lesson would be easy for them to understand or progress them further or challenge them further if I do it this way?' sort of thing. So [I was] questioning teachers rather than getting guidance from a book.
(Conversation with Molly, p. 22)

6.1 The approach to quantitative analysis

This chapter continues the quantitative analysis of data by reporting the findings of questionnaires that were completed by the mathematics strength PGCE cohort five months prior to my interviews with a selection of them. The questionnaires were circulated among the students at the end of their final maths session at the university and it serves three key purposes: 1) it provides a broader context in which to better understand the responses given by the participants in the interviews, 2) it strengthens the integrity of the interview data through triangulation and comparison of the key themes to arise and 3) it formed the basis of the design of the interview schedule and helped ensure that it was personal and relevant to the cohort.

In Chapter 4, I presented my mixed methodology as comprising both qualitative and quantitative data collection methods. I used the concept of the 'mixed method continuum' (Johnson and Christensen, 2014) to explain the precise nature of the combination of quantitative and qualitative methods that I used as they were not given equal weighting. Rather, the bulk of the data collected were through qualitative means, a detailed description of which can be found in Chapter 4. This chapter draws upon the quantitative data generated from the questionnaire to make generalisations about the entire cohort of PGCE students pursuing an interest in mathematics. This is an important contextual framework to establish a means through which to understand the context of their university-based learning. The inclusion of quantitative data contributes to an additional strand of my insider/outsider stance. As a mathematics subject leader, I must be something of a mathematics expert at my school. While the numerical analysis that follows is of a higher level than that needed for teaching the Key Stage 1 children at my school, I believe that its inclusion in my work adds an important layer of analysis. From a constructivist stance, it also gives meaning to the world by constructing realities based upon empirical evidence from the world.

From the outset, it is important to establish the tentative nature of the data presented in this chapter. While the entire mathematics strength PGCE cohort were included in the sample, this still only represented 34 participants and as with all statistical endeavours, larger numbers tend to provide more reliable findings. That said, the attitudes expressed through individual questionnaires are insightful in their own right and therefore, their analysis is relevant to the questions posed by the thesis.

In keeping with the theory/practice dichotomy that I identify and challenge through this thesis, some of the questions reveal something of the students' attitudes to theory while others of their attitudes to practice. However, for clarity, the data obtained from each question will be presented (in order) beneath the question from which it came. For numerical data, this will be tabulated. Following this, I will discuss the data for each question to draw out the knowledge they reveal. After presenting and discussing the data for each question, I will provide my own interpretation of the meaning behind the findings and any implications that arise. This interpretation is based on my own perception of the data, and I acknowledge that there could be alternative explanations.

To begin with, I present a vignette of the mathematics subject strength cohort as a whole and my own discussion and interpretation of its significance. This has been gleaned from the data that arose from following questionnaire questions:

- What is your gender?
- What is your age?
- What is your undergraduate degree subject?
- Did you engage with theories as part of your undergraduate degree?
- If yes, which areas of theory did you encounter?
- In your own words, what is your understanding of the term 'educational theory'?

6.2 The generalised characteristics of the mathematics strength PGCE cohort 2017-18

Like the majority of primary ITE programmes, the maths strength PGCE cohort was comprised predominantly of female students with 67.65% of the 34 students being women. The ages of the students ranged from those that were under 26 years and those that were in the 46-50 range. However, the significant majority of the students fell within the lower age range with 61.76% of students being under 26 and 82.35% under 30 years of age. This indicates that the majority of the students had recently graduated and had not had a vast range of employment-based experiences prior to commencing their PGCE.

Educationally, the students came from a range of undergraduate disciplines although notably, none were mathematics graduates and very few had a scientific background. In terms of trends, one third of students had studied education or childhood studies at degree level. This is significant because it suggests that they may have had some prior knowledge of educational theories and that for them, the PGCE may have enabled them to enhance or embed this understanding rather than encountering it for the first time. Indeed, 76.47% of the students were able to recall theories that they had encountered at undergraduate level. The range of remaining undergraduate degree subjects were evenly distributed other than the 21.21% of students who had studied sports education or coaching. It is possible that the scientific element of their sports-based degrees may have made the mathematics strength module more appealing to them.

6.3 The students' definitions of theory

Following the questions concerning the demographic of the cohort, the questionnaire asked the students to define the term 'educational theory'. The students were given the freedom to write their own responses. Each response included at least one of the following:

- reference to learning in general terms
- reference to children's learning
- use of the word 'pedagogy'

- reference to ‘good’ or ‘best’ practice
- reference to teaching
- reference to how education is represented or understood
- use of the term ‘research’
- reference to child development
- the names of educational theorists or broad, theoretical paradigms (e.g. social constructivism)

The vast majority of the students’ definitions included two or more of the above and there were 53 references in total. The data suggest that the term ‘educational theory’ is primarily associated with learning. 37.74% of the students’ definitions used the word ‘learning’ and 20.75% mentioned children’s learning specifically. This could suggest that student teachers see educational theories as more beneficial to children than to themselves. It is therefore of interest that only 3 of the students used the word ‘pedagogy’ in their definition. This is a rather surprising omission when considering that the questionnaires were completed during the month after the students had submitted their mathematics assignments. Notably, 2 of the 3 students that had used the term ‘pedagogy’ had studied either primary education or childhood studies for their undergraduate degree and had almost certainly encountered the word ‘pedagogy’ before they began their PGCE. 18.87% of students defined theories as the ways in which education is represented or understood. This stance could suggest that some students viewed theories as a generalisable set of principles that describe what education could or should be like. That said, only one reference was made to theories representing a best-cased scenario or being descriptive of effective practice. Viewed through the lens of constructivism, it is possible that, within the objective reality of their own schools, students had not seen theories being played out so were unable to construct their own meaning from them or attribute successful practice to them. This also raises some interesting questions about the way in which the university itself views theory and their teaching of it.

I believe it to be significant that only one student’s definition included the names of any of the theorists that they had learned about. I was expecting that more of their definitions might have been furnished with examples of the theories that they had encountered, particularly when they had all recently selected one or more to produce a 5000 word assignment about. Intriguingly, the student who did mention the names of theories wrote as her definition:

> ‘Vygotsky, Piaget, Bruner, Skemp etc.
> Does Montessori, Steiner, Malaguzzi etc. Count?’
> (Student 26, proxy group)

This struck me as an interesting insight as it suggests a perceived, theoretical hierarchy and some confusion as to what ‘counts’ as theory. The four theorists whom she seemed more certain about were those that had been presented as theories and were part of the taught element of the PGCE. However, the three additional names to which they refer were not included in the mathematics module so they seemed less confident in their classification of them. This could suggest that, for this student, rather than enabling the them to recognise and make use of theories, their university studies actually imposed on them a more fixed idea of what theory is and what it is not.

The following section presents the data obtained from each of the questionnaire questions.

6.4 The questionnaire data

1. **Please rank the following definitions of ‘educational theory’ from 1-5 with 1 being your favourite definition and 5 being your least favourite definition.**

Favourite definition	Mean Rank
Educational theories are ideas that describe how children learn effectively.	1
Educational theories are ideas that describe how to teach effectively.	2
Educational theories are complicated ideas about teaching and learning.	3
Educational theories are ideas about teaching that people learn about while they’re training to be teachers.	4
Educational theories are ideas about teaching from long ago.	5

Table 3: The students’ response to questionnaire Q1.

The data suggests that theories are perceived as slightly more important to children’s learning than they are to the students’ own learning and growth. The

Friedman test indicated that there were differences between the ranks among the five definitions of educational theories, $\chi^2(4, N = 33) = 91.514$, $p < 0.000$. Clearly, it was crucial to gain an understanding of the statements about theory that the students agreed with, but also ascertaining what they did not agree with provided an even deeper insight into their perceptions of theory. I therefore used the Nemenyi Test to determine which responses were significantly different from each other. The Nemenyi Test highlighted that the following pairs of statements involving definitions of educational theory showed significant differences. Where those definitions on the left were chosen, the corresponding definition on the right was statistically less likely:

Educational theories are ideas that describe how children learn effectively	Educational theories are complicated ideas about teaching and learning
Educational theories are ideas that describe how children learn effectively	Educational theories are ideas about teaching from long ago
Educational theories are ideas that describe how children learn effectively	Educational theories are ideas about teaching that people learn about while they're training to be teachers

This indicates that those students who associated theories with effective learning were less likely to see them as complicated, outdated or the preserve of students and academics.

2. **What do you do when you are unsure about how to teach a mathematical concept?** *(Please rank the statements from 1-5 with 1 being your most likely course of action and 5 being your least likely course of action.)*

Most likely course of action	**Mean Rank**
I ask the teachers at my placement school.	1
I ask the mathematics subject leader at my placement school.	2
I look for ideas in books.	3
I talk to other student teachers about what they have done.	4
I ask my university tutors.	5

Table 4: The students' response to questionnaire Q2.

When they were unsure about how to teach something, the students' most likely course of action was to seek advice from teachers at their placement schools in the first instance. After this, they would seek support from the mathematics subject leader at their school. When a Friedman Test of differences was conducted on the ranks among the five statements about what students do when faced with difficulty, it returned a Chi-square value of 44.897, which was significant ($p<0.000$). The Nemenyi Test revealed that the following pairs of questions showed significant differences where those statements on the left are more favoured:

I ask the teachers at my placement school	I ask my university tutors
I ask the teachers at my placement school	I talk to other student teachers about what they have done
I ask the mathematics subject leader at my placement school	I ask my university tutors

As the data suggest, it is significant that the students' least likely courses of action were approaching university tutors or other student teachers for support. This could simply be a matter of convenience and because the expertise of fellow teachers or the mathematics subject leader are more easily accessible while they are at school. However, it could also be that the students do not associate their university tutors (or each other) with classroom expertise and that they do not see any correspondence between the expertise of university staff and the staff at their placement schools. While this is a matter of perception, a constructivist stance might describe this as the students' subjective reality so whether or not there is a mismatch between the students' university-based and school-based support, the effect of this perception remains that students feel that they gain more from teachers at school.

3. In what ways do you learn the most about teaching mathematics?
(Please rank the statements from 1-5 with 1 being the most true and 5 being the least true.)

Means through which most is learned	**Mean Rank**
When you get to teach concepts for yourself.	1
When you observe more experienced teachers teaching.	2
When you talk to your mentor/teachers at your placement school.	3
When you're in maths sessions/seminars at university.	4
When you read about maths teaching.	5

Table 5: The students' response to questionnaire Q3.

When the students were asked about the ways in which they learned the most about teaching mathematics, the most popular responses were when they taught concepts for themselves or when they observed mathematics lessons being taught by more experienced teachers. Conversely, the least popular answers included while they were in mathematics seminars at university and when they read about mathematics teaching respectively. In this instance, the Friedman test indicated that there were differences between the ranks among the five different statements about when the students learned the most about teaching mathematics, $\chi^2(4, N = 33) = 57.382$, $p < 0.000$. The following pairs of statements showed significant differences with those on the left were more favoured:

When you get to teach concepts for yourself.	When you're in maths sessions/seminars at university.
When you get to teach concepts for yourself.	When you read about maths teaching.
When you observe more experienced teachers teaching.	When you're in maths sessions/seminars at university.
When you observe more experienced teachers teaching.	When you read about maths teaching.
When you observe more experienced teachers teaching.	When you talk to your mentor/teachers at your placement school
When you read about maths teaching.	When you talk to your mentor/teachers at your placement school

The T-tests revealed that there was also a significant difference in the average rank among respondents who identified as having been exposed to educational theories before their PGCE ($\bar{x}$=2.7, σ=1.04) and those who didn't or weren't sure ($\bar{x}$=3.7, σ=0.76) in evaluating the statement, 'When you talk to your mentor/teachers at your placement school'; $t(31)=2.800$, $p < 0.009$. Those who had encountered theories through their undergraduate degrees more readily learned about mathematics teaching by speaking to teachers and mentors at school than those that had not encountered theories as undergraduate students.

The data suggest that students valued their teaching practice in general terms over the university-based aspects of their PGCE. This is because those aspects ranked 1-3 all take place at school, while those aspects ranked 4 and 5 take place outside of school. It therefore seems reasonable to suggest that, for the students, there exists a significant gap in usefulness between theory and practice and that their perception is that practice offers the greater contribution to their training as teachers. That said, there is a possibility that this is dependent on the students' prior experiences. This could be because these students have had time for theories to become embedded in their understanding and that talking to teachers and mentors at their school unlocks or activates their tacit knowledge of them. This idea is expanded upon in Chapter 10 of the thesis. The T-tests also revealed that there was a significant difference in the average rank among female respondents ($\bar{x}$=2.6, σ=0.84) and males ($\bar{x}$=3.7, σ=1.16) in evaluating the statement, 'When you talk to your mentor/teachers at your placement school'; $t(31)=-2.686$, $p < 0.012$. It is interesting that female students more readily learned about mathematics teaching by speaking to teachers and mentors at their placement schools than male students, and this could be a potential area for future research.

4. **Which people's ideas about mathematics teaching do you listen to?** *(Please rank the statements from 1-5 with 1 being the most true and 5 being the least true.)*

Preferred influence	Mean Rank
Teachers who have good ideas about how to improve your mathematics teaching.	1
University tutors who have lots of practical suggestions for improving your lessons.	2
Teachers who are more experienced than you.	3
University tutors who have talked to you about educational theories.	4
Teachers who have talked to you about educational theories.	5

Table 6: The students' response to questionnaire Q4.

The data suggests that there are some different attitudes among the students toward those involved in their initial teacher education. As I discussed in Chapter 2, the preparation of a new teacher involves university tutors, link tutors, class teachers, subject leaders, mentors and head teachers. When asked about whose ideas about mathematics teaching that they listen to most readily, there were statistical differences between the ranks among the five statements about this question, $\chi^2(4, N = 33) = 51.491$, $p < 0.000$. The following pairs of statements showed significant differences:

Teachers who are more experienced than you.	Teachers who have talked to you about educational theories.
Teachers who are more experienced than you.	University tutors who have talked to you about educational theories.
Teachers who have talked to you about educational theories.	University tutors who have lots of practical suggestions for improving your lessons.
Teachers who have talked to you about educational theories.	Teachers who have good ideas about how to improve your mathematics teaching.
University tutors who have lots of practical suggestions for improving your lessons.	University tutors who have talked to you about educational theories.
University tutors who have talked to you about educational theories.	Teachers who have good ideas about how to improve your mathematics teaching.

The students' responses seemed to focus less on the *role* of the person offering advice and more on the *type* of advice they were able to offer. First and foremost, the students seemed to respect the views of qualified teachers who had good ideas about how to improve their mathematics teaching. Next, the students showed a preference for university tutors who had practical suggestions for improving their lessons. This serves to underline the students' perception of practical, classroom experience being the greatest tool at their disposal. Ranked third, the students would seek the support of teachers with more experience possibly because they too would be a ready source of practical suggestions that they may have used at some point themselves. In stark contrast, the students' least likely course of action was to seek support from teachers who had spoken to them about educational theories; they were marginally more likely to speak to university tutors about theory. This is revealing in two ways. Firstly, it reinforces the students' perception of the relative usefulness of practice in preference to theory and secondly, it could suggest that the students perceive educational theories as the preserve of university staff and not something that teachers know about.

5. **On which of the following occasions have drawn upon the educational theories that you have learned? <u>Please tick (✓) all that apply to you</u> and leave blank those that do not apply to you.**

Uses of theory	Percentage of students that used theories in this way
When you are planning your mathematics lessons.	72.73%
When you are marking/assessing children's work.	27.27%
When you are writing your university assignments.	100.00%
When you are evaluating your mathematics lessons.	63.64%
When you are deciding how to pre-empt or address children's misconceptions in mathematics.	45.45%

Table 7: The students' response to questionnaire Q5.

Rather unsurprisingly, all students reported that they had used theories in the writing of their assignments; indeed, this was a prerequisite of writing a successful assignment. Aside from this, the next most useful application of theory was while planning mathematics lessons with 72.73% of the students reporting that they had. I suspect that this is because a crucial part of maths lesson planning, is consideration of the ways in which concepts are presented to the children (reflected in the work of Bruner) and how best to support their learning (reflected in the work of Vygotsky). As I have discussed, this could suggest that theories are most useful if they contain a direct application to practice.

63.34% of students also made use of theories in the evaluation of their maths lessons. This was an area that I chose to ask the students about during their interviews and as the interview data suggest, this was mainly concerned with whether to 'do' more or less of what they had planned to do with the theories in subsequent lessons. Students made infrequent use of theories when they were marking or assessing children's work and this again suggests that theories were only really used when they could be applied directly to an approach to teaching and not as a retrospective exercise to either diagnose an area of misconception or equally, to explain why a lesson was successful. Indeed, 72.73% of students reported that educational theories helped them to decide how to teach concepts while only 24.24% sought theories to try to explain or reflect upon effective maths teaching. Again, this suggests that the students have a preference toward using theories (psychological tools) physically.

6. **Does your knowledge or understanding of any of the following disciplines support your understanding of teaching and learning mathematics?**

Supporting discipline	Percentage of students that used drew upon this discipline
Psychology	54.55%
Ethics	6.06%
Theology	6.06%
Sociology	18.18%
Philosophy	9.09%
Child development	72.73%
Any other discipline (please state)	12.12%

Table 8: The students' response to questionnaire Q6.

The two most influential supporting disciplines were child development and psychology with 72.73% of students making use of their knowledge of child development and 54.55% of them suggesting that an understanding of psychology was beneficial. It is possible that these were the most familiar areas to the students, particularly to the 33.33% who had studied education at an undergraduate level. 4 students (12.12%) shared other disciplines that supported their understanding of mathematics teaching, although it is interesting that none of these cited their own mathematical subject knowledge as significant. For me, this is a surprising omission. This could simply be the case that the students did not see this as relevant or particularly in keeping with the subject areas suggested by the questionnaire. However, it could also suggest that students see the understanding of children's learning in generalist terms and that being a competent mathematician is not a prerequisite for being a competent teacher of mathematics. This could simply be that the students did not consider that they were very good at maths themselves. Similarly, it is possible that the generalist nature of training to be a primary teacher contributes to this; after all, primary teachers must be able to teach all National Curriculum subjects competently. With that said, I remain surprised that primary students with a special interest in mathematics did not see their own subject knowledge as being crucial, particularly when, in time, it is these students who will go on to be mathematics subject leaders in schools. In Chapter 3, I recalled a conversation with a head teacher who very clearly felt that mathematical ability was an essential prerequisite for employment at her school. It is interesting that, as an experienced teacher and leader, mathematical ability was important to her whereas for the students, it did not seem to be so crucial to their success. In the conclusion to the thesis, I identify perceptions of mathematical ability among student teachers and qualified teachers as an area that is worth pursuing in future research.

7. **Please tick (✓) all of the following statements that apply to you. Please leave blank those that do not apply to you.**

Statement	Percentage of students to whom it applied
Educational theories help me to decide how to teach concepts.	72.73%
Educational theories help me to manage children's behaviour.	33.33%
When I have a good idea about teaching a concept, I try to find theories to back it up.	24.24%
I talk to the teachers/my mentor at my placement school about educational theories.	18.18%
The children's behaviour prevents me from trying out my ideas about educational theories.	9.09%

Table 9: The students' response to questionnaire Q7.

72.73% of the students reported that educational theories helped them to teach concepts while nearly one quarter sought theory to validate or strengthen their ideas. It is interesting the one third of students found theories useful when it came to behaviour management since the theories that they had encountered at university were not explicitly theories of behaviour. This could be because the students were referring to theories that they had encountered in other areas of the PGCE or through their own private reading and study. It could also suggest that the study of theory had broader implications for the students than the mathematical context through which they were introduced. Only six students (18.18%) said that they had ever spoken to their mentor in school about educational theories. This is a surprising finding since the students were required to complete their theoretical assignment with reference to their work in school. It could also indicate that mentors did not know about the theoretical aspects of the students' experience.

8. Educational theory is something that I will learn once and never learn again.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
12.12%	24.24%	27.27%	12.12%	21.21%	3.03%	0.00%

Table 10: The students' response to questionnaire Q8.

Nearly one quarter of the students perceived theory to be something that they would learn once and never learn again although none of them were certain of this perception. 63.64% disagreed to varying degrees and felt that theory could still be learned after they had qualified. This suggests that, for the students, theory was not simply a means to becoming a qualified teacher but that it could be relevant to (and worth learning in) their future careers.

9. My school-based mentor knows a lot about educational theory.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
3.03%	3.03%	0.00%	69.70%	9.09%	6.06%	9.09%

Table 11: The students' response to questionnaire Q9.

While 10 of the students were able to agree or disagree that their mentor know a lot about educational theory, the most notable result is that 69.70% of students did not know whether this was the case. When combined with the finding from Q7 that only 18.18% ever talked to their mentor about educational theory, it is perhaps unsurprising that the students were uncertain. This could suggest that, despite being central to the students' study of mathematics education, theories were not high on the agenda when they were at school. It may also indicate that mentors do not know enough about educational theories to engage their students in conversations about them. This thread will be picked up in Chapter 9.

10. The ‘Concrete, Pictorial, Abstract’ approach to teaching mathematics is based on educational theory.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don’t know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	3.03%	12.12%	27.27%	33.33%	24.24%

Table 12: The students’ response to questionnaire Q10.

The vast majority of students (87.88%) recognised that the CPA approach was based on educational theory. As I discussed in Chapter 3, the CPA approach has its roots in Bruner’s concept of different modes of representation so it is reassuring that the majority of students recognised this. That said, one could reasonably have expected *all* students to make this connection and the fact that some did not, raises some interesting questions. The T-tests revealed that there was a significant difference in the average rank among those aged under 26 ($\bar{x}$=5.3, σ=1.21) and those aged 26-plus ($\bar{x}$=6.4, σ=0.65) in evaluating the statement, ‘The ‘Concrete, Pictorial, Abstract’ approach to teaching mathematics is based on educational theory’; $t(31)=-3.492$, $p < 0.001$. There was stronger agreement among students that where over 26 years of age that the CPA approach was based on educational theories. Firstly, this could suggest that modern re-branding of works of theory distorts them to the extent that they become unrecognisable. In this example, I think this unlikely because of the obvious similarities between the two. It is more likely, I suspect, that as educational theory is a completely new area of study for some students, they first interpret it for themselves and their own learning before they are able to interpret it for use with children. Again, from a constructivist stance, this might support the notion that more experienced students are better at cognitive assimilation and linking theory with their practice.

11. The mathematics that is taught in Shanghai and Singapore is effective because it is based on significant educational theories.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don’t know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	12.12%	45.45%	18.18%	18.18%	6.06%

Table 13: The students’ response to questionnaire Q11.

When asked about current thinking in mathematics education, nearly 40% of students expressed agreement that the maths taught in Shanghai and Singapore is effective because it is based on educational theories. This makes it rather strange that the students' definitions of educational theories were not therefore more readily aligned with good practice. It almost suggests that, for the students, theories are not good ideas in themselves, but that they can be the stimulus for effective approaches to teaching mathematics.

12. Knowledge of educational theories makes me better at teaching mathematics.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	0.00%	6.06%	54.55%	33.33%	6.06%

Table 14: The students' response to questionnaire Q12.

None of the students disagreed that theories made them better at teaching mathematics although only 2 students (6.06%) were certain that they agreed and more than half (54.55%) only mildly agreed. This tentative agreement could suggest that students recognise the intrinsic benefit of theories, but that they are unable to define, with any conviction, how theories improve their practice.

13. Constructivist theories of learning suggest that group work is important for children when they are learning in mathematics.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	6.06%	12.12%	30.30%	45.45%	6.06%

Table 15: The students' response to questionnaire Q13.

This question was designed to assess the students' understanding of constructivism (and, by implication, their engagement with their learning about theory). The finding that the majority of students agreed (with 45.45% mostly agreeing) suggests that they recognise the suggestion that interaction with others contributes to a child's cognitive constructs.

14. Knowledge of educational theories helps me to understand 'mastery' better.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	12.12%	12.12%	36.36%	30.30%	9.09%

Table 16: The students' response to questionnaire Q14.

75.76% of students agreed that their knowledge of theories helped them to understand mastery better although only 3 students (9.09%) felt certain that this was the case. As I suggested in my discussion of Q12, the partial agreement of the majority of the students could suggest that, while they recognise that theory and mastery are linked, they are, perhaps unable to think of examples of how this is the case.

15. Learning about educational theories has had a significant impact on the way that I teach mathematics.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	0.00%	3.03%	12.12%	54.55%	27.27%	3.03%

Table 17: The students' response to questionnaire Q15.

84.85% of students reported that learning about theory had had an impact upon the way that they taught mathematics. However, only 1 student (3.03%) felt certain that this was the case and more than half of the students (54.55%) expressed only mild agreement. It is interesting to note that the statement used in the questionnaire asks the students whether theory has had a *significant* impact on the way in which they *teach* mathematics. This could mean that the majority of students did not see the impact of theory as overly significant or similarly, that they had not impacted on their teaching specifically.

16. Educational theories are more useful when I teach younger children in KS1 than when I teach older children in KS2.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
9.09%	9.09%	21.21%	45.45%	9.09%	6.06%	0.00%

Table 18: The students' response to questionnaire Q16.

This question was included because, from my insider stance (and through my incidental conversations with other mathematics leaders), aspects of the mastery curriculum have been deemed to be more applicable to the early acquisition of knowledge, skills and understanding. 45.45% of students either had no opinion or did not know whether this was the case. At a practical level, this could simply be because, at the time of completing the questionnaire, the students had only just begun their placement in the alternate Key Stage so had not had time to form an opinion. Similarly, it could also be that students did not feel strongly that there was a difference in the usefulness of theory when it is applied to older or younger children.

17. Educational theories are something that I can create for myself.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree
0.00%	9.09%	18.18%	33.33%	21.21%	9.09%	9.09%

Table 19: The students' response to questionnaire Q17.

Opinions on whether theories were something that they could create for themselves varied. A slim majority (39.39%) expressed agreement although one third did not know and 27.27% disagreed altogether. This suggests that for some, theories are unattainable and beyond their level of thinking – the preserve of academics – while some see them as simply good ideas that pertain to specific ways of working. This was of interest to me and it became an area of conversation in the interviews (especially in the conversations that I had with Tara and Eve) where we explored what 'counted as theory'. My conversations with Tara and Eve are discussed in Chapters 8 and 9 and a short vignette of each of the students can be found in the following chapter. It is interesting to note that both Tara and Eve were younger students because the T-tests revealed that there was a significant difference in the average rank among those aged under 26 ($\bar{x}$=3.6, σ=1.39) and those aged 26-plus ($\bar{x}$=5.2, σ=1.14) in evaluating the statement, 'Educational theories are something that I can create for myself'; $t(31)=-3.497$, $p < 0.001$. Those students that were over 26 years of age were more likely to agree that they were able to create theories for themselves. This could be a simple case of more experienced students having more self-belief in their ability to theorise or their knowledge that in other contexts, they have. Constructivists like Piaget and Von Glasersfeld might argue that this is because students with greater experience are better at cognitive assimilation. This means that they are better placed to align their experiences in school into conceptual structures that they have already internalised. It therefore seems feasible that students with more experience may feel better able to organise their practical experiences into conceptual frameworks of their own creation.

18. Which significant educational theory have you found the most useful in your training to date?

In terms of the students' favourite theories or rather, those to which they felt the greatest affinity, there were some significant trends and a number of the students listed more than one. With a total of 58 theories or theorists named, nearly one third of the students (32.76%) reported that the work of Bruner had been the most useful to them and that the 'Three Modes of Representation' in particular was favoured by nearly a quarter of the students (24.24%). The next most useful was the work of Vygotsky with 25.86% of students drawing upon the concepts of 'The More Knowledgeable Other' and the 'Zone of Proximal Development'. The prevalence of these ideas in particular again suggests that students prefer theories that can be more readily and directly applied to their practice. For example, Bruner's concept of the Modes of Representation translates directly into an approach to planning and teaching. Similarly, Vygotsky's notion of the ZPD links directly into the pitch and expectations of activities for children. However, Skemp's ideas were less easily applied directly to practice. They are of Instrumental and Relational Understanding and do not represent an approach to teaching per se, but rather a way of categorizing procedural and conceptual areas of mathematics. According to Piaget, (2002, p. xviii), 'The mark of theoretical fertility in a science is its capacity for practical application.' Within the context of ITE, this suggests that the usefulness of theories is determined by how well they lend themselves to a clear way of teaching. This is rather a surprising insight given Piaget's constructivist position and unlike Piaget, I do not perceive that the capacity for practical application derives from the theory itself, but from the individual and the scope of their experience. This is in keeping with my own, working definition of theory as a means through which practice and experience can be considered.

6.5 Conclusion

To summarise, the questionnaire data revealed some clear attitudes toward both theory and practice. Most notably, it suggested a limited use of educational theory beyond that of writing the assignment and the value of teachers' advice over that of university tutors. The students felt that they learned more from their time in school than they did at university. In the following three chapters, I delve further into some of these attitudes as I present the qualitative data from the interviews. The next chapter is a shorter, preface chapter that paves the way for the thematic analysis of Chapters 8 and 9. As well as explaining the methodological approach to the analysis of the interview data, it also serves as an introduction to Emily, Tara, Eve, Fran, Owen, Leanne, Molly and Sarah (anonymised) – the students whose thoughts, opinions and ideas I present.

Chapter 7: Preface to the qualitative analysis

In Chapter 2, the notion of the existence of a gap between theory and practice was proposed and the evidence from the interviews suggests that there is indeed a ‘gap’ between theory and practice. This means that there are barriers that restrict students’ ability to translate what they learned about educational theories at university into their teaching at school.

The chapter that follows this preface will attempt to define ‘the gap’ between theory and practice and explore its nature. It will also explore some of the reasons why students find it difficult to implement their theoretical learning into their teaching practice.

Initially, I had intended to use the semi-structured interviews to produce individual case studies of student teachers putting theory ‘into action’. Upon initial analysis, the interview data obtained from each student were incredibly rich and yet sufficiently bound by a similar set of themes that I decided that a thematic examination of data would be used to identify those factors that enable and constrain the use of theory. While an exploration of the key themes to emerge from the interviews will form the basis of the analysis and the recommendations made, the ‘voice’ of the individual students involved in the study will captured through the vignettes that follow. As well as giving the reader a context in which to set each theme and provide examples, it is hoped that they will retain the individuality and contribution made by each participant in the study.

I will begin by describing my approach to the thematic analysis of the interview data.

7.1 How I coded the data and arrived at the key themes

It had been my initial intention to make use of qualitative data analysis software (NVivo) to support the coding of the interview transcripts and to identify lexical relations between the students’ levels of satisfaction (or dissatisfaction) with the various topics covered by the interview schedule. Such software would also have enabled a degree of quantitative analysis by counting instances of the various responses and thus indicating their significance. However, I rejected this approach in favour of a more rudimentary, manual coding approach for three main reasons. Firstly, a central caveat of this study is that it is concerned with the students' perceptions and therefore giving voice to them directly and accurately is important. NVivo's use of manifold synonyms could lead to only partial retrieval of the data and I wanted to ensure that the students' tone of voice and implied meanings were captured in the analysis. Secondly, my insider/outsider stance makes an essential, methodological contribution to the thesis and the information from the conversations that I held with the students came to light through carefully crafted interplay between them and myself. As such, I wanted to retain complete control of the analysis to reflect the findings in the congenial way in which they were obtained. I felt that NVivo would make it too easy to disengage with my data and therefore from the participants themselves. Finally, on a purely practical level, my sample size was small so there was simply less need for qualitative analysis software.

A simple reading frame was created to help maintain a focus on the research objectives and references made to any of the following points were highlighted in each transcript:

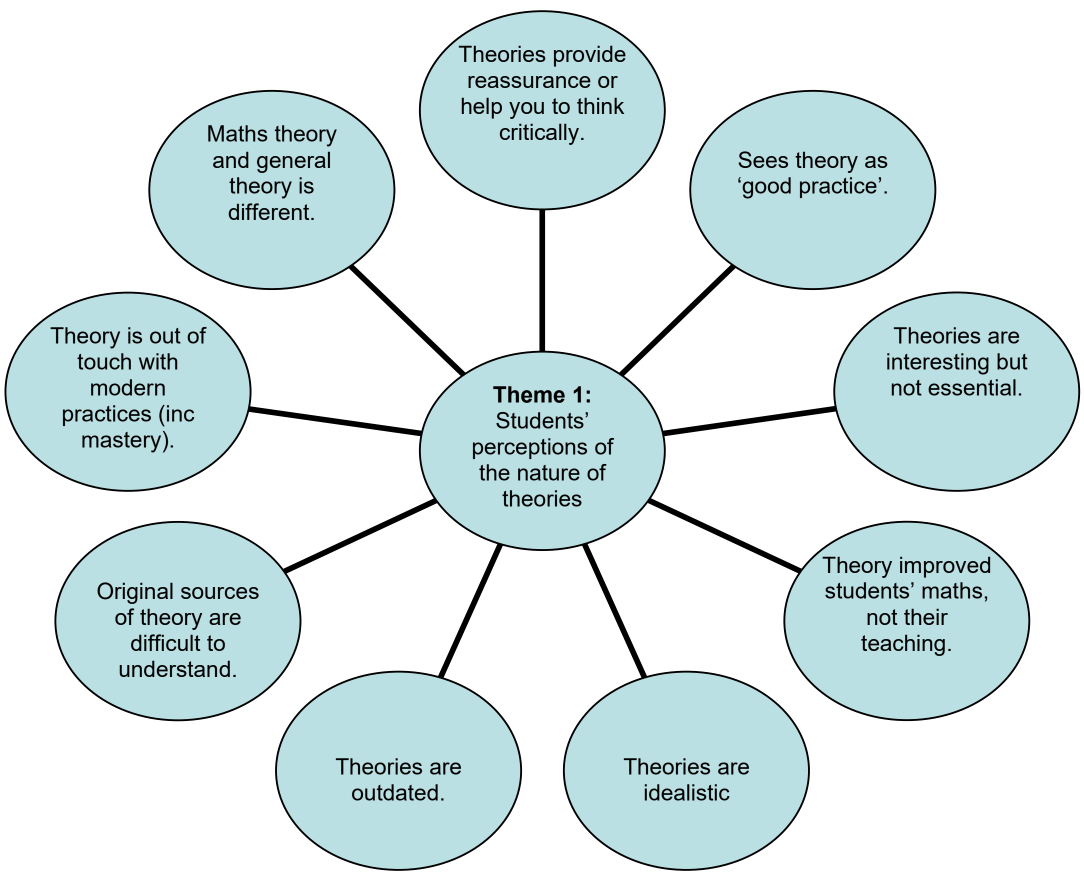
1. The things that the students found easy or difficult.
2. Their reasons for or explanations of their actions.
3. Opinions expressed about theories or any aspect of their work at school and university (including course literature).
4. References to the mastery curriculum.
5. Direct references to 'a gap' between theory and practice.

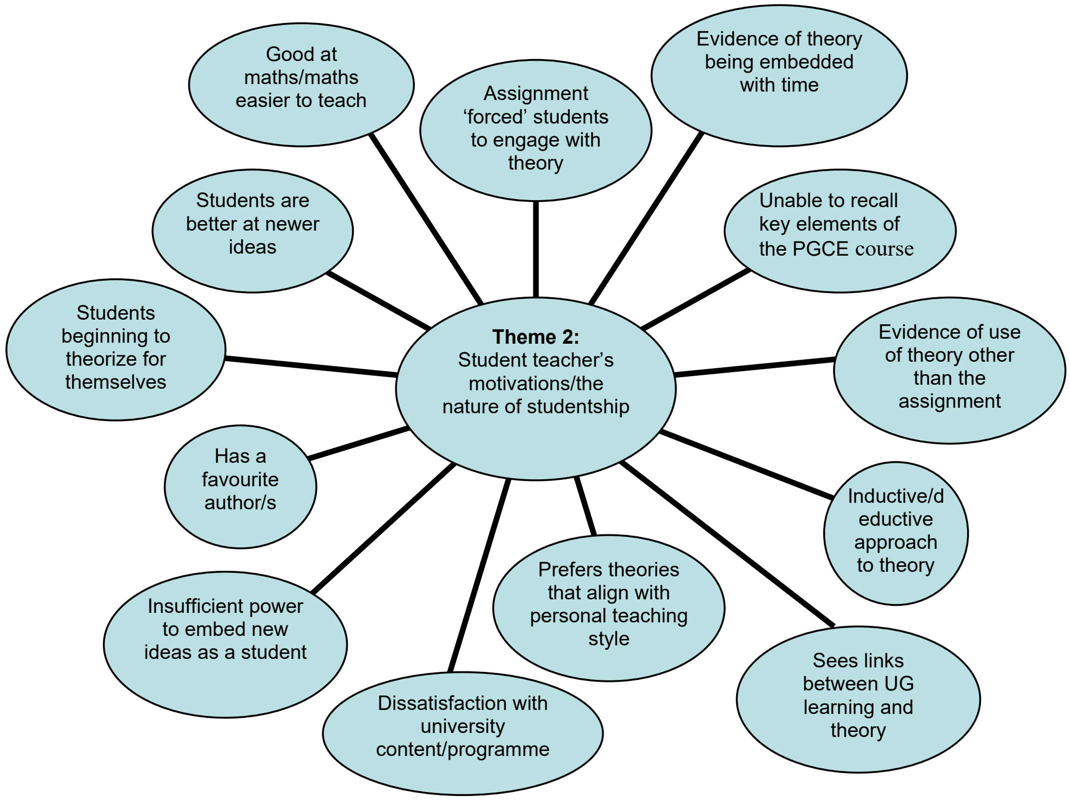
Any references to the above were recorded alongside the page number of the relevant transcript and colour coding was applied to responses that were common to two or more interviews (see Appendix 6, p. 273).

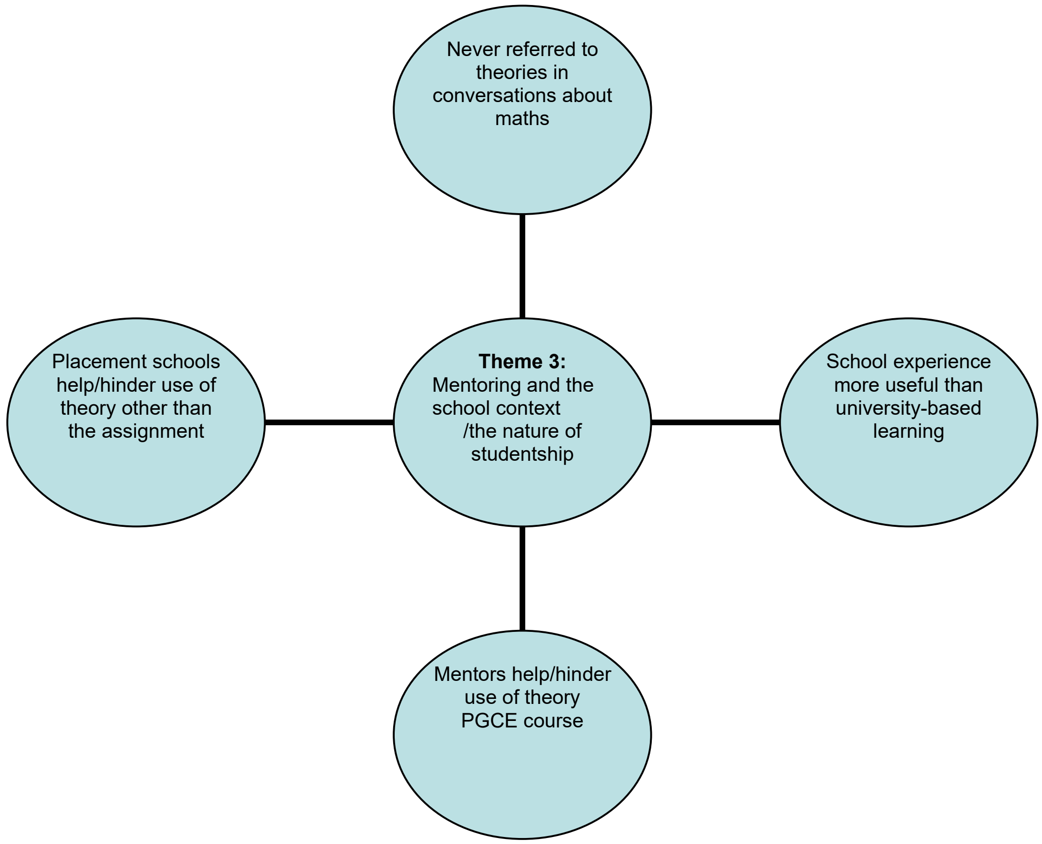
To give an indication of the significance of each response, an analysis grid was produced to indicate the number of times that each response was given and those areas where more than half of students agreed were deemed significant (see Appendix 7, p. 279). A third layer of analysis followed where commonalities between individual responses were sought and five key areas of significance emerged:

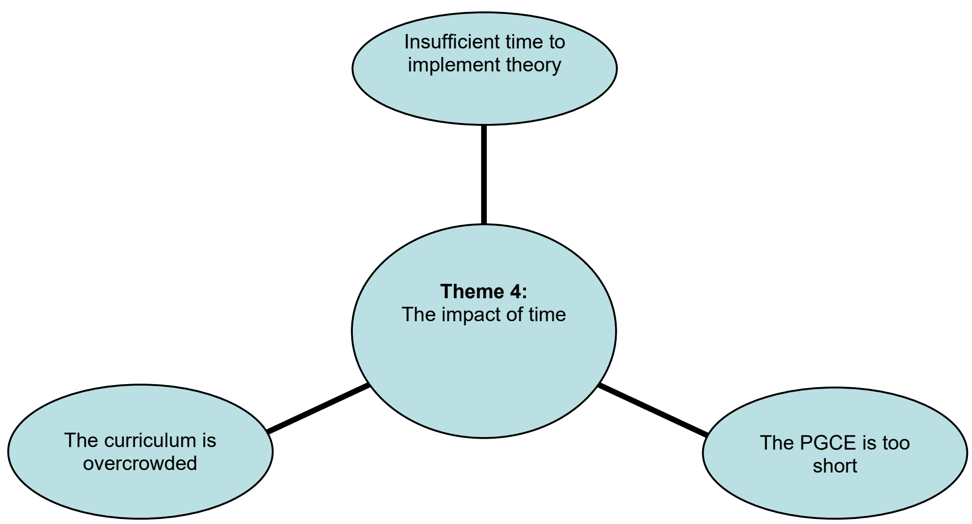
1. The students' perceptions of the theories affected their engagement with them.
2. The very nature of studentship and the students' motivations had an impact on their use of educational theories.
3. The school context and the quality of mentoring could either enable or constrain the students' attempts to make use of educational theories.
4. Time had a significant impact on the extent to which students used educational theories.
5. A 'gap' exists between theory and practice and it is a tangible entity whose nature can be defined.

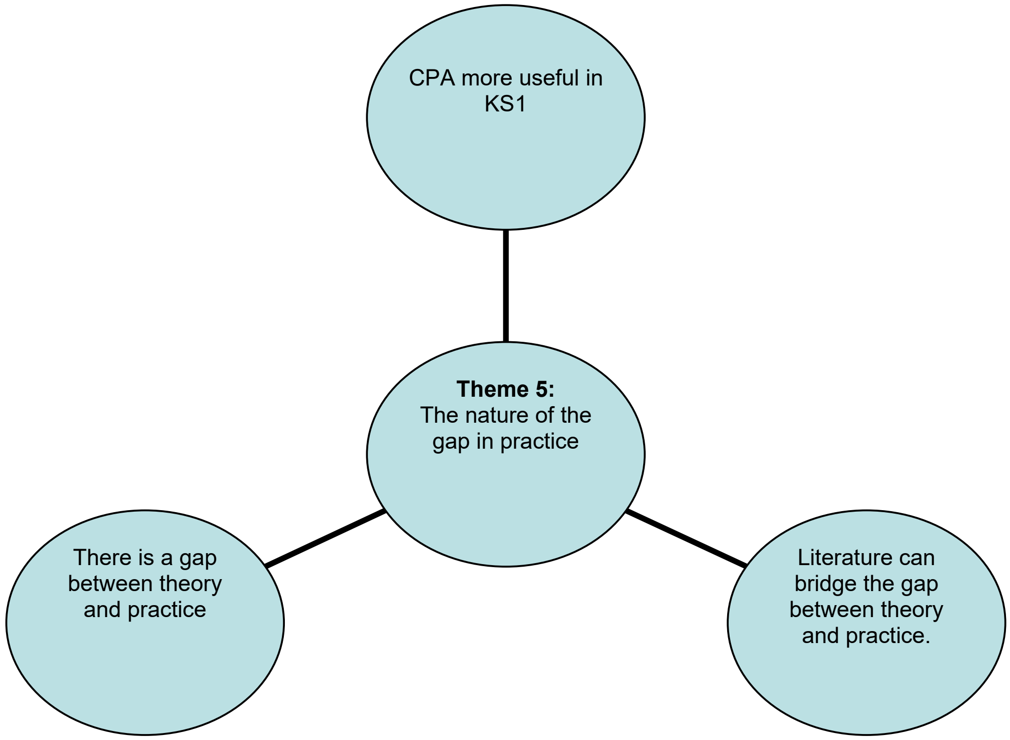
The diagrams below demonstrate how the common responses from the interviews contribute to each theme:




Theme 2:
Student teacher's motivations/the nature of studentship
Good at maths/maths easier to teach
Assignment 'forced' students to engage with theory
Evidence of theory being embedded with time
Students are better at newer ideas
Unable to recall key elements of the PGCE course
Students beginning to theorize for themselves
Evidence of use of theory other than the assignment
Has a favourite author/s
Inductive/deductive approach to theory
Insufficient power to embed new ideas as a student
Prefers theories that align with personal teaching style
Sees links between UG learning and theory
Dissatisfaction with university content/programme


Never referred to theories in conversations about maths
Placement schools help/hinder use of theory other than the assignment
Theme 3: Mentoring and the school context /the nature of studentship
School experience more useful than university-based learning
Mentors help/hinder use of theory PGCE course


Insufficient time to implement theory
Theme 4: The impact of time
The curriculum is overcrowded
The PGCE is too short



7.2 Vignettes

With the themes established, it seems apt to return to the students whose contributions are at the heart of the generalisations and recommendations that I will make through the final chapters. While their responses have been grouped and thematised, the nature of their experiences both before and during their teaching practice make a varied and individual contribution to the data. To conclude this preface, I present vignettes that I hope will help retain their individuality as well as provide a context with which to frame their responses to the interview questions.

Hobson (2003) proposes a three-fold typology for classifying student teachers that is based on their approach to using theory as they learn to teach. Firstly, ‘proceduralist apprentices’ are those students who desire practical approaches to apply in the classroom and have limited interest in the theoretical aspects of their training. Similarly, ‘education-oriented apprentices’ are primarily concerned with the development of their practical classroom craft although they acknowledge that they should also ‘Acquire a certain amount of ‘background knowledge’ about teaching and education’ (Hobson, 2003, p. 254). The final way in which student teachers are classified by Hobson’s typology is as ‘understanding-oriented learners’. Such students show interest in the concepts that underlie their practice and they actively engage with theory in order to reflect on and improve their practice.

Hobson’s (2003) typology is a useful lens through which to view a student’s approach to theory although it does not take account of the developmental nature of learning. It seems more likely that a student’s approach to using theory may change over the course of their training. A student in the early stages of their training is likely to be predominantly occupied by how to teach (making them a ‘proceduralist apprentice’) while later in their training, and having learned more at university, they could develop into more of an ‘education-oriented apprentice’ then an ‘understanding-oriented learner’. Cheng et. al. (2012) propose a similar, three-fold typology for the classification of student teachers. They suggest that students may take a ‘procedural approach’, a ‘reflective-adaptive’ approach or a ‘reflective theorising approach’ to combining theory and practice. Unlike Hobson (2003), they acknowledge that the different approaches are hierarchical and that students can (and indeed should) progress through each stage as they train to teach. However, I believe that rather than being developmentally progressive, different approaches actually take precedence at different points of the PGCE year. For example, when out on teaching practice, it seems natural that a student would be primarily concerned with developing their repertoire of teaching approaches and therefore exhibit the traits of a ‘proceduralist apprentice’. Conversely, on their return to university and when learning about theories, the traits of an ‘understanding-oriented learner’ are likely to come to the fore. Rather than simply falling into one of Hobson’s (2003) categories by preference, I argue that the nature of the PGCE and its structure actually imposes one of the categories on the students at different points in their training. This is exemplified later in this chapter when I describe Eve’s approach to using theory.

With this said, Hobson’s (2003) typology does provide an unambiguous snapshot of a student’s approach to theory at a given point in time. As such, as well as contextualising the responses given by each student in their interview, each vignette will end with an attempt to define their overall approach to theory *at the point of interview* in terms of Hobson's (2003) typology.

7.2.1 Student 1 – 'Emily'

Emily is a female, under 25 student from an education background. Before commencing the PGCE, she studied for a joint honours degree in education and early years with the intention of going on to be a primary school teacher. As part of her undergraduate degree, she reported that she had already encountered educational theory in the form of constructivism and behaviourism. She also stated that she had an understanding of psychology and child development. She defined educational theory as:

> 'Theories around education [that] help us understand how children learn and how the brain could work.'

Her perception of maths (and the reason why she chose it as her mathematics as her area of strength) was that it was more challenging than English or science and that it would therefore make her 'stand out'. By this, she meant that it would make her more desirable when seeking employment. Her assignment focussed on the use of Bruner's Modes of Representation in KS1 and she admitted to finding this difficult when coupled with the requirement to differentiate tasks for different abilities within the classroom. This immediately suggests that her chosen focus for her university assignment was at odds with the practical reality of the classroom. That said, she reported that she learned most about teaching maths through conversations with teachers at her placement schools and she valued the ideas of those teachers and university tutors who had practical experience to share rather then those that discussed educational theories with her. Despite this, she felt that educational theories had had a significant impact on the way that she teaches maths. In preparing her assignment, Emily read lots of educational texts although the majority of these were texts that she has become familiar with from her undergraduate degree, rather than those suggested on her PGCE reading list. Hobson (2003) might describe Emily as an 'education-oriented apprentice'.

7.2.2 Student 2 – 'Tara'

Tara is a 26-30 year old female student from an education background. As well as completing her undergraduate degree in sports education, she was also a teaching assistant in a primary school before commencing the PGCE. She had a foundation in psychology and human development and she defined educational theory simply as:

> 'The theory of how children learn effectively.'

She chose to specialise in maths because she found it easier to teach than English or science and she enjoyed doing maths herself. She attributed this to the sports science degree that she had completed that had more of a mathematical and scientific basis. She learned the most about teaching maths by teaching for herself and she turned to teachers at her placement schools for help when she needed it. During her interview, she was critical of the university's teaching of educational theories. She felt strongly that the university had failed to provide sufficient links between theory and practice and in particular, that she had not received enough guidance on teaching for mastery. She wrote her maths assignment about teaching multiplication arrays and chose to contrast Vygotsky's notion of scaffolding with Skemp's idea of instrumental learning. She did lots of reading for her assignment, but admitted that she had not referred to any of the recommended texts since completing it. That said, she made a clear link between her ability to theorise and being well-read. As her interest in theory did not extend beyond the writing of her assignment, in Hobson's (2003) terms, she is a 'proceduralist apprentice'.

7.2.3 Student 3 – 'Eve'

Eve is an under 26 year old female student who, prior to commencing her PGCE, completed an undergraduate degree in early childhood studies. As such, she had already encountered significant works of educational theorists – Piaget, Bandura, Vygotsky, Skemp, Brofenbrenner and Pavlov – before beginning her teacher training. Interestingly, her definition of educational theory did not refer to any of them, but seemed to be rooted in different approaches to teaching:

> ‘Theory that is applicable to learning e.g. how to teach, strategies, approaches and effects.’

Eve chose maths as her area of special interest because she found it easier to teach than English or science. She explained that this was because she ‘liked the logic behind it.’ When faced with difficulties with her maths teaching, Eve asked the teachers at her placement school in the first instance and she reported that she learned the most while watching more experienced teachers teaching maths while she learned the least from her maths lectures and seminars at university. Like Emily, she chose to focus on Bruner’s Modes of Representation when writing her assignment. It is interesting to note that, during her interview, Eve was unable to recall the topic that she chose for her assignment to begin with; she said that it had felt like a ‘long time ago’ and that she had felt like there was ‘no time to think or reflect’ on it. By her own admission, Eve did not do any of the ‘useful reading’ recommended in lectures. While she did refer to texts when writing her assignment, she found them difficult to engage with and she preferred reading from websites that made more explicit links to modern classroom practices. While this could be a symptom of a busy PGCE year, it could also indicate the extent to which the writing of her essay had a lasting impact on her practice. She agreed that learning theory made her a better maths teacher, but she strongly disagreed that her school-based mentor knew lots about educational theory. This does beg the question of how she managed to engage with theories in a meaningful way without guidance on their use while at school. Hobson (2003) might describe Eve as an ‘education-oriented apprentice’ although she seemed frustrated by her level of engagement with theory and there is a sense in which her lack of opportunity to reflect placed her into this category by default. Her responses in interview suggested that she was an ‘understanding-oriented learner’ at heart.

7.2.4 Student 4 – ‘Fran’

Fran is a 26-30 year old female student who completed her undergraduate degree in sports coaching. As part of this, she reported that she had encountered ‘social capital’ theories and she made some clear links between what she had learned as an undergraduate degree student and teaching and learning. The coaching aspect of her degree had inspired her to work in education. Before embarking upon her

PGCE, she was a teaching assistant in a secondary school. Her partner is a primary school teacher and during her interview, she expressed some very clear views on education and she even made some recommendations for how ITE programmes could be improved. She defined educational theory as:

> 'Anything which relates to the education of students (any age) and helps to progress/inform their learning.'

It is interesting that her definition emphasises that theories could relate to students of 'any age'. This may simply have been because that, at the point that she completed my questionnaire, she had both primary and secondary classroom experience (and, no doubt, insights from her teaching partner) but it could also suggest a deep engagement with the theories as a student teacher herself. She reported that she learned the most about teaching maths when teaching children herself and she most readily sought advice from other teachers at school when required. She chose to specialise in maths because her own ability in the subject is good. Indeed, she felt that her own mathematical understanding was almost too well-embedded to disseminate for children. When it came to her assignment, Fran chose to focus on Skemp's 'Relational and Instrumental Understanding' with Year 1 children. She chose this because she felt that this would be the easiest of the theories she had learned about at university to implement with the young children in her class at her placement school. With that said, like Eve, Fran was unable to remember the subject of her assignment to begin with. She had some very clear views on the literature that she engaged with as part of her PGCE. Indeed, she spoke with contempt about the 'big, fat, boring books' on the reading list and she reported that she preferred shorter articles that were easier to read and from which she could seek quotes to support and contradict the points that she wanted to make in her assignment. Like Tara, Fran only saw the value of literature and theory insofar as it helped her to complete the assignment so she falls into Hobson's (2003) category of a 'proceduralist apprentice'.

7.2.5 Student 5 – 'Owen'

Owen is a male student who is under 26 years old. Like Tara and Fran, his background is sports-based and he completed his undergraduate degree in sports education and coaching. As part of this, he reported that he encountered theories and cited ‘reflective practice’ and ‘pedagogy’ as examples. He chose maths as his area of strength because his own personal maths skills are good; he was keen to study for an A Level in maths, but it was not possible for him to combine it with his other chosen subjects at school. His definition of educational theory was interesting as it alluded to both theory and practice. He said that,

> ‘Educational theory is the theory of education and what areas of study are underpinned within teaching practice.’

This suggests that, for Owen, educational theories are generated through teaching practice. He also pointed out that educational theories were ideas about teaching and learning that are studied by those training to be teachers. When faced with problems or the need for advice, Owen chose to approach the maths subject leader at his placement school and he learned the most about maths teaching when talking to his mentor and teachers at school. He claimed that an understanding of psychology and child development have supported his learning about teaching and learning in maths. Owen chose to focus on the ideas of Skemp and Bruner for his assignment and he felt that Skemp, in particular, reflected his preferred approach to teaching maths. This was clearly of importance to him and the reason why he felt that he did not relate well to Vygotsky’s ideas. That said, he made repeated reference to the concept of ‘scaffolding’ (a key component of Vygotsky’s ‘Zone of Proximal Development’) throughout his interview. While he felt that learning theory had, at times, been ‘a bit boring’, Owen acknowledged that it was valuable and that it helped him to be a better teacher of mathematics. As such, Owen is perhaps best described as an ‘understanding-oriented learner’.

7.2.6 Student 6 – ‘Leanne’

Leanne is a female student within the 41-45 age category. She completed an undergraduate degree in computer science and she was unable to remember whether this included any learning about theories because, in her words, ‘it was over 20 years ago’. She had well-principled reasons for choosing to develop a strength in mathematics; she felt strongly about women engaging in STEM subjects and she recognised the importance of maths in ‘real life’ situations. Her own definition of educational theory was:

> ‘It is about the different ways that children learn – styles, approaches, resources etc.’

Like Owen, Leanne reported that she would approach, in the first instance, the maths subject leader at her placement school if she required support with an aspect of maths teaching. She learned the most about maths teaching by teaching concepts for herself and she reported that she learned the least from her maths lectures and seminars at university.

She said that an understanding of child development helped support her learning about maths education. Interestingly, her knowledge and understanding of this seems to have come informally through the experience of bringing up her own children rather than through any formal education or training. Indeed, she drew on examples of her own children’s mathematical development throughout her interview. Her essay was based on Bruner’s Stages of Representation and she did lots of reading to support the writing of her assignment. She particularly valued Askew’s (2012) book, Transforming Primary Mathematics because it was easy to read and she referred to it throughout her PGCE and not simply when she was writing her assignment. Leanne is therefore best described as an ‘education-oriented apprentice’.

7.2.7 Student 7 – ‘Molly’

Molly is a female student in the 26-30 year old category. She completed her undergraduate degree in business management and did not remember whether it contained any significant theoretical content. She chose to specialise in mathematics because she enjoyed the challenge and open-ended nature of mathematics. Her definition of education theory is:

> ‘Learning about the ideas of teaching in the most effective way to provide children with the opportunities to progress in their understanding, knowledge and skills.’

When faced with a problem with her maths teaching, she chose to approach her sister, who has a maths degree, rather than teachers at her placement school or university tutors. This suggests either that Molly's main difficulties with maths teaching were predominantly concerned with her own subject knowledge, or that she associates a high level of mathematical understanding with an ability to teach concepts effectively to children. Regardless of which is the case, she reported that she learned most about teaching maths when teaching concepts for herself. She chose to focus her assignment on the ideas of Skemp, Bruner and Vygotsky because she felt that they fitted best with her preferred style of teaching and she used them as evaluative lenses through which to review her own practice. Like Leanne, Molly valued Askew's (2012) text and she carried out plenty of reading for her essay. Interestingly, she also sought a text not on the reading list because it contained simplified versions of learning theories. While this suggested that she sees theories as complicated and difficult to understand in their original form, it also indicates her desire to understand and make use of them. This suggests that Molly should be classified as an 'understanding-oriented learner'.

7.2.8 Student 8 – 'Sarah'

Sarah is a 36-40 year old female student who, before embarking upon her PGCE, worked as a teacher in the private education sector (A Steiner Waldorf school). As such, she already had significant classroom experience before beginning her journey toward QTS. In conversation with her, she revealed that she chose to study for a PGCE to increase her understanding of mainstream education whilst broadening her employment prospects. Despite studying for an undergraduate degree that, according to her, did not contain any theoretical learning (a BSc in geology), her own definition of what educational theory actually is reveals her experience of working in educational settings:

> 'A vast collection of ideas from many different sources based on a combination of observational and/or experimental research (in an education context) that is continually changing and being updated to inform teacher on the most effective ...'

As her own, rather lengthy, definition of educational theory suggests, Sarah sees theory as the basis for how children learn and the best method for allowing access to teaching.

Sarah had read lots of books about teaching and learning. It is interesting to note that many of her ideas about theory came from her interest in (and reading about) Steiner. When struggling for ideas for maths teaching, she would more readily seek support from books or the internet than from teachers and, unlike all others interviewed, Sarah said that she learned the most about maths teaching during maths lectures and seminars at university and that she actually learned the least when teaching ideas for herself. That said, she admitted that she did not do as much reading as she wanted although she agreed that learning theory made her better at teaching mathematics. Despite this, Sarah definitely falls into the category of an ‘understanding-oriented learner’.

7.3 Thematic analysis and discussion

The following chapter analyses and discusses the five key themes to emerge from the interview data. To begin with, I will discuss the nature of the theories themselves and the impact of their presentation to students (through reading and lectures) on their engagement with them. As with all of the themes discussed in this section, the views presented are those of the students and of *their* perception of the nature of educational theories. I will persevere with a pragmatic approach that acknowledges that there could be a number of ways in which data could be interpreted.

7.4.1 The matryoshka effect

As this thesis is concerned with teaching adults to teach children, I am aware that it gives rise to a complex, multi-layered narrative. Arguably, any educational research is a study of study and in this instance it involves the concepts of teaching students to teach, theorising about adults who are theorising about children (using theories as a vehicle) and interpreting students’ interpretations of literature. Further complexity is added because the theories taught to students are theories of child learning (pedagogies) while there are separate theories of adult learning (andragogies) that apply to their learning about them. This forms part of a concept that I have chosen to call the matryoshka effect. This is because, like the layers of a Russian doll, research into teaching new teachers to teach and encouraging their learning about learning is a repetitive and deeply complex phenomenon. While each layer is bound by similar concepts (namely, teaching and learning), each layer also demands that learners use and apply the concepts in different ways. The use of visual imagery will help to encapsulate the essence of my findings that show how the layers can either impede or facilitate learning. The matryoshka effect as it applies to teacher education research is tentatively represented in the diagram below:

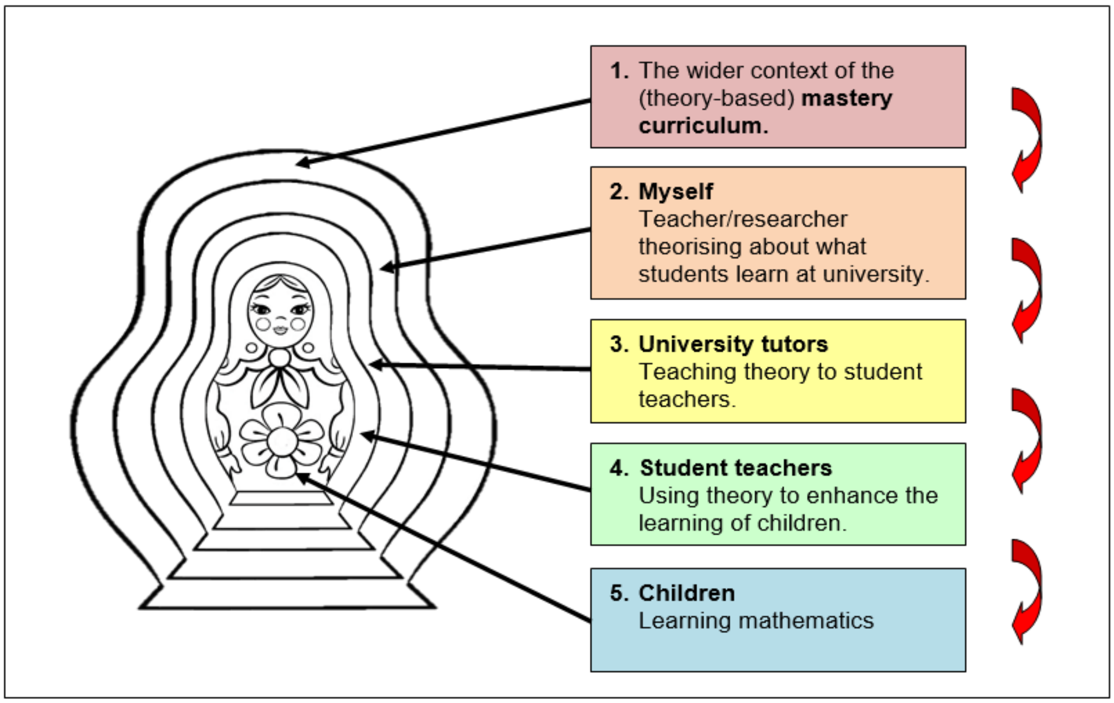


Figure 4: A diagrammatic representation of The Matryoshka Effect as it applies to teacher education research

As the diagram suggests, theory has to be used and applied in many different ways before any insight into the ways in which children learn can be gained. This gives rise to a complex, multifaceted consideration of both theory and practice that can, at times, be difficult to convey through language and difficult to implement effectively as a layered learning model.

7.4.2 Matryopraxis

The complexity of research into teacher education is mirrored in the process of learning to teach and the majority of texts about teacher education allude to these intricacies in some way. While many make reference to balancing theoretical and practical aspects of training, few scholars attempt to define the epistemological roots of the issue. In a study of teachers' self-regulation, Kramarski and Kohen (2017) begin to do this. They point out that a student teacher must assume, at different points, a 'learner's role' and a 'teacher's role' (Kramarski and Kohen, 2017, p. 158). Indeed, being both teacher and taught means that an awareness of both perspectives is important. They also suggest that a student teacher needs to 'understand their own and their students' metacognitive and motivational processes' (Kramarski and Kohen, 2017, p. 159). This suggests that learning about their students' ability to learn is also crucial. Korthagen et. al. (2008) define this as 'the congruence principle' which suggests that there is indeed a similarity between the aims of teacher education and children's learning in school and that this must be made explicit to student teachers. According to Korthagen et. al. (2008),

> It may help student teachers to see the process they are going through, including the struggles they encounter when learning to reflect on their experiences, as an important preparation for helping students in school go through the same kinds of processes. Reflection by student teachers on the ways their teacher educators model the helping process may add another dimension to learning to teach. (Korthagen et. al. 2008, p. 48)

This clearly suggests that modelling on the part of teacher educators is vital for students to see the link between their own learning and that of the children. In addition to the 'helping process' that they mention, I might add that teacher educators may need to model explicitly approaches to teaching mathematics both in terms of the content of *what* they teach and the *way* that they teach it.

I believe that the matryoshka effect can also offer a viable way of understanding how students learn to teach and therefore how children learn mathematics. It provides a way of understanding the process by which theory and practice connect and interweave and as such, provides a way of understanding praxis. I therefore propose a 'matryopraxis' model for understanding the complexity of learning to teach mathematics that is represented in the diagram below:

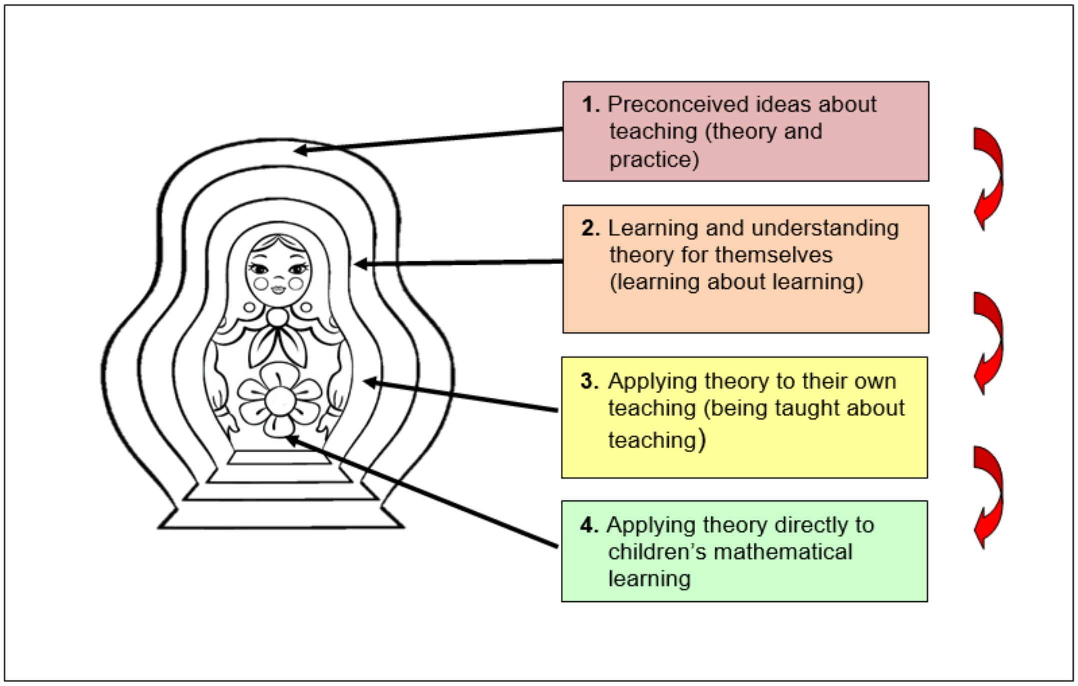


Figure 5: A diagrammatic representation of a 'matryopraxis' model for understanding the complexity of learning to teach mathematics.

As this suggests, matryopraxis involves a number of layers of understanding that must be established before students are able to consider the children's learning and yet, as I shall discuss throughout the remainder of the thesis, student teachers are seldom able to reach the core of the children's understanding during the course of their PGCE.

7.5 Pedagogy or andragogy?

In Chapter 2, I draw a clear distinction between pedagogy and andragogy that is based on the assumption that children and adults learn in fundamentally different ways. In Chapter 2, I suggested that adult education is more complex than the education of children because of the huge variation in the adults' experiences prior to commencing their PGCE. Indeed, it seems unlikely that a 'one size fits all' approach to teaching all students to teach could actually work. This is certainly true of the eight students interviewed for this research since some of them had spent no time in primary classrooms since they were children themselves, others were experienced teaching assistants and one was a teacher at an independent school for a number of years. Despite this, all were taught together and expected to engage with educational theories in a similar way. I believe that pedagogy can actually be gainfully applied to the ways in which adults learn. Indeed paradoxically, the data suggest that as well as being a one of the key theoretical ideas studied by the students at university (to use in their *teaching*), Bruner's Modes of Representation can also be applied to describe the ways in which the students preferred to *learn* about and apply theories.

The relationship between teaching and learning is one of interest. The questionnaire data show that students see theories as most relevant to children's learning although the data also contain a surprising paucity of any reference to children learning mathematics. Only in the interviews with Tara and Leanne was there any mention of how the children responded although this was asked about directly. I also propose that the students separated teaching from learning and they did not think that theories related directly to children's learning. Rather, they used theories as approaches to teaching and paid little attention to the impact of this on the children's mathematical development. In short, they were primarily concerned with their own learning and the ways in which educational theories can support them.

Chapter 8 - Data presentation and thematic analysis - Part 1

Five key themes arose from the interview data. The first two are determined by intrinsic aspects and are brought about by the students themselves. The final three themes are determined by extrinsic factors that are arguably beyond the students' control. Those themes that relate to intrinsic factors are discussed in this chapter. These are the students' perceptions of the nature of theories and the nature of studentship. A discussion and analysis of those themes that derive from extrinsic factors follows in Chapter 9.

Theme 1: Students' perceptions of the nature of educational theories

> ***… some of them [theories] were created like, a long time ago. I preferred to use the further reading that was more up to date because it relates more to modern practice.*** (Conversation with Eve, p. 31)

8.1.1 Introduction to Theme 1

As this study is concerned with student teachers' perceptions, it seems pertinent that the first theme that I will explore will give voice to them directly and discuss their perceptions of the nature of educational theories. This includes both the students' preconceived ideas about the usefulness of the theories as well as their perception of this after they had actually used them in practice. It gives an insight into the students' perceptions of the relevance of the theories in relation to modern practices (including the 'mastery curriculum') as well as their level of interest in them. This section also explores the impact that the way in which theories are presented to students has on their attitude toward them. This is strongly associated with constructivist perspectives that emphasise the importance of individuals creating their own, meaningful links with new ideas.

8.1.2 Theory versus practice

Biesta et. al. (2014, p. 1) suggest that it is not appropriate to establish *'unhelpful dichotomies'* such as *'theory versus practice'* because they do little more than give theory *'a bad name'.* While this thesis does not seek to denigrate either theoretical or practical aspects of the PGCE, 'theory versus practice' does seem to be a fitting term to adopt because the overriding sense from the interview data is the extent to which students separated theory and practice at a conceptual level. Some students felt that educational theories were too idealistic to be of much use to them. Leanne suggested that for her, theories did not reflect the reality of the classroom:

> *I think having knowledge of all the learning theories in the world does not ever fully equip you to take those into the classroom because there are those external factors. You know yourself, you don't know how the children are going to be on a day-to-day basis, you know, they might look at the blocks one day and go, "Oh yeah, those are blocks" and then next day, they might think, "I'm going to pick these up and throw them across the classroom!"* (Conversation with Leanne, p. 12)

In Leanne's example, the need to managing the children's behaviour was sufficient to inhibit her use of theoretical ideas in school. She suggested that theories were things to aspire to and, by their very nature, not entirely attainable. This is in keeping with Husbands and Pendry's (2000) view that trainee teachers struggled to make use of knowledge that did not directly support their day-to-day classroom practice at that point in time. Fran supported this idea by suggesting that trying to implement too many theoretical ideas can be overwhelming for both children and students alike. However, both Molly and Emily perceived theory to be representative of 'good practice'. Whether or not theories do actually represent 'good practice' or whether it is the students' perception that they do is an interesting question. Indeed, Sarah alluded to a temptation to value certain theoretical ideas simply because they have been produced by well-known and prolific thinkers and not necessarily because they had engaged with them critically, used them and found them to be effective. For example, she voiced some uncertainty over the work of Piaget and questioned the validity of his research methods (Conversation with Sarah, p. 12). Whether or not being put forward by a well-known author (who invariably observed and tested their ideas with children in a relevant context) 'proves' the validity of an idea, or whether 'proof' is created when individuals try them for themselves remains unclear, but it seems that theories do come with a weight and status that is attractive to students.

8.1.3 The incidental nature of learning about theory

As many of the students described theories as underpinning good teaching, I am able to propose that theories (or their effect, at least) may have actually been encountered by students without them being taught explicitly at university.

During her interview, Molly suggested that it may be possible to *'bump into [theories] while you're teaching'* (Conversation with Molly, p. 23). This suggests that, as theories are seen to underpin teaching, it may be possible to encounter them incidentally in your day-to-day practice. While this does mean that students must have a basic understanding of educational theories *before* they go out into schools (in order that they recognise them in action), it does suggest that Molly felt confident that theories are indeed reflected in everyday, classroom practice and that they can be encountered almost by accident.

While some of the students saw theory as simply 'good practice' and that they manifest themselves in effective teaching, they were less clear about whether theories were firmly embedded in their own teaching. Indeed, it was only Sarah who reported that theories were sufficiently engrained in her practice for them to be used without effort or explicit intention to do so (Conversation with Sarah, p. 13). Sarah cited the example of partner and small group discussion advocated by Vygotsky as being part of her day-to-day practice. Perhaps this is unsurprising considering that Sarah was an unqualified teacher of significant experience before commencing her PGCE and that she showed a strong, personal interest in educational theories. That said, Molly felt that, when theories had become internalised, true reflection and evaluation of one's practice ensues (Conversation with Molly, p. 23) and the conversations that she had with others about her mathematics teaching became more meaningful and more beneficial. Higgs (2013, p. 106) describes this as 'critical astuteness' that helps teachers to determine the most relevant and effective practices for the classroom without being preoccupied by 'ideological and political concerns' that may dominate when theory remains an additional, indeed peripheral entity.

8.1.4 Theories are interesting, but not essential

Three of the eight students interviewed felt that educational theories were interesting, but that they did not necessarily make an essential contribution to their learning and development as teachers. For example, when asked to recall an instance of where educational theories had been useful to her when on a placement, Fran was hesitant in her response:

> *Um…. [Pause]….I don't know if useful is the right word! I found some of them interesting and sort of got some nice ideas for the kids from theories but again, that was because uni had said, 'You need to do this with this theory or you need to do this.' It wasn't because any of the teachers thought, um, they might be useful or anything like that.*
> (Conversation with Fran, p. 14).

Interestingly, she was hesitant in her response to begin with and this suggests that she considered her point about theories being of limited use may be, in some way, controversial and that perhaps theories ought to be more useful than she had found them to be herself. She also seemed to value autonomy when it came to the application of theory and suggested that her interest in some theoretical ideas was somehow spoiled by *having* to use them and that they may have had more credibility had they also been promoted and situated by teachers at her placement school. In her view, using theories was an interesting activity that enriched her practice rather than being fundamental to her development (Conversation with Fran, p. 14). It is clear that engaging with theory was not a significant priority for her and that theory might be more a source of enrichment rather than fundamental to understanding of teaching and learning. Jackson and Eady (2008) warned that at master's level, if student teachers are to bridge the gap between theory and practice, it is essential that they do not *'divorce the one from the other'.* Indeed, it seems that Fran had done just that to the extent that theory had become the 'irrelevant bolt-on' that they describe (Jackson and Eady, 2008, p. 8).

Conversely, Owen suggested that theories were essential to his thinking as a student and that they will continue to be of use to him in the early stages of his career. That said, Owen felt that this usefulness was temporary in nature (Conversation with Owen, p. 9).This suggests that for some students, theories are their armour: a failsafe set of familiar ideas that they can return to for comfort when they are unsure. When asked if he would continue to refer to educational theories when qualified, Owen was emphatic in his response:

> *Definitely for the first couple of years while I try to get into the swing of things as an NQT, try to use things that you've learned on the PGCE, putting it into practice. Obviously, once I get to know it more, it'll kind of be embedded in my practice so I won't have to kind of refer to it constantly.* (Conversation with Owen, p. 8)

This implies that, rather than dispensing with the protection afforded by the theories in the early stages of his career, Owen would continue to make progress in his theoretical understanding once qualified to the extent that the theories became embedded in his practice. Far from disappearing, the theory would become an irreversible part of his practice. This suggests that theory and practice can have a symbiotic, rather than a disparate, relationship. For Leanne, theories provided 'armour' in a very specific way:

> *Surprisingly, I've used a lot of notes from uni in all of my placements. Not to teach me how to… about the subject matter for a lesson, but more just things to think about.* (Conversation with Leanne, p. 13)

To begin with, it is interesting that Leanne did not expect her university notes to be of any use to her while on teaching practice and was surprised that they were. While she acknowledged that theories would not be able to provide her with practical lesson ideas, this suggests that they would provide her with a framework through which to consider her practice. Owen had a similar experience and reported that theories had provided him with '….*the understanding of how children learn….'* (Conversation with Owen, p. 21/22). His reference to giving him *the* (rather than *an*) understanding of how children learn alludes to the high-esteem in which he holds educational theories. That said, he also acknowledged that mastery may not be the only approach to teaching maths and this suggests that he is able to view curricular developments critically and does not simply take and apply them at face value. This also suggests that for students, theories enable them to think critically about approaches to teaching and this is in keeping with Thomas' (2011, p. 2) view of theory as, 'The thinking side of practice.'

8.1.5 Theories are boring

Despite the protective armour that theories can provide, many of the students expressed a lack of interest in learning about them. Owen felt that the prospect of learning about theories may be enough to put students off to the extent to which they could be closed to the messages that they contain even before they had the time to engage with them in a meaningful way. He implied that the effort involved in learning about theories could be a barrier to students' engagement with it:

> *Obviously at first, when you get told that you've got to learn about all of it, it can be a bit of a put-off - how much you've got to read about – but when you get into it, the nitty gritty bits, then it's really beneficial.* (Conversation with Owen, p. 22).

As this is concerned with the mode of study rather than to do with the ideas themselves, it does lead me to question whether the theories, by their nature, are inherently 'boring' or whether students find the way in which they learn about them cumbersome. Fran shed some additional light on this in her interview when she bemoaned *having* to learn about theories through *'boring lectures'* (Conversation with Fran, p. 12). She also pointed out that, as she learned more about maths teaching through observing experienced teachers teach it than she did through engagement with theory, the theories became an *'annoying distraction'* to her progress (Conversation with Fran, p. 13). This idea of the forced nature of learning about theory and an evaluation of its impact will be explored in greater depth later in this chapter.

8.1.6 Educational theories are outdated

Another theme that is concerned with the nature of theories is that students see them as outdated and, therefore, of limited use to their training in modern schools. The principle theorists that students were taught about (Vygotsky, Dienes, Dewey, Bruner, Piaget, Skemp etc) all produced their seminal works during the middle of the twentieth century. Firstly, it seems significant that 60.61% of students were under 26 years of age and that they found it difficult to relate to ideas published before they were ever born. It is also possible that, with the rapid development that has characterised mathematics education since the inception of the 2014 curriculum, students assume that older ideas simply cannot be relevant to modern practice. Eve, for example, said that she preferred to engage with reading that was *'... more up to date ...'* (Conversation with Eve, p. 31). Of course, it could be possible that the reading that Eve was referring to was actually *about* modern themes and that it was easy to relate to her practice because it was a direct reflection of what she had seen (and was expected to do) in school. It may be that, while the educational theories she had learned about did not describe modern practices, she lacked the experience or motivation to apply them to her modern context. That said, Tara seemed to agree with this stance and pointed out that she likes to read about *'what's going on now'* and that she had subscribed to the NRich and Third Space Maths websites from which she did *'more up to date reading'* (Conversation with Tara, p. 17). However, she did also acknowledge that modern ideas could still be considered works of theory because '[the authors have] *done it. They've done it in their classrooms; they've done it so you could argue that it's theory*.' (Conversation with Tara, p. 18). This suggests that, in her view, theories are simply ideas that have been thought of by educators and that are tried and tested with children. Using this definition, as a teacher and mathematics subject leader, I too have theorised about the best ways of teaching mathematics. For example, I have recently rethought my school's approach to teaching fractions to children in KS1. Traditionally, children are introduced to the concepts of one half and one quarter to begin with as these are easy to model in concrete and pictorial terms and they are also fundamental building blocks of telling the time. However, through practical application, I have discovered that teaching fractions in this way actually inhibits children's understanding of what a fraction is and that an appreciation of a quantity of equal parts can be better gained if children are shown a number of different fractions (7ths, 11ths, 34ths, for example) before they encounter halves and quarters. Having tried this approach with different groups of children and realising that children's conception understanding improved as a result, I am happy to recommend this approach. Whether or not my thoughts about teaching fractions have universal validity and can be considered 'theoretical' remains open to debate, but it does leads me to question whether or not it matters and whether the very term 'theory' (and its connotations) is responsible for some of the students' attitudes toward it.

Whether or not they deserve the status of theories, Owen felt that the work of more recent authors had more credibility than ideas that were put forward in the past. Indeed, he chose to focus his assignment on the work of Skemp rather than Vygotsky simply because his work was produced more recently (Conversation with Owen, p. 4-5). It is important to remember that this is about Owen's choice of focus for his assignment. This could mean that he simply found the work of Skemp easier to write about than other ideas, or that the availability of sources was greater. It does not, necessarily, mean that he found the ideas of earlier theorists (such as Vygotsky) intrinsically less useful. My interview with Sarah shed some light on this as she said that she too would be more likely to read about current mathematics thinking when seeking inspiration in the future. Like Owen, she seemed more drawn to the work of more modern authors and she felt that theories can be difficult to relate to modern practices and the requirements of the 2014 curriculum. That said, she did suggest that older theoretical ideas can be made more useful by the work of more contemporary authors:

> *What has been really useful… is the work by Boaler, Askew and Liebeck. They have looked at various theorists and provide explanations or thinking points about how a particular theory can be transferred to the classroom and used practically.* (Conversation with Sarah, p. 13)

This seems to suggest that educational theories may require a modern, contextual lens through which to view them. While some students are capable of providing this lens for themselves, others need the work of more contemporary authors to contextualise older ideas on their behalf. This is a good example of how concepts must be viable in the mind of the individual to whom they are presented. While some of the students simply dismissed theory as outdated, a constructivist perspective might suggest that students simply do not yet see them as viable models for thinking within their field of experience. This idea will be returned to and analysed at greater depth when exploring the last of my five themes (in Chapter 9) that attempts to define the link between theory and practice.

8.1.7 Simplified versions of seminal works of theory enable greater engagement with them

The final theme regarding the nature of theories concerns the way in which they are presented to students. Specifically, this section explores the value of simplified versions of seminal works and how they support students' engagement with them.

As I discussed in Chapter 5, the reading list for the mathematics strength PGCE module does not contain any original sources of learning theory (i.e. any books written by thinkers such as Bruner, or translations of works by Piaget or Vygotsky). This implies that, to complete the mathematics strength module successfully, students need not engage with or refer to anything written by the theorists themselves and that an understanding of some of their key ideas is sufficient. That said, some of the students that were interviewed reported that they had, in fact, sought the original texts that presented the theories that they were learning about. Emily had consulted an original text by Bruner but felt that it had contained a lot of what she called *'jargon'* (Conversation with Emily, p. 14). Instead, she preferred to read from simplified compilations that presented various works of theory in a way that was easier to understand. Likewise, Tara had attempted to read about Piaget from original texts and she reported that, '... *the language and the way it was written…I just didn't get it.'* (Conversation with Tara, p. 7). It is interesting to note that it was the *language* used to convey the ideas rather than the ideas themselves that Tara found complicated and she spoke about the importance of engaging with theories that she could understand. In her usual, forthright style, Fran said that she disliked *'big, fat, boring books'* (Conversation with Fran, p. 15) and that she preferred to read from shortened articles. Even Sarah, with her extensive classroom experience and interest in theory admitted to finding Piaget's original works *'confusing'* (Conversation with Sarah, p. 12). Despite being a purveyor of Piaget's work, even von Glasersfeld (2002, p. 53) admits that Piaget 'did not always try to put himself into his reader's shoes' and that his writing was part of his own sense making and cognitive construction of ideas. This, he suggests, does not always lend itself to helping the reader's understanding. In Chapter 5, I described how texts about theories are subject to a 'second order interpretation'. This does not mean that anything other than original ideas are somehow second-rate because arguably, even original work fits my description of a second order interpretation and they too have implications for students' understanding and therefore engagement with them.

Applying the theoretical lens of constructivism does provide an insight into the reasons for this. Theories are most readily shared by means of language and, in constructivist terms, this is not the same as sharing an *idea*. Rather, it is telling students about an idea using language that is actually most meaningful to the original thinker. According to von Glasersfeld (2002, p. 12), an additional layer of difficulty arises in Piaget's work when it is translated into English from its original French. He suggests that some translations unwittingly distort the original work to fit their own perceptions and that a pure, Piagetian orientation is extremely difficult to understand from translations. It is perhaps of little wonder, therefore, that students come into difficulty when they attempt to make use of theories because their perception of them is based only on the author's own interpretation and ability to relay their ideas and experiences through the written word. Some of the gap that exists between theory and practice is down to hermeneutics and the students' ability to unravel the original meaning intended by the authors of the texts that they read. Furth (1968) suggests that such problems with interpreting the work of Piaget are based on translation and Piaget's choice of language. For example, there is some ambiguity surrounding Piaget's use of the terms 'representation' and 'internalisation' because he uses the French, *intérioriser* to describe both deep internalisation of concepts as well as functional imitation of sensory motor acts (Furth, 1968, p. 151). As von Glasersfeld concludes,

> There is no way of discovering what he [Piaget] had in mind – not even by reading him in French. All I – or anyone – could do, is interpret, which is to say, construct and reconstruct until a satisfactory degree of coherence is achieved among the conceptual structures one has built up on the basis of the read text. (von Glasersfeld, 2002, p. 109)

On a personal level, I too find Piaget's work challenging to read but I do recognise that I am in the privileged position to be able to spend time reading and interpreting it as fully as possible, rather than having to turn to simplified versions of his work in order to meet the requirements of a taught university programme. In this sense, second order interpretations of original works really are key to the students' understanding.

All of this presents an interesting, almost ideological, conflict. On the one hand, avoiding original sources of work could be considered anti-intellectualism (the irony of which is significant when teaching and education are surely hinged on the intellectual) and inhibiting students' opportunities to engage with theory in its purest form. On the other hand, student teachers are learning to be teachers so, while they are training, simplified versions are an acceptable means through which to encounter theories for the first time. In either instance, students' experiences of original sources of theory seem to be generally negative because the ideas are presented in a way that is not simple to understand.

As well as those students who had actually read from original sources and found it difficult, it also seems that students may have preconceived ideas about the complexity of theories even before they do. For example, Molly independently sought a simplified compilation of learning theories that was not on the reading list (Bob Bates's 'Learning Theories Simplified') as she used the brief overviews of different theoretical ideas to establish a basic understanding of them before exploring them at greater depth (Conversation with Molly, p. 20). Indeed, the impact of this was significant and Molly described reading simplified versions as an important preparatory exercise before tackling original works (Conversation with Molly, p. 21).

Far from anti-intellectualism, in this example, the simplified version allowed the student access to more complex interpretations and enabled her engagement with them. If, as Molly suggested, the simplified version provided a basic understanding that could lead to deeper understanding, then perhaps simplified versions have a serious part to play in the education of student teachers. Despite this, the literature suggests that this can jeopardise the development of students' expertise. In particular, English (2008, p. 160) warns against allowing students to engage with *'A highly reductionistic and oversimplified list of generalities.'* Higgins (2010, p. 446) goes further in his description of much educational literature as *'thin and inspirational'* and suggests that so-called 'kitsch' interpretations of theories eliminate a student's desire and indeed ability to think critically.

Only one student supported this possibility and again, Sarah's significant teaching experience seemed to give her a different stance to the others. During her interview, Sarah revealed that, once qualified, she would be unlikely to refer to educational theories in literature. However, this was not because she could not see their value, but because she thought that accessing original sources of theory would be difficult when she was no longer a student. Indeed, as the following excerpt from her interviews suggests, condensed or unoriginal versions of educational theories could actually be detrimental to her understanding of them:

> Sarah: *…most of what's available is other people's paraphrasing about the theory, I guess.*
> JG: *And is that something that puts you off?*
> Sarah: *Well, I suppose they make it biased depending on the views of the author?*
> (Conversation with Sarah, p. 11)

It seems that, for Sarah, the integrity of a theoretical idea was important so that accessing it before it has undergone interpretation by another author was important, presumably so that she is in control of the interpretation herself. Arguably, this approach would neutralise the effect of what Greene (1987) calls an *'... over reliance on received knowledge'* that might damage a student's subsequent development.

8.1.8 Conclusion to Theme 1

Many of the students reported that older ideas do not relate to modern practice. Chapter 3 discussed mastery in depth and it described the widely-held view that the precepts of a mastery curriculum are based on the constructivist ideas of Bruner, Skemp, Vygotsky and Piaget. Indeed, it was discussed how such claims to theoretical foundations have been used to promote mastery learning and add strength to its status as the most desirable approach to teaching and learning in primary mathematics. That said, a number of students interviewed for this study cited a conflict between theoretical learning and the mastery curriculum as a significant barrier to their use of theory in their practice.

The theory taught to students can be a diluted, condensed version of the original theories and possibly a fundamental distortion of the original work. For example, Vygotsky's tentative theoretical and indeed philosophical framework (reasoned within the framework of Marxist Historical Materialism) for considering human learning may get turned into 'fact' or made rigid (the 'Zone of Proximal Development') when it is open to discussion and dispute about what exactly is meant and which interpretations are either a) congruent with the original or b) defensible and useful in their own right. The latter seems to be the case as the most popular texts from the reading list were those that offer a second order interpretation of the original ideas (as well as practical suggestions for their use in the classroom) that the students find easier to understand and therefore apply. It could be argued that condensed or reinterpreted theories somehow undermine the integrity or value of the original ideas, but I now believe that they are essential.

Whether or not the dilution of seminal works for theory is appropriate (or whether it represents anti-intellectualism in a profession that arguably is solely about the promotion of intellectualism), there does seem to be a clear case for 'potted versions' of theory that enable access to complex and detailed ideas quickly. This is a clear advantage in a teacher education course in which time is a limiting factor. The students interviewed suggested that condensed versions of the theories bridged the understanding gap rather than barring access by providing superficial versions of complex ideas. Indeed, it is possible that this practice is enabling rather than constraining. This theme will be returned to in the following section that explores student teachers' motivations and the nature of being a PGCE student.

Key Theme 2: Student teachers' motivations and the nature of 'studentship'

Even when I was doing the assignment, a lot of the reading I was doing was, 'Right, I need a quote that says something along these lines….' So I'd just be skimming through books trying to find somebody that I needed rather than understanding the theories.'
(Conversation with Fran, p. 15)

8.2.1 Introduction to Theme 2

The nature of the theories taught to students and the ways in which they are presented to them through literature has an impact on the student teacher's motivations to use them and attitudes toward them. As such, the second key theme will explore the nature of studentship and provide an insight into what it is like to study mathematics as a primary PGCE student. Successful completion of a PGCE not only results in a master's level, academic qualification but it also provides students with a professional qualification (QTS). In practical terms, this means that PGCE students have to carry out activities typically associated with students (attending lectures, engaging in private study and writing assignments) as well as demonstrating their competence as classroom teachers. The term 'student teacher' that is often used suggests that students are simply apprentices or teachers in training. However, I would argue that referring to them as student/teachers seems more fitting as, in essence, they must be both student *and* teacher. Tang (2004) adds a further perspective and suggests that their developing repertoire of knowledge (student) and their school-based learning (teacher) combine with a student's sense of self as a teacher and contribute to the 'dynamic and interactive nature of professional knowledge construction' (Tang, 2004 cited in Cheng et. al. 2012, p. 782) that characterises learning to teach. This third, personal perspective is significant because as Britzman (1991, p. 4) describes, ‘The taking up of a [teacher’s] identity means suppressing aspects of the self’ and while this serves to develop the student teacher, it can also be a source of personal conflict. The triadic identity of student, teacher and self seems to affect students in a distinctive way as each of the three aspects is called upon and must come to the fore at different points in their training. Naturally, when they are at university, attending seminars and writing essays, their student persona is the most prominent. As soon as they begin a school-based placement, they must switch (very quickly) to their teacher persona and engage with the full range of professional activities that are involved. When they reflect on their own learning (both academic and professional) and consider their successes and failures, their ‘self’ persona prevails.

Each persona of the triadic identity is characterised by different behaviours, attitudes and activities. As a student, they must spend time in the library, read books and show an interest in theory and scholarship. As teacher, the students must engage in different activities centred around planning, preparation, teaching and assessment. Additionally, they must engage in professional socialisation and development. Examples of this include attending meetings and training and working with other professionals and the parents of the children that they teach. As themselves, the students have their own ideas about teaching and learning and their desire to be successful both academically and professionally. I suggest that each of these identities is sufficiently different to create conflict and that students find it difficult to switch between them. Within the context of education, this identity is unique to student teachers who arguably have a more complex set of identities to work within than qualified teachers do; unlike qualified teachers who must juggle their professional, teacher identity with their personal identity, student teachers must also incorporate their student, learner identity into the mix. As well as being themselves, they are simultaneously educator and educated. This is particularly challenging when they are, as novices, the least equipped to cope with this. The result of this is that students are in danger of ‘spreading themselves too thinly’ and they have to focus their efforts on developing one of their identities. As they grapple with becoming competent teachers, they choose to prioritise the school-based aspects of their training (and thus develop their teacher identity) to the detriment of their student identity and themselves. This is actively promoted by their mentors in school who, as I suggested in Chapter 6, had little understanding of or interest in what the students learned about at university.

The complexity lies in the fact that there is not a developmental and progressive growth from one persona to another because school placements and university sessions are distributed across the year and students sense of self is there from the outset, is rooted in their prior experience and will remain with them and evolve throughout their career. This is reminiscent of Bourdieu's concept of 'habitus' – the cognitive schemes of perception that, in his own words, 'reproduce in their own logic, the fundamental divisions of the field of positions' (Bourdieu, 1993, p. 64). In other words, a student's 'self' identity projects its own reasoning to define their position (and therefore perception and opinion of) the educational phenomena that they encounter both at university and at school. For example, a student is likely to recognise 'theory' or 'teaching' (Bourdieu would describe these as 'fields') but the habitus would help them to define whether the theory was fascinating, pertinent or banal and whether teaching was child-centred, focussed or lacklustre. For Bourdieu, the habitus is such an innate and fundamental appreciation of an individual's reality at any given moment that it seems likely that it may outweigh a student's 'student' and 'teacher' persona. A constructivist perspective might suggest that students construct their own reality as part of their joint personas so that it becomes even further removed from that of the teachers at their placement schools or their university tutors.

The data indicate that this unique student/teacher/self position affected the way in which students engaged with educational theories in three ways:

1) the students' choice of assignment theory,
2) their approach to reading and private study,
3) their level of experience and their perceived status in school.

This section will therefore address each of these in turn.

8.2.2 The choice of assignment theory

As previously discussed, the students wrote one of the two 5000 word essays required for the PGCE on mathematics. For this, they had to choose some of the theories that they had learned about and use them to discuss and analyse a series of maths lessons that they had taught in school. All of the interviews began with asking the students what they had chosen as the focus for their maths strength assignment and their choice of theory. The reasons for their choice provide a useful insight into their motivations.

Tara, Owen and Molly all chose theories that they felt reflected their preferred teaching style. Tara chose to contrast Vygotsky's notion of scaffolding with Skemp's 'instrumental learning' when teaching arrays because she was aware that she was already using scaffolding and that it would fit well with her teaching. Molly decided to focus on Skemp, Bruner and Vygotsky for her assignment and again, she cited their alignment with her preferred teaching style as the main reason for her choice (Conversation with Molly, p. 3). While Molly was reluctant to select a theoretical focus that would force her to deviate from her preferred style of teaching, she also wanted her choice to reflect her personal values and beliefs with regard to mathematics education. Owen similarly felt that a personal connection with a theoretical idea was an important part of his choice (Conversation with Owen, p. 5). Owen even suggested that he would be prepared to manipulate a theoretical idea to make it fit his practice. When arriving at his choice, Owen rejected works by Vygotsky because they did not lend themselves to his practice (Conversation with Owen, p. 15) while he felt that Skemp's idea of 'relational understanding' was better suited to his teaching style at that time.

It would be easy to assume that students chose the theory that best matched their teaching style because it involved the least deviance from their normal behaviour and would therefore be easier to implement. Indeed, Owen made explicit reference to wanting to *'pass the whole thing'* (Conversation with Owen, p. 5) but he also referred to a desire to 'make the assignment personal' and this suggests that he also saw his assignment (and therefore his choice of theory) as an important part of his development. From my insider stance, this presents as a well-principled rationale but from my critical, outsider stance, it could be argued that a student could develop more by 'stepping out of their comfort zone' and focussing on the development of competencies that they do not yet possess. When viewed through the lens of constructivism, the latter seems to be the case. Vygotsky is well-known for his description of effective learning taking place in the 'Zone of Proximal Development' - a level of challenge slightly above that which the learner could easily achieve by themselves. In Piagetian terms, cognitive assimilation occurs when learners are challenged or perturbed by their findings. By choosing theories that already aligned with their practice, it is unlikely that the students yielded sufficiently 'perturbing' results that challenged their thoughts or evoked new or interesting ways of teaching or insights into learning. Like Piaget, I too believe that learning can only take place when an individual is required to look beyond what they are able to do and what they find easy. With that said, the PGCE (like the primary curriculum) is designed for linear and measurable development, not for deep knowing or indeed anything that might not adhere to the requirements of the programme.

Irrespective of this, Owen also recognised that his choice could have an impact on the children's learning (Conversation with Owen, p. 5). Tang (2002, cited in Cheng et. al. 2012, p. 782) found that an affinity with knowledge in relation to actual practice, practical relevance and emerging professional and educational values were all relevant criteria used by students in assessing the usefulness of the theoretical knowledge they learn at university. This suggests that theories that are easier to relate to their practice give students confidence and the ability to impart knowledge in their lessons more effectively. Above all, the evidence from the interviews highlights the distinction between an inductive and deductive approach. Popkewitz (cited in Biesta et. al., 2014, p. 13) endorses an inductive approach and concludes that theories *'order what is seen, thought about and acted on'.* However, Thomas (2011) is more cautious and questions whether theories should be the *'product'* of our endeavours (inductive reasoning) or a *'tool'* for making sense of our practice (deductive reasoning). The unique, student/teacher perspective of those interviewed gives rise to a distinctive approach to the implementation of theory that is neither inductive nor deductive in nature. In one sense, the requirement to select a theory through which to view their practice suggests a deductive stance, whereas through choosing theories that best suited their practice, an inductive approach is implied. Tsui (2009) defines this as 'theorising practical knowledge' and 'practicalising theoretical knowledge' and suggests that both are essential to a student's development as a teacher.

‘Theorising practical knowledge’ involves making the tacit knowledge gained from experience explicit while ‘practicalising theoretical knowledge’ involves the creation of personal connections with, and interpretations of, formal knowledge through practical experiences.

8.2.3 The students’ approach to reading and private study

Despite the centrality of the written assignment to the mathematics strength module (the work for which formed an essential element of the students’ first placement), I was surprised that four of the eight students interviewed were unable to recall the focus for their assignment without prompting or reference to their notes from university. While this could be put down to nerves (this was, after all, one of the first topics for discussion in the interviews), it does seem to be a significant omission when viewed in light of the students’ attitude to, and engagement with, the course literature.

Eve was very honest in her admission that had only used the course literature to complete her assignment and not to broaden her understanding of maths education. She said, ‘When I have to do an essay, that’ll be like when I’ll start doing all the research. I need the pressure of an essay to make me!’ (Conversation with Eve, p. 31). This approach was echoed by both Tara and Molly who reported that they had not referred to any of the literature since the completion of their assignments. Tara was keen to assert that this did not mean that she had abandoned reading about mathematics education altogether but that now, she did what she described as ‘*more up-to-date reading’* (Conversation with Tara, p. 17). Conversely, Molly had not done any wider reading since the completion of her assignment at all because she felt that she gained more from actually teaching and asking for teachers’ suggestions for how to improve (Conversation with Molly, p. 22). This suggests that students see literature and the reading list as a necessary part of completing their assignment and that, once it has served its purpose, it becomes redundant. Their motivation to read is governed solely by the requirement to complete the course as Owen suggested in his interview:

> *I'll be honest, at times it has been a bit of a drag and a bit boring, but it's relevant so obviously, you just kind of stride through and you get through it.* (Conversation with Owen, p. 9)

This implies that reading is seen as something to endure and a means to an end, rather than a source of ideas. Fran rather succinctly summarised this attitude:

> *I did that [read course literature] in order to pass and I haven't looked at it again.* (Conversation with Fran, p. 16)

Despite the students' motivation and attitudes toward literature, they did all have to engage with it to some degree, if only in the preparation of their assignment. There were some commonalities in the way that students approached their reading. For Leanne, the choice of texts that she used was very important and, after borrowing it from the library, she chose to purchase her own copy of Mike Askew's (2012) book *Transforming Primary Mathematics.*

Askew was mentioned by a number of students as a key text because it was easy to read and understand. Like Leanne, others were put off by texts that presented ideas in an overly complex way, even though they were recommended on the university's reading list. Owen felt that, irrespective of their content or stance, all texts were of use because they would invariably ether support or contradict the points that he made in his assignment so they could be used in his critical analysis in some way or another. That said, Owen also implied that, rather than directing or even contributing to his understanding, texts were used retrospectively and inserted into his essay to bolster his conclusions that he had, in fact, already drawn. Fran used texts in a similar way to prepare her assignment:

> *Even when I was doing the assignment, a lot of the reading I was doing was, 'Right, I need a quote that says something along these lines….' So I'd just be skimming through books trying to find somebody that I needed rather than understanding the theories.* (Conversation with Fran, p. 15)

Like Owen, Fran clearly already had ideas and pre-existing thoughts to write about. To strengthen her claims and to fulfil the requirements of a master's level, academic assignment, she sought *'quotes'* from texts to insert into her work. Arguably, this 'sandbagging' provides intellectual veneer that gives the appearance of real engagement with literature while, by her own admission, her understanding of the content of what she had read remained underdeveloped. This finding is reminiscent of Higgins' (2010, p. 448) view that the use of theory can become *'the mere recitation of the names of theorists'.* Higgins (2010) is certainly not alone in doubting the depth of theoretical understanding among student/teachers. Giroux (2014) argues that students studying in HEIs are subject to a form of neo-liberal corporatism where *'critical learning has been replaced with mastering test-taking, memorising facts, and learning how not to question knowledge'* (Giroux, 2014, p. 6). Within the context of this study, Giroux (2014) might feasibly argue that student/teachers who learned *about* educational theories can complete the programme and attain QTS without having necessarily learned *from* them or really understood them.

8.2.4 The students' level of experience and their perceived status in school

The final area of discussion around the theme of the students' motivations is concerned with their level of experience and their status. Again, the unique student/teacher position of those involved in this study gave rise to very specific perception. In other words, even as students, those completing their PGCE are invariably educationalists already. That said, they remain 'young' in terms of their professional standing. This status seemed to present both challenges and opportunities.

Tara suggested that her level of experience as a teacher was advantageous when trying to implement the mastery curriculum at school:

> *And what was really helpful then was because I got it, because I've come in fresh to it, so I haven't got any background of how we used to do maths.* (Conversation with Tara, p. 6)

Indeed, her inexperience enabled her to approach ideas without bias and this is clearly advantageous during times of rapid, curriculum change. Likewise, Eve's current knowledge of the CPA approach clearly gave her an advantage when it came to teaching for mastery and this strength stemmed from her being a student. That said, as a student, she also felt that her ideas and point of view many not have had sufficient credibility. According to Tara, credence and being taken seriously was enhanced by her study of maths theory. Rather like Fran's desire to strengthen the claims in her essay with literature, Tara suggested that she could draw upon her knowledge of theories to give added weight to her ideas and enhance her status among fellow teachers (Interview with Tara, p. 21).

As well as these advantages, some of those interviewed felt that, as students, they were at a clear disadvantage. For example, Owen felt that he needed more experience before he was able to recognise theories being played out in the classroom but that even from his first to main placements, he could see an improvement in his ability to do so (Conversation with Owen, p. 10). Similarly, Leanne's appreciation of Vygotsky developed with experience over the course of her training (Conversation with Leanne, p. 20) and Molly reported that she had seen improvements in her ability to scaffold learning, but they she still had some way to go (Conversation with Molly, p. 13). This is reminiscent of Mason's (2002) concept of 'noticing'. This refers to a teacher's ability to analyse situations and make links between their actions and the children's learning. Significantly, Mason (2002) describes this as a trait of 'expert teachers' so perhaps it is little wonder that students do not see the link between their learning and the mathematical development of the children when they are in the emerging stages of becoming a teacher. It strikes me that the contrived way in which students use theory may be to blame and that theory really ought to come later in the career of a teacher.

It would seem that a lack of teaching experience means that students are less able to engage with their learning from university that they would be if they had a bank of examples of practice through which to frame what they are taught. However, it is also clear that, even for the relatively brief duration of their training, they can develop both expertise and credibility while they are students.

8.3 Conclusion to Theme 2

Providing students with a degree of flexibility when it comes to the topic of their assignment seems to engage them in their learning while also giving them a sense of ownership over both their work in school and the written outcome of their endeavours. However, it also seems that students (perhaps inevitably) choose to 'play safe' and select theories that lend themselves to the style of teaching with which they're most familiar. It could therefore be argued that the students' motivation to ‘get the job done’ actually narrows their experience of a range of approaches and inhibits their professional development. An unintentional side-effect of the nature of the assignment was that students had no choice but to apply deductive reasoning to their practice. While this clearly contributed to their knowledge of educational theories, they did try to steer toward a more inductive approach that may have had a greater impact on their practice. As Counsel, Evans, McIntyre and Raffan (2000) suggest, the value of the theories selected should be measurable by their relevance to teachers’ practice and there is a sense in which the students hand-picked those that worked best of them.

Furthermore, students used the course literature in a fundamentally superficial way that gave the illusion of critical thinking while doing little more than paying lip-service to the academic requirements of the course. As students, they did not have sufficient influence to implement what they were taught at university and they were concerned that their ideas are not given credence among more experienced teachers. The unique student/teacher/self position proposed in this thesis means that the students were subject to a distinctive performativity, like that described by Ball (2003) that both forced them to consider and implement educational theories (student) and restrained their use in practice (teacher).

Chapter 9 - Data presentation and thematic analysis – Part 2

Chapter 8 discussed and analysed those themes that derived from factors intrinsic to the students themselves. The following chapter discusses the remaining three themes that arose from extrinsic factors to which the students are subject.

Theme 3: The impact of time

I was just very conscious of getting everything done and the time that took. It was almost annoying that there wasn't a bit more time to chill out a bit and read and then understand things …
(Conversation with Fran, p. 15)

9.1 Introduction to Theme 3

The next theme to arise from the data is that of the impact of time on students' abilities to make use of educational theories; seven of the eight students interviewed reported that time had had an impact. It is intrinsically linked to the themes discussed in the previous chapter because it is firmly enmeshed in how the students perceived the theories themselves (Theme 1) and their motivations and attitudes toward them (Theme 2). As well as continuing to provide an insight into the students' priorities from the previous chapter, this section provides an insight and the pressures to which they are subject as they try to balance their unique student/teacher/self position.

The interview data strongly suggest that time, or rather a perceived lack of it, is a significant factor affecting the extent to which students engaged with the theories they were taught. Those interviewed made a direct reference to the inhibiting factor of time on their use of educational theories and this seemed to be in two different ways. Firstly, a lack of teaching time dedicated to mathematics because of the demands of an overcrowded curriculum and secondly, students referred to a lack of personal study time to engage with theories. The effect of this was that the students began to view theory as a desirable, 'bolt on', intellectual activity rather than a means through which to develop competence.

9.2 There is no room for theory in the curriculum

Emily was excited by the prospect of studying and making use of educational theories but she felt that her attempts to do so were hampered by a lack of time to implement them. During her interview, she seemed genuinely frustrated by this and she blamed the lack of time on the rigid timetable at her placement school (Conversation with Emily, p. 9). In this example, time pressures seemed to have a negative impact on the student in two ways. Firstly, Emily's school had chosen to assign a week to the teaching of multiplication tables and, as such, had implemented a pre-determined planning schedule to ensure that their learning objectives would be met by the end of the week. It is clear that she found the pace of this difficult to manage and she seemed sceptical about the practical reality of an in-depth exploration of multiplication tables (albeit in concrete, pictorial and abstract terms) within such a short space of time. In my own experience, I too would feel challenged by the prospect of teaching such a fundamental area of mathematics in such a narrow timeframe. Secondly, Emily felt restricted by the broadness of the wider curriculum and the need to cram lessons in other subject areas into the school day. Sarah was similarly critical of the National Curriculum itself and suggested that it did not allow sufficient time for the development of ideas (Conversation with Sarah, p. 10). It is interesting that Sarah's response to the question included a reference to 'depth' and 'speed' because the mastery curriculum promotes depth of conceptual understanding over speedy, procedural fluency. It therefore seems that Sarah is implying that mastery learning is not compatible with the National Curriculum programmes of study because there is insufficient time to fully embed it.

9.3 There is no room for theory in the PGCE

In addition to an overcrowded curriculum leaving insufficient time to embed theory in practice, the students also felt that the PGCE itself did not allow for sufficient time to engage with their theoretical learning at university.

Sarah felt strongly that the workload of the PGCE inhibited her implementation of theory. She cited *'the day-to-day classroom stuff [such as] individual lesson plans and things like that'* as consuming of time that might otherwise have been spent on deepening her knowledge and understanding of educational theories (Conversation with Sarah, p. 20). Indeed, while she suggested that the texts on the reading list were of good quality and well-chosen, Sarah wished that she had had more time to read and felt that it as simply not possible to read all of the texts from the reading list while juggling the other requirements of completing a PGCE (Conversation with Sarah, p. 16). Fran also felt that the PGCE course did not allow sufficient time for her to reflect on things properly:

> *... with the PGCE, because there's so much that you have to fit in, there's not really a lot of time to think about it or to understand it. It's kind of more a case of do it, get this box ticked, right, move onto the next one.*
> (Conversation with Fran, p. 12)

This suggests that educational theories require time not only to 'do' them, but also to ponder them and to truly internalise their meaning. Eve also shared this perception. During her interview, she was unable to recall the theory that she chose to write her 'core strength' assignment about and by her own admission, she also could not remember the key elements of any of the other works of theory that she had studied. At the time, I was surprised that a student would be unable to recall the focus of a 5000 word assignment that they had only written a few months before, but Eve felt as though it was a long time ago and attributed her inability to recollect it to the pace with which the PGCE programme moved on and a lack of time to *'think or reflect on anything'* (Conversation with Eve, p. 11). It was clear that Fran valued theory (or that she found it interesting, at least) and that she would have liked to have made greater use of it. That said, she felt unable to consider it at any depth while coping with the demands of the PGCE and thought that it may have been more influential later in her career when planning and preparation for lessons became faster (Conversation with Fran, p. 13/14).

9.4 Insufficient time is dedicated to theory on the PGCE

In addition to the workload associated with completing a PGCE, one half of the students interviewed felt that the university itself could have dedicated more time to the exploration of educational theories through lectures and seminars. For example, Sarah clearly held theory in high-esteem and she would have appreciated a greater emphasis on it in her university sessions. She implied that direct teaching of theoretical aspects of mathematics teaching may have been beneficial but that other areas may have been prioritised (Conversation with Sarah, p. 7). Tara also felt that the university did not go into theories enough and that she relied on her own, private study to develop her understanding of them (Conversation with Tara, p. 7).

Arguably, all taught undergraduate and postgraduate programmes involve an element of private study and it seems entirely appropriate to direct students toward relevant reading and to expect them to gain knowledge and understanding for themselves. That said, Tara might have appreciated more of an emphasis on theory at university before being directed to read about them for herself. Indeed, Sarah's assertion that it was impossible to read all of the texts on the reading list (Conversation with Sarah, p. 16) may indicate that much of the theoretical content of the PGCE was promoted through private reading and study which, as will be discussed later in this chapter, may or may not have been completed by the students.

The result of this perceived lack of direct teaching time allocated to educational theories seems to be twofold: a diminished understanding of theory and less engagement with theory. Fran felt that, even after they had been taught at university, she did not know the theories well enough to recognise them when on placement at school. Furthermore, while she alluded to daily, classroom management tasks pushing theory to the 'bottom of the pile', she also suggested that, had she had more time for reading and private study, this may not have been the case. Molly was sure that with time, a student should be able to refer to and draw upon theories naturally (Conversation with Molly, p. 13).

9.5 School placements are not long enough

The final time-related issue that the students seemed to have with applying theory was that their placements were too short. Typically, PGCE students carry out three placements in schools between the October and June of the academic year of their course. The first two placements last for approximately eight weeks each and the final placement for six weeks but for some students, this did not seem to be long enough. For example, Fran made a direct link between the amount of time she had for study and her understanding of concepts (Conversation with Fran, p. 15). She even went as far to suggest that the study of educational theories may not be appropriate on a course such as the PGCE and that it would be better suited to a longer, undergraduate programme where students would have more time to engage with it properly.

Owen felt that it was difficult to implement some of the things that he had learned about at university because he was not at his first placement school for long enough (Conversation with Owen, p. 19). Although similar in length, the ‘first’ and ‘main’ placements of the PGCE differ in terms of the teaching commitment required of the students at each stage of their training. For their first placement in the autumn term, students work up to a 60% timetable that can include group or whole-class teaching. For the main placement in the spring term however, the students build to 80% whole-class teaching (the same requirement for an ECT) for much of the duration of the placement. In this example, Owen felt unable to make much of an impact when trying to introduce concrete resources with his Year 5 class as he had been taught to at university. While it seems unlikely that he would ever have been able to reverse a well-established approach to teaching mathematics at his placement school, Owen attributes this to the length of time that he was there. Conversely, within the increased teaching commitment of his main placement (with more time in front of the class), he felt better able to implement the CPA approach with his class. Later in his interview, Owen actually returned to the notion of a time restraint when discussing his experience of promoting the mastery curriculum at school (Conversation with Owen, p. 20). This did emphasise the extent to which it restricted Owen’s attempts to use educational theories. In the academic year 2019-20, the university reshaped the placement pattern for its students. The changes included a slower-paced introductory period in the autumn term followed by longer placements through the spring and summer terms. This does make me wonder whether or not Owen would have been more successful in his endeavours had he undertaken his training in the new format.

Only Tara presented a somewhat different view of how time impacted on her understanding and application of educational theory. She felt that timing was crucial when applying theory to her practice and she drew on Vygotsky’s notion of scaffolding as an example:

> Tara: *….the main one I usually used [was] scaffolding but obviously, there was an element of flaws within that while teaching.*
> JG: *Like what?*

> Tara: *So, time? And knowing with that more knowledgeable other when is there an appropriate time to step back.*
> (Conversation with Tara, p. 2)

In this example, Tara seemed less concerned by a lack of time to engage fully with educational theories and more interested in timing their implementation with children for the greatest impact on learning. There is, perhaps, a case not only for universities to provide a more in-depth exploration of theories during lectures and seminars, but also for them to suggest practical timescales for their implementation in school.

9.6 Conclusion to Theme 3

It is clear that time is a constraining factor in students' ability to make use of their learning from university. Firstly, the PGCE is arguably the most intensive route to QTS and as such, university tutors do need to condense the theoretical aspects of the programme into a reasonably short time frame. Secondly, the students themselves spend their year of training carrying out a large part of the job of a qualified teacher alongside the demands of achieving a master's level qualification. It seems that the condensed nature of the university's presentation of educational theories is directly reflected in the students' attitudes to it. In other words, as the students perceived that the university spent little time on teaching them about theories, they felt that they too could apply minimal time and effort to their study of them.

Theme 4: The importance of mentoring and the school context

Unless I am talking about educational theories at uni, I have never discussed them with other teachers. Actually I don't think I've heard other teachers talk about them in general conversation.
(Conversation with Sarah, p. 15)

9.7 Introduction to Theme 4

An essential element of any ITE programme involves students spending time in schools. Frequently referred to as 'school-based training' or 'teaching practice', students are provided with opportunities to practise teaching classes of children throughout their period of training. Clearly, the type of schools in which students may be placed varies considerably and the size of school, its ethos and priorities as well as the experience level of staff invariably has an impact on the experiences of individual students and the opportunities that they are afforded. Typically, students have little or no choice about the schools in which they are placed and from my own experience as a student mentor, senior leader and training manager for an ITE programme, it can be difficult to find enough suitable schools that are willing to accommodate student teachers. As discussed in Chapter 2, the literature on ITE is awash with perspectives on the concept of ‘partnership’ between schools and HEIs. Cameron-Jones and O’Hara (1994, p.140) suggest that this is simply a question of deciding what students learn best from university and what is best learned from a student’s time in school. This does seem to be a rather simplistic view that does not take account of a student’s development over the course of their training. Moon (2008) suggests that the very process of learning at university gives rise to a shift from a ‘black and white’ view of the world or as Cheng et. al. (2012) call it, an ‘absolutist understanding’, toward a more contextualised conception of knowledge. Cheng et. al. (2012, p. 782) suggest that this shift in understanding relies upon the nature of work-based (school) placements where students are able to make ‘significant independent decisions’ about their practice. I might add that even in a best-case scenario, students remain restricted by both a shortage of time and their inexperience. As such, the nature of their placement schools and the opportunities and freedom they are afforded is of the utmost importance to their development. Indeed, the data suggest that the context of the schools in which they are placed has a significant impact on students’ abilities to make use of the theories they were taught about at university. The school context consists of two key areas:

1) the position of the school itself, its priorities, character and ethos and
2) the mentoring that the students receive from staff at the school.

As such, this section will discuss these two areas independently and it will begin with an analysis of the context of the schools themselves.

9.8.1 The School Context

The general sense from the students was that, for a number of reasons, the school context actually inhibited their ability to engage with theories while on teaching practice. Eve felt that her own understanding of using the CPA approach may have been at odds with the school's approach to teaching mathematics (Conversation with Eve, p. 13). Indeed, she implied that her own knowledge of current, mathematical thinking (gleaned through her study of educational theories) may have outweighed that of her placement schools that were actually behind in their approach. This possibility was also alluded to by Leanne who also felt that her use of her learning from university was inhibited by the school in which she carried out her placement (Conversation with Leanne, p. 7). This suggests that university may present an optimum or idealistic view of mathematics teaching that schools, for a number of reasons, may not be able to keep up with. One such reason (as Leanne suggested) seems to be concerned with a paucity of resources available in some schools. Invariably, spending priorities in different schools vary and from my own experience, teaching resources for schools can be inordinately expensive. By her own admission, there *'weren't enough resources to go round'* (Conversation with Leanne, p. 5) at one of Leanne's placement schools and while the need to share (somewhat incidentally) made her consider Vygotsky's 'More Knowledgeable Other', Leanne was clearly at a disadvantage by not being able to try out her learning from university at school.

In addition to the financial issues and lack of resources that may result, there were other, organisational characteristics of schools that made it difficult for students to make use of theories at school. At the end of her interview, I asked Molly whether there was anything else about her maths teaching or her use of theories that she wanted to tell me. Of the many things that she could have mentioned, she told me that she thought it significant that she had been placed in mixed-age classes for each of her teaching placements in schools and she felt that this inhibited her ability to teach for mastery and to make use of the theories she had learned about (Conversation with Molly, p. 25).

Often, mixed-age classes are a feature of smaller primary schools where it would not be economically viable to separate each year group. That said, my own school chooses to organise its Reception and Year 1 children into mixed classes and sees a number of benefits although interestingly, not in mathematics where the children are still taught in their separate year groups. Like Molly, we found that teaching for mastery was too difficult, and indeed ineffective, in a mixed-age class.

Another feature specific to each school that seemed to inhibit some students' use of theory was the behaviour of the children. On the surface, a poorly behaved class ought not inhibit students' maths teaching more than anything else, but the students' need to effectively 'try out' their learning from university on the children means that some of the approaches used may be unfamiliar to the children. While this can be engaging and actually have a positive impact on the children's engagement with learning and behaviour, the unknown can also be detrimental to the standard of behaviour in the classroom. For example, Leanne felt that introducing concrete resources into maths teaching could actually inhibit their use (Conversation with Leanne, p. 11). In fact, Leanne referred to the children's behaviour, the level of classroom support and classroom organisation as *'external factors'* (Conversation with Leanne, p. 12) that might inhibit a student's ability to implement their learning from university at school. What she did not include in her list of 'external factors' was each school's individual priorities, policy (with regard to mathematics education) and the progress that they have made toward implementing a mastery curriculum. Molly, however, did feel that this was a constraining factor (Conversation with Molly, p. 14). This suggests that, for a number of reasons, students may not be allowed to implement their learning from university at school (and yet despite this, Molly seemed determined to try). It could be that in a six to eight week placement, schools are not keen for students to interfere with their established practices – particularly with the incessant, Ofsted-driven focus on standards – and that experimenting with new, innovative practices may jeopardise the children's understanding of concepts. It is also possible that a school's approach to teaching mathematics may be determined by a scheme of work that they have chosen to follow. Tara felt that schemes of work could narrow a student's experience and she felt fortunate to be allowed some '*free reign'* while on teaching practice (Conversation with Tara, p. 16). It would seem that this is precisely what students need in order to implement what they have learned at university, but that it is not easy for a school to accommodate when following a single, prescribed way of teaching mathematics. Similarly, it could also be that schools are simply prioritising another area of the curriculum and, although the students have a particular interest in mathematics, the school may be working on a different area of school improvement. Eve alluded to this possibility in her interview (Conversation with Eve, p. 23); the class that she was placed in was clearly more focussed on the children's development in phonics than in mathematics and it is quite possible that phonics and reading was a whole-school priority. Irrespective of the rationale, it is clear that students developing a strength in mathematics who were placed in schools where maths was not prioritised were at a disadvantage.

As well as having implications for practices in partnership between schools and HEIs, the very concept of school-based placements is also deeply theoretical. For constructivists like Piaget and von Glasersfeld, the concept of 'truth' is replaced by that of 'viability' and as such, constructivism does not attempt to describe a real world but rather, it provides a model for rational knowing. This seems to conflict with the school-based aspect of the PGCE because each school within which the students are placed represents its own experiential world – there are no objective realities within education. A fortunate student may find themselves in a school where they are able to see examples of theories being played out while a less fortunate student might find themselves in a school where they teach no mathematics whatsoever. In other words, the theory that they learn at university could be wholly viable in one school context and completely useless in another and this is, perhaps, an unavoidable risk when theory and practice converge.

9.8.2 The quality of mentoring

In the second sub-category within the theme of the school context, I will explore the impact that the staff at students' placement schools had on their ability to implement their learning from university into their practice. During their time in schools, student teachers are supported by a number of professionals but those involved in this study had support from three key roles. Firstly, the class teacher in whose class they were placed, their school-based mentor (this is typically, although not exclusively a different person to the class teacher) and finally, the mathematics subject leader who has the responsibility for maths across the school. While each of these roles differs in nature, all three may provide mentoring and support for the students in different measures. I will therefore refer to all teaching staff at the school as 'mentors' where appropriate. Cheng et. al. (2012, p.

783) stress the importance of ‘quality mentoring support during field experience’. While this may be true, to make a contribution to professional practice, I will endeavour to define precisely what ‘quality mentoring support’ meant to the students in this study and in keeping with the precepts of a mastery curriculum, this will be defined in terms of what it is and what it is not.

The general sense from the interviews was that how good mentors were at mathematics was a crucial factor in determining the success of their placement and the extent to which they could ‘try out’ their learning from university at school. That said, conversations about mathematics education seemed to vary in quality and students were rarely (if ever) able to discuss educational theories with mentors at their placement schools. This struck me as a crucial contradiction and as I suggest in Chapter 10, it raises questions about the content of mentor training.

Leanne and Sarah reported that they had never referred to educational theories in their conversations about mathematics teaching at school (Conversations with Leanne, p. 15 and Sarah, p. 15). Tara had also not discussed theories at length when she was at school although she was not afraid to bring them up in conversation. In her words, she would *‘bring to the table’* that she had *‘done Vygotsky and looked at all of that’* (Conversation with Tara, p. 13). This suggests that, to Tara, theories were something to be learned and brought out as tools in a given situation rather than influential to her thinking and embedded in her understanding. This did not seem to be the case for Molly who had referred to them, albeit in general terms:

> *I probably did more than I realised because sometimes, you just talk about it and you don’t think, ‘Oh, that’s a theory’, you just talk about it. Like think, ‘Oh, which resource shall I use today?’ or ‘How can I scaffold their learning?’ I don’t think, ‘Oh, that’s what Skemp said’ or ‘That’s what Brunovsky [sic] said’ or whatever. Think I talked about it, but didn’t realise I was talking about theory.* (Conversation with Molly, p. 18)

While the names of theorists did not feature in her conversations (indeed, they seemed to elude her during her interview), it is clear that Molly’s learning from university was discussed at school. Her reference to only realising she had been discussing theory in hindsight does suggest that, to some degree, educational theories had become embedded in her thinking and therefore, a part of her practice. Eve felt that this may have also been true of the mentors at her placement school and cited this as one of the reasons why she had not been able to talk about educational theories with other teachers at school (Conversation with Eve, p. 26).

It could therefore be argued that not recalling and naming theorists' work does not necessarily indicate a diminished engagement with the theories themselves and that maybe, theories are learned and internalised by teachers when they are students and that they become embedded in their practice thereafter. In andragogical terms though, it may still be desirable for school mentors to refer explicitly to theories when they are working with students so that they develop their ability to recognise them in action.

The interview data suggest that both class teachers and mathematics subject leaders played an important role in the development of the student teachers. Both Molly and Sarah reported that when in need of support, they approached their class teacher in the first instance. Molly had been placed in smaller schools for her teaching practices so she did not have a lot of choice when it came to accessing the expertise of staff. She thought that is was of additional benefit that her class teacher was also the mathematics subject leader because in her view, they were better-placed to help with her maths-related queries. It does seem inevitable that a student would approach the teacher of their class before anybody else in their school if only for convenience's sake. After all, students have a daily opportunity to talk with their class teacher as opposed to a weekly meeting with their mentor or possibly more limited access to the subject leader.

Molly also reported that she had developed a positive, working relationship with her class teacher which meant that she felt comfortable enough to approach them for support when necessary (Conversation with Molly, p. 19). While Sarah did not allude to her relationship with her class teacher, she too approached them in the first instance (Conversation with Sarah, p. 18). For Sarah, it was less about a friendly conversation with her class teacher, but more to do with their common understanding of the children she had to teach and their perception of her teaching style. With these in place, Sarah's class teacher was able to discuss her lesson plans with her and advise her on the best approaches to use. Again though, it seems that convenience has a part to play as Sarah succinctly concluded:

> *... generally, I found the class teacher the best person to ask – just because they were there.* (Conversation with Sarah, p. 19)

The question of convenience and access to expertise was echoed in my conversations with other student teachers. For example, Owen also reported that he would approach his class teacher to begin with because they were readily available and they know the class best but for additional ideas, he would approach the maths subject leader. This does imply that Owen's perception is that subject leaders ought to have better ideas than class teachers. He also considered contacting his maths tutor from university for advice on pitching his lessons correctly. This could suggest a hierarchical perception of his support network that begins with the class teacher then progresses to the maths subject leader and finally, when all else fails, university tutors offer the ultimate support. This perception seems to be derived from Owen's own experience of seeking and receiving support from others (Conversation with Owen, p. 16).That said, Owen also suggested that those with different roles actually provided a different kind of support. He seemed to rely on his university tutor for impartial advice and reassurance and he suggests that the subject leader offered 'quick fixes' rather than the ability to help himself. This is reminiscent of Dewey's (1904) criticism of ITE programmes that provided students with *'immediate skill….at the cost of the power to keep on growing'* (Dewey, 1904, p. 320).

Tara considered herself fortunate that her class teacher was also the maths subject leader and that he allowed her opportunities to try out the theoretical ideas she had learned about and he encouraged innovative, mathematical thinking. Eve also felt lucky to be placed in a class with the maths subject leader for one of her placements and she too reported that they encouraged her use of concrete resources and that they had a particularly well-resourced classroom. Interestingly though, Eve did recall that, in another placement school, she had limited access to the school's subject leader and that she was reluctant to approach them for support (Conversation with Eve, p. 27/28). Again, this may suggest that there is a perceived hierarchy when it comes to supporting students in school and that, unless they happed to also be the class teacher, they are somehow removed from the students and not accessible to them. This certainly seems true of Eve's experience:

> *I was never really properly introduced to them [the mathematics subject leader]. It was what you'd picked up along the way. Like, 'Oh, they must be the maths subject leader then because they're doing a staff meeting on maths'. There was never really a, 'I'm the maths subject leader. If you've got any questions, come and find me. I'm readily available for you'. It's just, sort of, that's just a teacher. I didn't actually know who the subject leaders were until I kind of picked it up myself.* (Conversation with Eve, p. 18)

This insight raises a number of important questions and again, suggests a lack of andragogical understanding on the part of school mentors. In pedagogical terms, had Eve been a child in the school, the teachers there would have undoubtedly got to know her strengths and interests and planned to build upon them. The subject leader would have been instrumental in this development had they known or cared. It suggests that, in some schools, a student's subject strength is not considered of importance and with an increasing paucity of schools prepared to host student placements, it is unlikely that schools are specifically selected to accommodate students' areas of interest or their subject specialisms. From my experience, this is because in the primary phase, both qualified teachers and students alike are seen as generalists in the first instance. Areas of responsibility and subject leadership are frequently assigned to teachers on the basis of the school's needs and not on the basis of a teacher's expertise or even interest. Indeed, despite having completed a specialism in Design and Technology for my own undergraduate teaching qualification, I have never put it to use as a subject leader in any of the four schools that I have worked in.

The students' initial perceptions of mentors at their placement schools were that they had an enhanced knowledge and understanding of mathematics. That said, many of the students reported that they had found that teaching experience was not necessarily an advantage when it came to implementing new ideas or considering current thinking. Despite the current high-profile association with using concrete resources (manipulables) with all children to develop their deep, conceptual understanding, Eve found a somewhat negative attitude among experienced teachers toward their use with older children (Conversation with Eve, p. 25). This suggests that there may be a hesitancy in departing from historically effective methods and 'the done thing' but the reference to theory is echoed by

Leanne who also perceived a problem with a lack of understanding of theory on the part of more experienced teachers although she also suggested that this manifested itself as a lack of high-quality, early experiences of maths for young children (Conversation with Leanne, p. 9). Owen was very direct in his interpretation of the reasons for this and he suggested that experienced teachers could become 'set in their ways' and less receptive to implementing new ideas (Conversation with Owen, p. 20) Indeed, there is certainly a sense that 'old ideas die hard' and that, as previously discussed, schools may be reluctant to change established, effective approaches to their curriculum. Leanne however was less generous in her perception and felt that more experienced teachers were simply behind in their thinking (Conversation with Leanne, p. 7).

The age, or rather the level of experience of teachers did seem to have a tangible impact on students' abilities to implement their learning from university and the general sense was that the less experience school mentors had, the easier it was for students to work with them. Owen found that young teachers were more flexible and less afraid to implement new ideas (Conversation with Owen, p. 21). He clearly found a younger teacher easier to work with and he suggested that this was because they had fewer preconceived ideas about the ways in which maths ought to be taught. He also attributed some of this willingness to his teacher's continued habit of keeping up to date with subject developments through reading. However, Owen did not suggest that there was any common ground by virtue of their similar age and gender or that, as a recently qualified teacher, his class teacher may have had a clearer recollection of the nature of studentship. This is a theme that will be picked up later in this chapter.

9.8.3 Conclusion to Theme 4

Part of the difficulty that student teachers have with understanding theory is that their school mentors also seem to lack knowledge or understanding of educational theories themselves. While this seems strange (as they were, presumably, taught it themselves when they trained to teach), the problem seems to lie in the resultant inability to engage in conversation with their students about it and it is clear that this impacts on the students' own use of theories and widens the gap between theory and practice. The reasons for this are likely to be multifaceted, but it is clear that teachers in schools are not trained, adult educators. Rather, they seem to apply their understanding of how *children* learn to the development of the adult student teachers in their care. In agreement with Cheng et. al. (2012), mentors are essential in helping student teachers to go beyond a purely procedural approach. As such, mentors need to have sufficient pedagogical subject knowledge themselves. If school mentors received further training in both pedagogy and to develop their andragogical awareness, they may be better able to support the learning of student teachers and narrow the gap between theory and practice.

Theme 5: The nature of the gap in practice

I think there is a gap between interpreting the learning theory and the practical activities/advice that will allow you to meet the National Curriculum.
(Conversation with Leanne, p. 17)

9.9.1 Introduction to Theme 5

During the interviews, some of the students made reference to a disparity between the theoretical and practical aspects of their course. As I discussed in Chapter 2, I have chosen to refer to this disparity as 'the gap between theory and practice'. Although the word 'gap' might suggest an empty void between theory and practice, the data actually suggest that 'the gap' is a specific, tangible entity that can be clearly defined and therefore addressed. This section includes the students' perceptions of the nature of the gap as well as their own recommendations about how it could be addressed. Within this theme, four key ideas emerged from the data:

1) Students were better able to implement maths-specific theories over generic theories of cognitive development
2) A gap is created by *having* to learn about educational theories
3) The gap between theory and practice can be narrowed by supported contextualisation and reflection
4) Literature could be used to address the gap and to create links between the theoretical and school-based elements of the PGCE.

9.9.2 Is there a difference between maths-based and generic theories of learning and cognitive development?

Some of theories that the students pursuing a strength in mathematics encountered on their PGCE could be described as 'maths-specific'. By this, I mean those theories that were written to describe the relationships between teaching and learning in an intentionally, mathematical context. Similarly, students were also introduced to what I have called 'generic theories'. These are theories that were not originally proposed with children's mathematical development in mind, but were produced to describe cognitive development in general terms that could be applied to a number of subjects and contexts. Before addressing a 'theory/practice gap', it seems that there first exists a 'theory/theory' gap between maths-specific theories. To begin this section, I will explore students' perceptions as they related to learning both maths-based and generic theories.

Five of the eight students interviewed chose to use Skemp's (1971) ideas of 'Relational and Instrumental Understanding' in their assignments. Skemp's theoretical framework describes how children learn in a mathematical context and defines two kinds of learning: 'instrumental understanding' results in procedural competence and involves knowing and applying rules while 'relational understanding' is concerned with conceptual awareness and involves understanding why rules work and making connections between them. Similarly, five of the students made use of Bruner's 'Stages of Representation'. Although not originally presented in a mathematical context, Bruner's work has been so widely interpreted in terms of the mastery curriculum (and is well-known under the guise of the CPA approach now commonplace in the nomenclature of teachers and student teachers alike). In the previous chapter, I presented the students' perception that theories were outdated and that they required re-branding in order to retain their validity and usefulness (for example, Bruner's Modes of Representation becoming the CPA approach and Vygotsky's 'Zone of Proximal Development becoming 'Purple Learning'). This insight suggests that students are also better able to engage with theories that pertain directly to maths or those that have undergone mathematical contextualisation before they are accessed by students.

During her interview, Emily described theories that she had encountered in her undergraduate degree as not *'particularly maths-based'* (Emily p. 1). Indeed, she reported that maths-specific theories were both few and far between and difficult for her to understand. For example, she attributed her difficulties with understanding Dienes to her prior knowledge of more generic educational theories. Her reference to making sure that she 'didn't go off on a tangent' into education and early years theory seems to be significant first because she attributed her difficulties with learning maths-based theories to her understanding of other theories and, secondly, because she made it clear that generic theories of education were not the same as specific, maths-based theories (Conversation with Emily, p. 15). This suggests that, in order to be accessed by students, theories need to pertain directly to mathematics.

9.9.3 What is the impact of having to learn about educational theories?

The assignment that the students were required to write clearly demanded a level of engagement with theories both through personal reading and exploration of them at university and through planning and teaching mathematics lessons at school. The idea of there being a gap between what was learned by students at university (theory) and what they taught at school (practice) was echoed by a number of students in their interviews, but it was explained and interpreted in a slightly different way by each of them.

In her interview, Tara agreed that at university, she had gained a firm understanding of a number of educational theories but she suggested that this did not automatically enable her to draw upon this learning in the classroom. This perceived gap between theory and practice was characterised by the need for more practical examples of how the theoretical ideas could be manifested in activities that could be used with children. Tara felt that this ought to happen during sessions at university where students could be taught how to teach before the need to have to do so with actual children (Conversation with Tara, p. 15).

Eve echoed this dissatisfaction in her explanation of her difficulties with seeing theories in action with children. Like Tara, she felt that university could have done more to interpret theories and to translate them into practical examples for the students:

> JG: *I just wonder why there seems to be a gap between what you've been taught and your ability to recognise that when you're at school?*
> Eve: *I think it might be because when they tell you in lectures, I don't think I ever got that understanding of the examples of what it would look like in practice or the examples of different ways that you can lead children's learning to a mastery level. I didn't think there was quite the….. [Pause]…..yeah, the examples of practice, I guess.*
> (Conversation with Eve p. 16)

It is interesting that both students laid the responsibility for the interpretation of theories firmly in the hands of the university and not in their own reflection and critical thinking. Leanne made a clear and explicit reference to the gap between theory and practice when she said that theory told her *how* to teach and that the National Curriculum told her *what* to teach and that university fills the gap between them (Conversation with Leanne, p. 18). She felt strongly that there was a clear relationship between theory and practice and that having an interest in mathematics was important when implementing the theory.

The reasons for this perception are not clear, although it could be because as students, the participants in this study had insufficient experience to enable them to think of examples of theories or ways to use them. As former primary teachers themselves, university tutors do have the experience so can think of practical examples to support teaching and learning. Interestingly, Fran alluded to this possibility during her interview and reported that the classroom experience she had gained as a teaching assistant prior to commencing the PGCE enabled her engagement with theories (Conversation with Fran, p. 12).

This suggests that for some students, 'the gap' refers to a lack of experience that might enable them to understand how theories could be used in their practice. In his interview, Owen summarised this conflict succinctly by explaining that learning *about* something (theory) is not the same as knowing *how* to do it (practice). (Conversation with Owen, p. 18)

A number of students actually seemed to blame the writing of the assignment for the emergence of a gap between theory and practice. This is an interesting perspective with a number of significant implications. Firstly, the assignment is clearly the university's way of providing the opportunity for students to engage with theories. However, it seems that this contrived engagement with theory might actually hinder students' ability to engage with them in an inherently meaningful way and that seeing the true value of theories is important. Secondly, Tara felt that she had learned a great deal about theories during her PGCE, but she questioned whether that was as a result of reading for and writing her assignment or through teaching the children. After all, if theories are the basis of effective teaching, then she may well have encountered them at school anyway. She seemed unsure about this, but she did confirm that she had not returned to any of the theoretical ideas explicitly once she had submitted and passed her assignment. This could suggest that without a good reason to do so (like the need to complete an assignment in order to achieve QTS), the theories did not lend themselves to everyday classroom teaching.

9.9.4 The gap between theory and practice can be narrowed by supported contextualisation and reflection

The issues with having to learn about and apply theory also emerged in my interview with Eve when she was not able to relate what she saw in mathematics lessons to the theories she had learned at university (Conversation with Eve, p. 27). Eve did attempt to draw upon (*'link back'* in her terms) her learning from university while she was in the classroom and while she was able to relate her practice to the practical approaches and teaching strategies that she had been taught, this did not extend to the works of theory on which they were based. Not only does this suggest a clear gap between theory and practice, but it also hints toward the gap being occupied by those university sessions that offered practical strategies for teaching maths to children. This idea is supported by evidence from my discussion with Leanne who clearly defined 'uni practicals' (that I shall refer to as 'university practicals' from now on) as bridging the gap between theory and practice. As the evidence for Theme 4 suggested, the quality of the partnership between HEIs and schools is of the utmost importance.

This relationship between learning about theories, learning how to teach maths lessons and practising teaching can be tentatively represented by the diagram below:

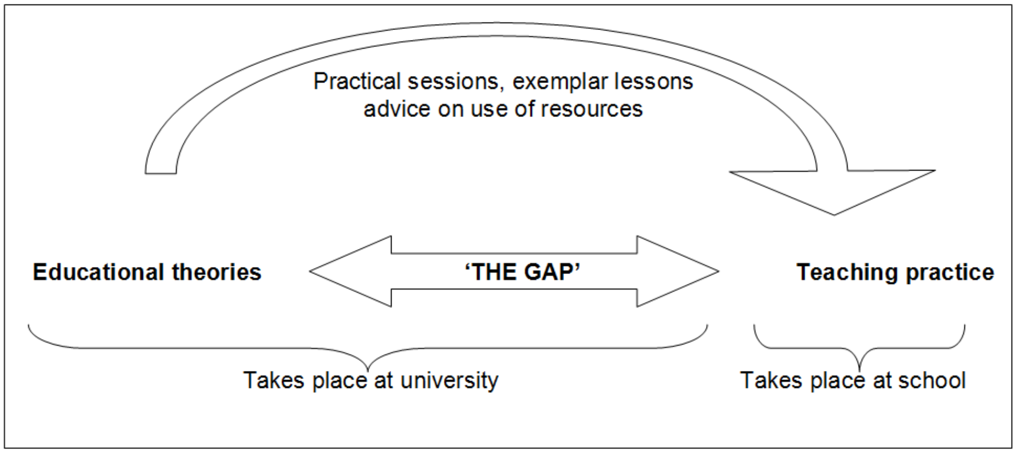


Figure 6: A simple view of the gap between theory and practice.

It would seem that, without the bridge of practical ideas taught during university sessions, there is a discord between theoretical ideas and teaching mathematics. To extend the bridge analogy further, Eve went on to suggest that there was a further gap between university practicals and the reality faced by students in each individual classroom:

> *... it's really easy at uni for lecturers to say, 'This'd be a really good approach to do with, like, a reception class because blah, blah, blah ... But actually, when they're saying it, they can't plan for what children you're going to have in that class.* (Conversation with Eve, p. 29)

Clearly, it would be unrealistic to suggest that university tutors should be able to prepare each individual student for each class that they (may or may not) teach while training, but Eve's point seems to be significant. This is because firstly, it suggests that learning is contingent and that the success of students' attempts to use theories is dependent, in part, on the context of the school/classroom in which they are placed which, as I discussed through Theme 4, is outside of their control. Secondly, it suggests that 'the gap' is perhaps wider than first thought and that, as well as seeing examples of theories in terms of practical lesson ideas, students also require a degree of support with contextualising these to apply them to each class that they teach. As such, it seems pertinent to propose a refinement to my simple, diagrammatic representation of the gap between theory and practice proposed in Figure 6:

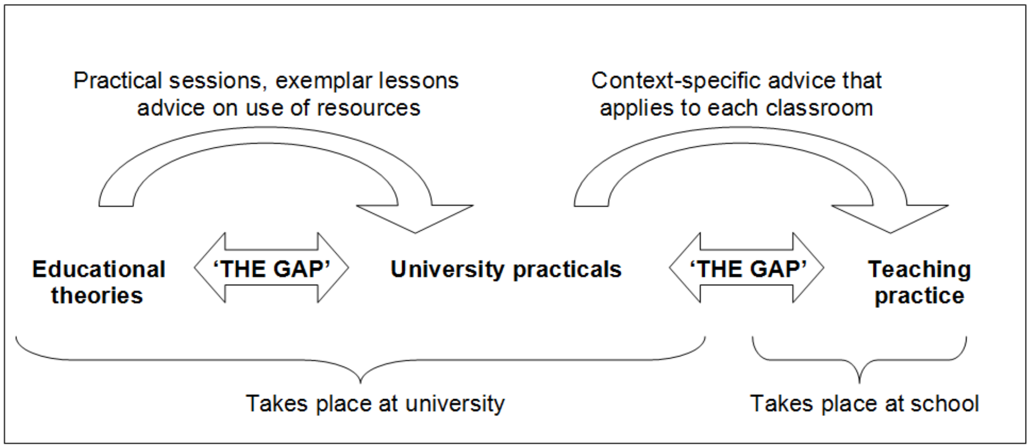


Figure 7: A view of the two-step gap between theory and practice

The two-step contextualisation of theory proposed above seems to be a more accurate representation of 'the gap' between theory and practice where 'university practicals' are seen as more of a stepping stone (as opposed to a bridge) between theory and practice and that contextual understanding and reflection on the part of the student is required first to translate theories into ideas for teaching and then secondly, for students to translate those ideas into specific practice that they can apply to the context of their specific school. There is the sense that the closeness of an experience to another is of great importance and the closer that experiences are, the more likely that learning will become cemented in a student's understanding. However, this model does seem somewhat at odds with Cameron-Jones and O'Hara's (1994, p. 140) view that schools should provide a contextualised version of learning while a university provides learning that is more easily generalised because it seems that the students required a degree of contextualisation of ideas from the university and a chance to rehearse and practise their ideas and understanding of theory *before* going out into their schools.

Whether the conceptual gap between theory and practice is indeed a single gap or whether it can be divided (and therefore made more manageable) into two, smaller gaps remains open to interpretation although it is becoming clear that contextualisation and reflection on the part of the students is necessary when it comes to bridging 'the gap'. As Eraut (2007, p. 419) observed, 'Formal learning contributes most when it is relevant and well-timed, but still needs further workplace learning before it can be used to best effect.’ During her interview, Eve made a direct reference to this as she explained that there seemed to be so little time to reflect on and contextualise ideas while studying for the PGCE. It is also significant that she suggested that her interview with me was providing some of the opportunity to reflect that she had required all along. When asked whether theories had influenced the way that she taught, Eve was not convinced that they had. She felt that she would not seek ideas from theory when she was teaching, but that theoretical ideas seemed to *‘crop up a lot’* (Conversation with Eve, p. 19) in practice. Through the conversation that ensued, she surmised that, perhaps theoretical ideas were, to some extent, embedded in her practice and that actually, theories had influenced her maths teaching more than she had first thought.

It could be argued that the opportunity to reflect on her teaching was necessary for this student to make the link between theory and practice and in Chapter 11, I suggest that there is a methodological contribution to be made by my approach to data collection. As discussed in Chapter 4, my ‘insider/outsider’ stance was a crucial factor in determining the quality of the data collected. Indeed, it could be argued that the interview itself had (albeit unwittingly) provided an important opportunity for discussion and reflection that may have helped to bridge ‘the gap’. As Eve herself commented, *‘…..this [interview] is like a full-on reflection, counselling kind of session!’* (Conversation with Eve, p. 20). By this, she meant that it was a rare and much-needed opportunity to discuss her mathematics teaching with a ‘more knowledgeable other’. While it would be outlandish to suggest that an interview is a necessary vehicle for reflection, there is, perhaps a case for a structured opportunity for students to discuss their maths teaching with a knowledgeable and interested teacher that could be either from their school, from university or from ‘outside’. I suggest that, since reflection is a personal process, student teachers need the identity of ‘learner’ (imposed by university tutors) and of ‘teacher’ (imposed by school mentors) removed in order to access the ‘self’ part of their triadic identity and to reflect in a meaningful way. However, it is untenable to suggest that this role could be fulfilled by a link tutor or a training manager. Not only are these roles fulfilled by individuals whose only real concern is the students’ ‘teacher persona’, but as a training manager myself, I recognise that this role is heavily biased toward the assessment of students rather than their learning. Orland-Barak and Yinon (2007) call this 'guided reflection' and promote its importance when it comes to the development of student teachers; they suggest that, through reflection, theory and practice converge and personal and professional development ensues. This is also very much in keeping with a recommendation by Elder and Kwiatkowski (1993, p. 9) that a *'theory-led reflection process'* ought to be incorporated into ITE programmes.

9.9.5 'The Gap' can be filled with literature

In this section, I have attempted to define and challenge the nature of the gap between theory and practice in terms of those things that the students felt might fill it. So far, the students have perceived this as a need for practical sessions that show what the theories could look like in practice, further contextualisation and application to specific schools and opportunities for students to reflect on their practice. Finally, I propose that educational literature may have a part to play in helping students to link theoretical ideas to their work in school.

During their interviews, students were asked if there were any texts that they had found particularly useful either in the writing of their assignment or in ideas of their maths lessons. While all of the students were able to discuss useful sources of information, Leanne and Sarah in particular provided some significant insights. During her interview, Sarah suggested that the gap between theory and practice could be filled by other people's views about theories. While this could either come from university tutors or from relevant literature, Sarah was clearly suggesting that theoretical ideas were most useful when they had been subject to a layer of analysis and interpretation by others *before* they had been accessed, analysed and interpreted by the students. Indeed, Sarah was able to identify specific examples of this:

> *What has been really useful in my planning and implementation of lessons is the work by Boaler, Askew and Liebeck. They have looked at various theorists and provide explanations or thinking points about how a particular theory can be transferred to the classroom and used practically.*
> (Conversation with Sarah, p. 13)

This insight is significant in two ways. Firstly, because it suggests that theories require a modern, contextual lens through which to view them. The evidence from the interviews indicates that some students are capable of providing that lens for themselves, but this suggests that some students may rely on the work of contemporary authors to contextualise older, theoretical ideas. Leanne also placed some of the work of interpreting theories in the hands of authors of books on mathematics education. Specifically, she felt that Mike Askew's (2012) book, *Transforming Primary Mathematics* did a good job of this (Conversation with Leanne, p. 17). For Leanne, Askew's summary of theories at the beginning of the book was less useful than his practical suggestions of lesson ideas and the interpretations of theories done on her behalf by Askew helped her to use theories in her own teaching. Indeed, her own definition of the gap between theory and practice refers directly to this:

> *I think it's [the gap] then interpretation…..I think there is a gap in between interpreting the learning theory and the practical activities slash advice that will allow you to meet the National Curriculum.* (Conversation with Leanne, p. 17)

While the interpretation of theoretical ideas presented in literature can clearly enable students to engage with them in a more meaningful way, Sarah suggested that this might not always be advantageous and that people (particularly students) may simply follow their way of working without considering whether it is the most appropriate approach to use (Conversation with Sarah, p. 14). Again, this suggests that, even those theoretical ideas that have undergone initial interpretation in the literature still require a level of critical thinking and interpretation by the students before they are of use in the classroom.

9.9.6 Conclusion to Theme 5

The data strongly suggest that students do experience a level of difficulty when using theoretical ideas in their practice so, as the title of the thesis suggests, there is indeed a 'gap' between theory and practice.

A gap emerges first from the distinction between generic and maths-specific theories that the students encounter; indeed, it could be argued that they stand little chance of addressing the gap between theory and practice without first addressing the gap between (generic) theory and (maths-specific) theory. The result of this is that students are not always able to translate theoretical ideas directly into their teaching and that ‘a bridge’ may be necessary to enable this. For many of the students, practical sessions at the university seemed to bridge the gap by showing them how the theories may manifest themselves in the classroom. For others, key texts that provided interpretation and contextualisation of ideas helped. In both cases, the students’ perceptions were that it was the responsibility of the university (and not of their schools) to provide the context for the theoretical ideas that they had encountered. Hagger and McIntyre (2000, p. 487) acknowledge the generalist nature of educational theories and research and suggest that at ‘the core of expert practice’ lies the ability to make subtle judgements about practice that may be only loosely based in the generalisations from the original ideas. As the students are not yet experts, it is perhaps unsurprising that they are unable to do this for themselves.

Chapter 10: The efficacy of the continued role of HEIs in ITE – Findings and Recommendations

There are specific reasons why PGCE students with an interest in mathematics are not always able to use and apply the theoretical aspects of their training while they are on teaching practice. I have chosen to refer to these as 'the gap between theory and practice'. Although the word 'gap' suggests that there is an empty void that exists between theory and practice, I have found that the gap between theory in practice is, in fact a tangible entity that, in its absence from the PGCE, can prevent students from making use of the theory that they learn.

This chapter of the thesis presents my findings and recommendations for evidence-based practices that emerged from the analysis of the data. The chapter will address each of the research questions in turn and in doing so, I will make recommendations about the structure of the PGCE, partnership between schools and universities and the quality of mentoring. Although I recognise the impracticalities of some of the recommendations that I will make, they present a best-case scenario which will make a valid contribution to the education of primary teachers.

While I have included personal reflections throughout the thesis, this chapter adopts a reflexive perspective (Grace, 1998, Lingard, 2009) which interrogates my own positioning and objectivity as a primary teacher, leader and teacher educator. It acknowledges that my professional and life experiences have influenced my responses to the materials and students that I encountered. When combined with the thesis as a whole, this chapter offers a bifurcated discussion of ITE and mathematics education and explores the efficacy of the theoretical aspects of the primary PGCE.

My distinctive insider/outsider position yielded useful data that has both breadth and depth. This is a clear asset to the study, but to maintain a focus on the purpose of the study and to give this chapter structural integrity, I shall discuss the data in terms of the research questions (RQs) set out below:

1. How does the mathematics course literature accessed by primary PGCE students compare with the original sources of learning theory to which it pertains?
2. To what extent do student teachers draw upon theories of learning in the planning, delivery and evaluation of their mathematics lessons within the context of a 'mastery curriculum'?
3. What are the enabling and constraining factors that student teachers face when using theories of learning in their mathematics teaching?
4. What are the implications for the continued role of universities in the education of primary mathematics teachers?
5. Is there a need for adult learning theory to describe the learning of primary PGCE students?

10.1 Research Question 1

How does the mathematics course literature accessed by primary PGCE students compare with the original sources of learning theory to which it pertains?

I have found that student teachers rarely, if ever, referred to original sources of learning theory and of those who did, 88% reported that they had found them difficult to understand. Instead, they preferred to engage with condensed versions of theoretical ideas that are contained within more modern texts about mathematics teaching in general. This is perhaps unsurprising as these are the types of text found on the reading list. By far, the most popular text on the reading list was Askew's (2012) *Transforming Primary Mathematics*. The students liked it because it gave practical examples of theories in action and was, as one student remarked, 'the bridge' between theory and practice (Conversation with Leanne, p. 17). This is because it provided an all-important, modern context for the theories that served to help students to understand them as well as demonstrating that they are actually relevant to mathematics teaching today.

Throughout this thesis (and in Chapter 5 in particular), I refer to 'second order' interpretation of texts. By this, I have referred to those texts that present the authors' own interpretations of original theoretical ideas that are simplified, pre-contextualised and embedded in practical examples on behalf of the reader. I had considered such reproduction and distortion of original works anti-intellectual and somewhat undermining of the value of the original ideas although as I have discussed, all language conveys only an *interpretation* of thoughts and concepts and not the thoughts and concepts themselves. In this sense, even Piaget in his original form features an account of his own thoughts and ideas that could be considered 'second order'. However, the 'second order interpretations' proved essential in allowing the students to understand the meaning of the theories and thus make use of them in their own practice. Emily seemed to benefit from those texts that, 'Put them [theories] all together and made it quite easy…in layman's terms, [so that] you get to understand it' (Conversation with Emily, p. 14). Similarly, Molly revealed that she had, of her own volition, sought a text not on the reading list that would help her to understand the theories better. She referred to Bates's (2016) *Learning Theories Simplified* in order to gain an overview of the key tenets of each theory that she had heard about at university before she sought out the original texts (Conversation with Molly, p. 21). She felt that without the use of this text in the first instance, her subsequent engagement with other texts (including original sources) would have been more difficult. In addition, this example suggests that before relating theory to practice, there seemed to be a gap between theory and theory itself. By this I mean that the book of simplified theories served to bridge a gap between theory that Molly did not understand and theory that she was able to understand as well as children's thinking that she could not understand or predict. Again, second order interpretations of theories were crucial tools that enabled greater engagement with thinkers like Piaget and Bruner and in constructivist terms, they provided an essential part of the students' own educational reality and their understanding of theories.

As I have already discussed, I believe that pedagogy can be applied to the ways in which student teachers, as well as children, learn and the text that Molly sought provided a form of scaffolding that is similar to Vygotsky's 'Zone of Proximal Development' because it allowed her access to an area of understanding that was beyond her grasp at the time. When viewed from a pedagogical perspective, student teachers actually *need* the condensed, second order interpretations of theory. According to Bruner (1960, p. 24), 'Detailed material is conserved in memory by use of simplified ways of representing it. These simplified representations have what may be called a 'regenerative character'.' This does, however, suggest that the original versions should come first and that the simplified versions should follow and serve to maintain the profile of the theories in the minds of the students. When considering this, my own 'insider/outsider' stance seems to create an axiological conflict. As an outsider, I feel strongly that student teachers should also be intellectuals. After all, the PGCE is a masters level qualification so it seems reasonable to expect that those students studying for a PGCE should be able to understand and interpret a work of theory in its original form. However, I have found that student teachers want to be taught in the way that children are taught and from my insider stance, I could never recommend introducing a concept to children in its most complex form in the first instance. It therefore makes sense that student teachers' first encounters with theories are simplified and made accessible to them, just as children's first experiences of, say, addition are simplified to make them more accessible. A good teacher would never consider introducing a Reception child to columnar addition (a formal method of calculation for larger numbers involving adding the ones and tens from each number) because they had not yet understood the fundamentals of additive relationships and of place value that are necessary. Indeed, it would be inappropriate to do so. In a similar way, it would be wholly inappropriate for students to be expected to read and understand Piaget's work in its original form before they had first understood the precepts of his work in simpler terms. While simplified versions go some way to re-brand and modernise seminal works of theory, students still see theory as outdated and therefore not relevant to modern ways of thinking, such as mastery. Some of this is due to their inexperience and an inability to apply their own, contextual lens to the theoretical ideas that are presented to them. It is also due to the superficial way in which they engage with the theoretical ideas at a practical level.

While it clearly has a part to play in the learning of both children and student teachers, the concept of scaffolding does present something of a theoretical conflict. While Vygotsky's socio-cultural stance emphasises the importance of the 'more knowledgeable other' and is centred on teaching, a constructivist would, I believe, reject the concepts of scaffolding as being inherently restrictive and overbearing. Scaffolding implies a supportive framework that crucially, is designed and constructed *externally* by a ‘more knowledgeable other’ while constructivism suggests that knowledge is the product of *internal* reasoning. It could be argued that second order interpretations of theories are not compatible with a constructivist stance since they impose an author’s own cognitive constructs on an individual rather than allowing them to create their own. However, I believe that where second order interpretations are used to enable students to construct their own understanding of the original ideas, they can be part of a constructivist approach.

The accessibility of educational theories is clearly of importance and I strongly believe that students should be given easy access to original sources of educational theories alongside simplified, more accessible versions of them. Ideally, this would be through a planned attempt to build upon simplified versions with increasingly rich and complex interpretations up to, and including, original works of theory. This would be beneficial for three reasons: 1) so that students could access theory at a level best suited to their current level of understanding or experience, 2) so that students are not unduly and prematurely ‘put off’ by complicated, theoretical ideas and, 3) to maintain high standards of intellectualism within a profession that is arguably about the production of intellectualism in others.

10.2 Research Question 2

To what extent do student teachers draw upon theories of learning in the planning, delivery and evaluation of their mathematics lessons within the context of a ‘mastery curriculum’?

10.2.1 The students’ approach to using theories

In Chapter 8, I suggested that student teachers’ are required to develop and maintain a complex, triadic identity and that this gives rise to a distinctive approach in their implementation of theory that is neither inductive nor deductive in nature. In one sense, the requirement to select a theory through which to view their practice suggests a deductive approach. However, through choosing theories that best suited their practice, an inductive approach is implied. Tsui’s (2009) definitions of ‘theorising practical knowledge’ and ‘practicalising theoretical knowledge’ provide a useful distinction between to two approaches. ‘Theorising practical knowledge’ involves making the tacit knowledge gained from experience explicit while ‘practicalising theoretical knowledge’ involves the creation of personal connections with and interpretations of formal knowledge through practical experiences. I suggest that students’ time could be best spent by ‘theorising practical knowledge’, in other words, by applying their practice to theory as a retrospective exercise.

Many of the students described theories as underpinning good teaching, but the study of educational theory is seen by the majority as an interesting, ‘bolt on’ activity rather than a fundamental element of their training and understanding as a new teacher. I have found that theories (or their effect, at least) may have actually been encountered by students without them being taught explicitly at university (I will identify this as a potential area of further study in the final chapter). During her interview, Molly suggested that it may be possible to *‘bump into [theories] while you’re teaching’* (Conversation with Molly, p. 23). By this, she meant that, as theories are seen to underpin teaching, it may be possible to encounter them incidentally in your day-to-day practice. While this does mean that students must have a basic understanding of educational theories *before* they go out into schools (in order that they recognise them in action), it suggests that Molly felt confident that theories are indeed reflected in everyday, classroom practice and that they can be encountered almost by accident.

While some of the students described theory as simply ‘good practice’ and expressed their belief that they manifest themselves in effective teaching, they were less clear about whether theories were firmly embedded in their own teaching. Indeed, it was only Sarah who reported that theories were sufficiently engrained in her practice for them to be used without effort or explicit intention to do so although significantly, Sarah was also the student with the most significant classroom experience so had more practical knowledge to theorise. In a sense, this suggests that the effectiveness of theories does not lie in the ideas themselves, but rather in the experience of individuals that allows them to be activated. To enable greater engagement with theory, the PGCE could be restructured so that students only encounter it later in the programme once they have significant classroom experience with which to contextualise theoretical ideas. Similarly, educational theories could be reserved for longer, undergraduate teacher training programmes where there is time for it to become truly embedded and useful. In time, the PGCE could become more of an apprentice-based programme that equips students with basic, classroom competences rather than trying to incorporate a condensed and inherently superficial theoretical element. These students could learn about theoretical approaches through CPD and as part of their early career teacher programme.

10.2.2 The students' use of theory in their teaching practice

Seven of the eight students interviewed reported that they found the practical, school-based aspects of the PGCE more beneficial than their university-based, theoretical learning. They felt that time in the classroom better equipped them with the skills they would need to be able to hold their own once qualified. Once again, this emphasises the perception among the students that the 'training' aspect of the PGCE is of more value than the 'education' aspect. The result of this is significant because there is a danger that primary teaching could be reduced to a narrow set of administrative and managerial skills without any genuine knowledge or understanding of the intricate relationship between teaching and learning. I believe that this can be remedied by learning about theory because it provides a broader, almost eternal context through which to view professional practice.

Despite the students' perception of the relative usefulness of theory and practice, all students did draw upon theories, to some extent, while they were at school, because this was a requirement of their assignment. As I shall discuss in response to RQ3, the assignment itself both enabled and constrained the students' ability to make use of theories. What follows is a brief summary of the ways in which the students made use of theory aside from writing their assignment.

In terms of their planning, some of the students were clearly influenced by Bruner's Modes of Representation. This is perhaps unsurprising when you consider that the principles of Bruner's framework underpin the mastery curriculum and the CPA approach. For example, both Eve and Emily considered Bruner's approach to be the most obvious choice when it came to planning for their Year 1 classes. Although Emily planned a unit of work on repeated addition for her Year 1 class using the CPA approach, her lessons were unsuccessful because of the need to differentiate for a broad range of needs within the class. While some of the children were suitably challenged by the concrete representation of counting in 2s that she had created, others found this too easy and seemed ready for experiencing repeated addition in abstract terms and completing written calculations such as 2+2+2+2= . She therefore deemed it untenable and abandoned the approach. Significantly, Bruner does not suggest that teachers should not differentiate at all. Indeed, he endorses the use of 'scaffolding' as the means through which a teacher controls '… those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence.' (Wood, Bruner and Ross, 1976, p. 90). This suggests that Emily had wrongly attributed one of the precepts of the mastery curriculum (that all children should move through the curriculum at broadly the same pace) to Bruner's theoretical framework for understanding concepts and had deemed the theory unworkable in the classroom. Despite this, Emily did make reference to Bruner's 'Spiral Curriculum', but this was only to say that she was unable to consider it in her planning for progression because, as a student, she did not have any real insight into what the children had been taught before her placement began. Leanne drew upon Vygotsky's concept of 'The More Knowledgeable Other' in an attempt to negate the issue of having insufficient resources for each child. She reasoned that, if she could pair a lower attaining child with a more able child, there would be enough resources to go around and that both children in the pair could benefit from the dialogue between them as they worked. On reflection, Leanne found that this had not worked because the more able children had been held back while the lower attaining children had been simply confused.

In their teaching, a number of students reported that they drew upon Vygotsky's notion of scaffolding. Fran reported that she had even been able explore the concept of negative numbers with some of her Year 1 children by scaffolding their understanding of subtraction. Owen also enjoyed success when teaching columnar multiplication to a Year 5 class and he attributed this to his use of scaffolding. Owen's class of Year 5 children contained a broad range of mathematical ability with some children working at a Year 3 level while others were exceeding expectations and working more like Year 6 children. He was able to use concrete apparatus such as ‘Base 10’ to ensure that the less able children were still developing their understanding of multiplication without overburdening them with the requirement to produce written calculations.

Only Tara and Owen made reference to any use of theories in the evaluation of their mathematics teaching. Owen used his evaluations to made decisions about whether to scaffold concepts more or less in subsequent lessons. Tara reported that, through her evaluations, she learned that she too made lots of use of scaffolding throughout her lessons. That said, the theory seemed to provide her with more questions than answers and she felt that her instinct to withdraw her support of the children to prevent an over reliance on her help may have been at odds with Vygotsky’s ideal scenario.

Despite her negative view of the CPA approach in practice, Emily did use it as an assessment tool (rightly or wrongly) following her lesson. She perceived that students who had moved on to abstracting were attaining at a higher level than those that were still working with concrete apparatus. Bruner’s presentation of the enactive, iconic and symbolic modes does suggest that a child’s age determines which stage they’re at, but it does not suggest that their ability to make use of a particular mode of representation within a given context indicates their level of attainment with regard to that context.

As this summary suggests, the students seemed to enjoy limited success as they attempted to make use of theories outside of their written assignment and apply them directly to the children’s learning. While they showed some understanding of theoretical perspectives with regard to the children’s learning (pedagogies), they seemed to lack a theoretical model for their own learning. Andragogy (Knowles, 1988) maintains that intrinsic motivation outweighs extrinsic motivation and that learning is most valuable when it is problem-based and collaborative rather than imposed and inherently didactic, however, when left to their own devices, the students enjoyed less success than when they were extrinsically motivated by the need to complete their assignment. This humanistic approach is at odds with the structure of the PGCE that does not afford the students such flexibility or an organic learning experience. Rather, the tenets of cognitivism (of which constructivism is an aspect) are more prevalent; although they are adults, the students are bound by the restrictions and expectations of their course as well as by what they are taught by their tutors.

10.3 Research Question 3

What are the enabling and constraining factors that student teachers face when using theories of learning in their mathematics teaching?

10.3.1 The assignment

Interestingly, the students' assignment both enabled and constrained their use of theory. The requirement to write an assignment that made use of theories ensured that the students had at least heard of them and had had a structured opportunity to engage with them in the classroom. Without this, the data suggests that the students may not have bothered. However, it simultaneously imposed a reductionistic approach to their application by *forcing* the students to make use of them within a precise context and timeframe, irrespective of their ability to do so or the context of the individual schools in which they were placed. This actually led to a somewhat contrived assignment that was also too focussed on one or two theories and one instance of teaching for it to be a truly useful insight. For example, only Tara, Owen and Molly explored their practice through more than one theoretical lens and Fran admitted that she had only chosen Skemp's 'Instrumental and Relational Understanding' because she thought that it would be the easiest to try weave into what she was already doing at her placement school.

While the students were effectively forced into considering educational theories as part of their PGCE, for some students, the element of choice when it came to which theories to focus on for the assignment actually enabled a greater engagement with them. This is because they preferred (and therefore chose) those theories with similarities to their personal teaching style. Three of the eight students interviewed reported that they had enjoyed writing their assignments because they had had a positive and meaningful engagement with the theories that they had chosen. Indeed, they did not want to deviate from this or choose theories that might be at odds with what they would ordinarily do. I had unfairly assumed that this would be down to reasons of convenience and ease of data collection while they were in school, but actually, some of the students did provide well-principled reasons for this; they wanted their assignments to be personal to them and for their choice of theory to reflect their values and beliefs with regard to mathematics education. However, despite the principles behind their choices, the net effect of students choosing their own theories was that they received a very narrow snapshot of theoretical thinking that did little to challenge their own thinking or make an impact on their practice. A constructivist perspective might suggest that the students required a level of perturbation in order to truly benefit from their theoretical learning. Piaget implies that perturbation can result from internal and external challenges and contradictions to an established cognitive scheme. For him, perturbations can be described in two ways: as *obstacles* and as *lacunae* (Piaget, 1985). Within the context of selecting theories for their assignments, it seems that the students were subject to both. Firstly, they were subject to the obstacle of theories seeming to be incompatible with their current practice or practices at their placement schools. Secondly, a lack of thorough understanding of the theories created a cognitive lacuna. These factors represent external and internal perturbation respectively although by selecting theories that seemed to align most easily with their preferred teaching style, the students opted to avoid perturbation altogether. As Di Paolo et. al. (2014) point out, this creates the Platonic conundrum:

> I can only perceive what lies in front of me if I understand it with the categories and skills I already possess; yet new categorisations are required to perceive something new and there seems to be no source of categories other than those I had before. (Di Paolo et. al., 2014, p. 4)

This deviation from a constructivist approach could go some way to explain the students' difficulties with making use of theoretical concepts, although the gradual emergence and development of new ideas that constructivists describe takes time that the students are unable to invest when confined by an assignment deadline. Indeed, the students' motivation to make use of theory is predominantly extrinsic and concerned primarily with passing the assignment. Students seem to lack the intrinsic motivation to consider theories for their own benefit and to help develop their understanding of teaching and learning. This extrinsic motivation gives rise to some anti-intellectualism in terms of the way in which students produce their written assignments. They engage with literature in an inherently superficial way; they are not truly critical with the ideas of others, but they seek references from course literature to insert into their work to bolster their claims and to give weight to their arguments. It is enough for the students to give the *illusion* of critical thinking. The superficiality and contempt with which theories are learned and applied by the students is propagated by the assignment which should perhaps not have a theoretical emphasis at all. The tentative and situational nature of educational theories means student teachers do not simply learn theory at university and apply it at school. Rather, their practice is pragmatic and posteriori. There remains some doubt as to whether they really understand Vygotsky or Piaget on the one hand, and on the other, whether they needed to. The case for the latter is that when they understand the fundamental concepts in the work, they can, at least make informed decisions about the best approaches to use in their teaching of mathematics in the future because as students, they are unlikely to be allowed to make a genuine change to the practices of their placement schools. They should be obliged to return to this later in their careers through CPD opportunities, pupil progress meetings and performance management reviews. Learning is, after all, a process and not an event and the lifelong learning aspect requires a less mechanistic approach than we have at present.

As an alternative, I propose that students should keep a reflective diary detailing interesting instances of their mathematics teaching. Rather like my own research diary, it would record the students' growing understanding and capture the exigency of interesting instances of teaching and learning without infringing upon the busyness of the school day. This approach would also provide longer lasting, intrinsic motivation over the more short-lived, extrinsic motivation to get the assignment done. The reflective diary could then be used toward the end of their PGCE as a personal context through which to learn about educational theories.

To conclude this section, the students' assignment actually served to make theory a singular, peripheral activity to be completed rather than central to their longer term understanding of how children learn mathematics. Furthermore, the timescale involved in completing the assignment does not reflect the incremental nature of learning that ironically, many of the theories themselves promote. For example, Bruner's well-known and respected concept of 'The Spiral Curriculum' suggests that learning occurs when individuals return to familiar concepts and extend their understanding of them each time that they encounter them. This is particularly pertinent in the mathematics curriculum where there are a finite number of mathematical concepts that are explored at greater depth and complexity as children develop. Indeed, adults studying for mathematics degrees can only be taught about addition and additive relationships because they were also taught about addition and additive relationships as Reception children. Despite this cycle of learning and returning to concepts to deepen understanding over time, PGCE students are expected to simply learn theory and apply it, at masters degree level, within the space of a few months.

10.3.2 Theory comes too soon in the PGCE and it needs to be activated and contextualised before it becomes truly useful

I suggest that students' difficulties with understanding Piaget or Bruner in their original form perhaps has more to do with *when* in the course the theories are presented to them rather than the content of the theories themselves. While pedagogy can be gainfully applied to the way in which adults learn with Bruner's 'Modes of Representation' being the preferred approach, the PGCE is structured in such a way as to be the complete reverse of Bruner's process. Students first read about theories from text books and journal articles, they then discuss them in practical sessions at university and finally they get to try them out in with children in school. As I have suggested, students have difficulty with making use of theories not because of inability of lack of intellectual prowess, but rather because they have insufficient classroom experience on which to base the theoretical aspects of their learning. Bruner seems to agree and suggests that, '... even relatively well-prepared teachers do not have sufficient opportunity to learn their subjects in the special way that comes from teaching it. For teaching is a superb way of learning.' (Bruner, 1960, p. 88). This suggests that theory needs to be activated and contextualised by prior classroom experience to be truly useful. In their description of 'realistic teacher education', Korthagen et. al. (2008, p. 45) agree and suggest that taking an inductive approach can help to bridge the gap between theory and practice. This begins with student teachers engaging in a period of school experience where they can observe and develop classroom competence. Following this, they attend university where they learn about theoretical concepts and have the opportunity to reflect on their experiences in their terms. Finally, they return to school having gained from their theoretical reflection on their practice. They argue that this approach is inherently meaningful provided that students' initial experience retains a strong focus on their professional learning, rather than becoming dominated by their professional socialisation (Korthagen et. al., 2008, p. 43). When this structure is adopted, Koetsier, Wubbels and Korthagen (1997, p. 122) suggest that students do not necessarily see the university input as theoretical since it is so closely related to their personal experiences. This could be additionally advantageous when considering the negative connotations that some of the students in this study attached to theoretical learning. 'Realistic teacher education' could be likened to a 'theory sandwich' in which theoretical learning is supported on both sides by structured classroom experience. Logically, this approach sits within the theoretical framework of constructivism because it suggests that student teachers build their own understanding before understanding from external structures (such as constructivist learning theory, ironically) is imposed upon them. It is perhaps of little surprise then that Sarah demonstrated the deepest understanding of and engagement with theory because of all those that I interviewed, she was the one who had the most significant classroom experience before commencing her PGCE. After all, she had already completed the pre-theory school experience advocated by Korthagen et. al. (2008), so she was best able to cope with the theory that she encountered at the beginning of her PGCE. I am now able to propose that theory simply comes too early in the life of a teacher and that in most cases, has lost its meaning by the time the theoretical assignment is submitted at the end of the autumn term of the PGCE. In his presentation of 'The Spiral Curriculum', Bruner (1960, p. 27) suggests that '… it might be wise to assess what attitudes or heuristic devices are most pervasive and useful, and that an effort should be made to teach children a rudimentary version of them that might be further refined as they progress through school.' While he is, once again, proposing this for the education of children, I suggest that this too can be (indeed should be) applied to ITE.

In light of this, I now present 2 alternative proposals for a more fruitful engagement with theory. The first is an ideal scenario that, in a sense, showcases how I believe that students *should* engage with educational theories:

a) As the students had insufficient experience with which to make proper use of theories, I propose that the PGCE should, in fact, not include a compulsory theoretical element at all. Of course, students may encounter theories incidentally or be directed toward key texts about them, but removing the element of forcing students to use them (by removing the requirement to read and write about them) would ensure that students' encounters with theories would make a more organic contribution to their development as teachers.

Instead, I suggest that students should not be taught about theories and that they should be woven first into their ECT induction period and then subsequently through CPD throughout their early careers. Rather like Bruner's 'Spiral Curriculum', returning to the theories and viewing them within the context of increased classroom experience will allow them to be truly learned. In the early stages of their careers, teachers need to embrace pedagogy and the CPD programmes for ECTs (that are provided by Teaching School Hubs and Local Authorities) need to be ramped up and for theory to be taken seriously. With a demise in Local Authority provision (following the General Election in 2010), universities are plugging some of the gaps in CPD and the expertise of their tutors could be used to support this. Either way, students must be obliged to engage with theory-driven CPD both in their ECT induction period and beyond and Local Authorities (who are responsible for ECTs) should rise to this challenge.

However, this recommendation relies on a number of cooperative factors that may not, in reality, be tenable. For instance, it is commonplace for ECTs to be employed on fixed-term contracts for one year. Their school may well provide theory-rich CPD and training through their induction programme but when the ECT moves to another school, there is rarely a transition process (as there is for Year 6 children moving on to secondary school). Prior learning would need to be taken into account by new employers and contextual discontinuity could result in mixed experiences (and therefore learning outcomes) for the ECTs. Even where ECTs are able to remain in their first schools for more than a year, school priorities are subject to change and as I have discussed, Ofsted inspections frequently cause disarray and uncertainty. This could shift the focus of CPD away from theoretical understanding and development to the detriment of the teachers themselves.

I therefore propose a more realistic amendment to this recommendation that would leave control of theories firmly in the hands of universities:

b) Learning about theories must come much later in the PGCE once students have had more classroom experience. In this way, they will be able to view the theories with the benefit of a meaningful context. In addition, students should not be required to write an essay about them. It is both off-putting and unfair to assess students on the basis of theories (that were developed by experienced educationalists over many years) that they are given mere weeks to understand. To facilitate this, students should be encouraged to keep a reflective diary. In the way that my own research diary has supported my emerging understanding of the areas covered in this thesis, student teachers should also keep a research diary as part of the evidence base for their PGCE that will note the contexts that they encounter at school to enable reflection on them both as a formative and summative exercise. As well as supporting ongoing evaluation and improvement of their maths lessons, their reflective diary could also be brought to university after an extended period in school and be used as the context through which to apply various theoretical lenses. In this way, rather than manufacturing a context to 'make theory happen', they would be producing theory from personal (and inherently meaningful) experience. As university study effectively forces students into seeing their mathematics teaching through theoretical frameworks, far better, I propose, to encourage students to use a range of theoretical frameworks as lenses through which to view their teaching and the children's learning. This could mean that, following an episode of mathematics teaching, students reflect on it (and write about it) briefly though a number of different theoretical lenses so that, at least, they are able to consider a broader range of ideas that might have a further-reaching impact on their practice.

10.3.3 The question of time

The majority of the students whom I interviewed cited a lack of time as a significant barrier to their use of educational theories. This was due, in part, to their perception of their importance. As they were, in the main part, viewed as an additional, bolt-on activity – something to 'do' if there was time – they were not prioritised and, with the pressures of day-to-day classroom teaching, they were pushed to the periphery of the students' consciousness. Additionally, some of the students identified that there was too little time on their PGCE programme to truly engage with the theories they had learned. Student teachers do not simply learn theory and apply it, they need time to develop an understanding of it that is pertinent to themselves, their experience and their specific school context.

In Chapter 3, I discussed the precepts of a mastery curriculum for mathematics. Such an approach emphasises ‘depth over breadth’ so that the children develop a genuine understanding of each concept that they encounter, rather than a more superficial level of procedural understanding. While this approach is actively promoted as ‘best practice’ when it comes to teaching the children, it seems that the principles of a mastery curriculum are not adhered to when it comes to teaching the students themselves. They do not explore educational theories in much depth but instead, they attempt to learn and apply a diluted version of them in order to complete their assignment to a satisfactory standard before moving on to another aspect of their teacher education. This is not to say that university tutors are in some way falling short, but sadly, the ITE system seems to mirror the primary education system where a standards-driven agenda creates a ‘sausage machine’ effect where qualified teachers are produced regardless of whether they have developed a deep, conceptual and theoretical understanding. If they can teach a class competently, that is deemed to be a success. Student teachers are a product, a marketable commodity and despite the best efforts of teacher educators, new teachers are produced on demand and insufficient regard is paid to their development as individuals. As such, the students are victims of a form of neo-liberal corporatism (Giroux, 2014). One of the tenets of corporatism is that knowledge becomes a marketable commodity and this seems to be the case where the students are concerned. Not only is this to the detriment of the development of individual students, but it’s also destructive of the intrinsic benefit of education.

Over a third of the students interviewed made reference to their efforts being hindered by the National Curriculum itself. In their view, there was simply too much curriculum content to cover to enable to them to concentrate on the development of their mathematics teaching. Over the course of their PGCE year, it is possible that primary education students do not have time to delve deeply into, or reflect upon their mathematics teaching because of the variety and breadth of the other subjects that they must teach. The daily mathematics lesson may be one of four or five different lessons that day, so it is of little wonder that they find it difficult to reflect on their day-to-day maths teaching in a truly meaningful, organic way. In this way, it is also of little surprise that the university forces them to engage with theory for the assignment because they realise that the more desirable ‘drip feeding’ of theory throughout the PGCE may simply be impractical.

Recent educational developments may actually promulgate this problem. The new emphasis placed by Ofsted on the curriculum content for the foundation subjects has some significant implications. A heavy emphasis on standards in reading, writing and mathematics that has been driven by Ofsted in recent years has placed teaching and learning in English and mathematics in the limelight. Since a renewed Ofsted inspection framework came into force in September 2019, schools have undergone a considerable shift in emphasis away from the incessant focus on reading, writing and mathematics skills toward a focus on (some might say obsession with) pedagogy and progression of knowledge in the foundation subjects (such as history, art and music). This attempt to teach for a more holistic education is, in my view, a welcome shift in emphasis and it is possible that some of the skills learned in foundation subjects may help students to understand different ways of learning and pedagogy in more general terms. However, now that mathematics is no longer at the centre of schools’ attention, opportunities to pursue a mathematics specialism are likely to be fewer than they have been. Arguably, now more than ever, PGCE students developing a strength in mathematics are having to substitute a deep, theoretical understanding of their subject for a superficial set of skills and ‘quick fixes’ in order to plug the national teacher shortage.

10.3.4 The problem of university-school partnership

In Chapter 2, the thesis explored different models for partnership between schools and HEIs in ITE. This is because teacher education relies upon effective collaboration with the schools where the students practice their newly-acquired skills. However, the data suggest that the type of school in which students are placed has a significant impact on their ability to understand educational theories and that there is often a mismatch between the expertise of the students and the schools in which they are placed. Some of this is down to the school’s current position with regard to mathematics and their school development priorities. Where mathematics was a current priority (this is often determined by the outcome of a school's most recent Ofsted inspection), students were given more freedom to implement some of the things they had learned at university. In this context, a school's desire for rapid improvement in mathematics might allow the students to do more of the things that are not usually given any attention (like drawing upon theoretical knowledge). I feel strongly that this is not the right reason and that schools should be chosen for students rather than students being chosen for schools.

That said, a recent development at the university does represent a step in the right direction. The university form used by schools to request students for various placements now includes a place where schools can request students with particular areas of expertise and interest. However, this is primarily concerned with how useful the students can be to schools and not how useful (or rather, appropriate) a school is to a student. This really does need to be reversed so that the university places students in schools that have the relevant expertise to support them. This means that students who have chosen to develop a strength in mathematics can easily find themselves placed in schools with insufficient skills and expertise to support them. It is perhaps assumed that, as mathematics is a high-profile subject in all schools, each school will have individuals that are well-placed to support the trainees. The reality is that the nature of the mathematics strength module is very specific and focussed on educational theories that many schools are not equipped to support. When choosing a school for a student's teaching practice, it should be less about a student's interests and providing them with opportunities to teach different things, and more focussed on what the students are able to *learn* from each placement school. For example, Eve was placed in a school where there were firmly-established practices with regard to the teaching of mathematics. Her perception was that the school 'knew best' so despite the specialist teaching she had received at university, she was not able to develop this aspect of her practice while she was on her placement (Conversation with Eve p. 13). A reflective diary may have allowed Eve to consider these issues.

A part of my role as a Training Manager for the School Direct programme involves seeking and arranging school placements for both the salaried trainees and the

School Direct PGCE students in the cohort. Schools that host a PGCE student receive payments from the university for each placement; these are to cover the additional costs that may be incurred while the student is at school. In my own school, the monies received contribute to cost of release time for mentors to meet with and adequately support the students during school time. However, in my experience of seeking placements for PGCE students, the financial incentives schools receive are a significant part of the motivation for some schools to host a student at all. Again, the neo-liberal corporate agenda means that students are effectively sold to schools on the basis of what they are able to offer the school. In my view, too little regard is paid toward what schools are able to offer the students. On a number of occasions, I have received last-minute requests from universities to offer placements to students at my school. Sometimes, I even receive these the day before a placement is due to commence. In trying to persuade me to host a student, the emphasis is always on how 'good' the student is or how successful their previous placement had been. Rarely have conversations ever included reference to the students' areas of specialism or whether my school is well-equipped to support them. This suggests that quantity, rather than quality is a priority when it comes to school-based placements.

10.3.5 The importance of school-based mentors

The quality of the mentoring that the students receive is of critical importance to their ability to make use of the educational theories they have learned about. Where mentoring was at its best, mentors were at least interested in what the students had learned about at university and were able to talk to them in general terms about their mathematics teaching. However, generally, the students' school-based mentors were not mathematics specialists themselves and, other than facilitating the opportunity for the students to carry out the work required for their assignment with the children, mentors rarely supported the students' development as mathematics specialists. Zeichner and Tabachnick (1981) describe a 'washing out of progressive attitudes' that occurs rapidly when students qualify as teachers. While Korthagen et. al. (2008, p. xi) do not blame teacher educators for this, they suggest that their failure to take account of student teachers' preconceptions of teaching before they begin their training contributes to the 'washing out' effect. However, I have found that this attitude to theory occurs before the students qualify and that mentors who display little interest in, and actively dismiss the student's university-based learning are, in part, responsible for this. Clearly, this raises questions about mentor training and development. John (1997, p. 28) found that mentor training tended to focus more on the use of monitoring of students and the use of documentation to record their progress than on pedagogy. The mentor training that I have completed myself did make reference to the monitoring of students, but focussed more on the principles of mentoring and coaching than on the specific elements of the PGCE. I propose that there is a need to increase involvement in mentor training by making it a compulsory condition of hosting a student. Students developing a strength in mathematics also need to have a quality mentor who is trained and knowledgeable about the content of the taught elements of the PGCE (including a firm understanding of the works of theory that their student will learn about at university). In addition to the 'soft skills' of mentoring and coaching that characterise mentor training at present, the mentor training that the university provides should also include information about precisely what the students are taught about at university and how this can be supported by them at school. School mentors should be obliged to take theory more seriously. This could be achieved by making the support of student teachers one of the professional standards for teachers. From my own experience as a teacher educator and training manager for an ITE programme, there seems to be a lack of interest among mentors when it comes to theory. Before demanding greater engagement with theory from student teachers, mentors need to embrace pedagogy both to adequately support the students in their care and to serve as fitting examples of scholarship with a genuine interest in learning and development.

There is another aspect of mentoring that I had not considered until carrying out the interviews and one interview in particular alerted me to a new possibility that I detail in the following chapter. In brief, my interview with Eve revealed the value of our discussion from her stance. She described her interview as a 'counselling session' that allowed her to openly reflect upon theory and practice and I had (admittedly unwittingly) provided a form of mentoring that seemed to be absent from her experience until that point.

10.3.6 The very nature of being a student teacher

In addition to the school context, the very nature of studentship or more specifically, student teachership presented a constraint on the students' abilities to make use of theory. Juggling a teacher persona and a student persona alongside aspects of themselves gives rise to a phenomenon that is unique to teacher education. First, they, as learners, are taught about teaching then they must put into practice what they have learned in order to teach the children – ever mindful of what the children are learning. I have chosen to call this 'the matryoshka effect' because, rather like the layers of a Russian doll, student teachers are taught about teaching and learn about learning in a strangely repetitive, microcosmic sequence that affects both themselves and the children that they teach. The impact of the matryoshka effect is significant because it means that student teachers find it incredibly difficult to make links between their own learning and what the children must learn. In effect, students must grapple with a simultaneous interpretation of theory both for themselves and for the children they teach so that theory and practice become separate entities: the former important at university and the latter important at school. Students do not seem to see a link between their own learning and that of the children that they teach. They learn theories for themselves (and in order to pass the assignment) rather than seeing the impact of them on the children's mathematical development. Theory has become a rite of passage and a means to becoming qualified. There is a risk that they become doubly disadvantaged because they are unable to see the relevance of learning theory either for their own learning or for the children's learning. Explained from a constructivist perspective, children do not present an ontological reality – they respond to teaching in different (indeed, unpredictable) ways. According to von Glasersfeld (2002, p. 17), it is difficult to apply general, theoretical ideas to specific situations when the cognising participant is not ourselves, but an individual that we are observing. This is true of the students as they consider children's learning in theoretical terms and serves as a poignant reminder of the inherent difficulty of this. This is also true of myself as I have made use of theories to consider the students' learning. In many ways, this perspective expands the 'matryoshka effect' and adds a further layer to the Russian doll analogy. Perhaps this difficulty should be acknowledged so that students can overtly apply pedagogies to their own learning without any expectation that they are able to simultaneously apply them to the children's learning.

10.4 Research Question 4

What are the implications for the continued role of universities in the education of primary mathematics teachers?

As a profession, teaching is currently afflicted by a nationwide recruitment and retention crisis. Universities up and down the country are being instructed to do everything possible to improve the numbers of students taking up PGCE and BEd places: this includes lowering entrance requirements for their programmes and removing the requirement for trainees to pass the QTS Skills Tests. This erosion of intellectual standards for prospective teachers is worrying but while it is keeping the number of those applying for ITE programmes buoyant, retaining those individuals in schools once qualified appears to be a separate issue. According to the DfE's ITT Census for 2019-20, the number of entrants to primary ITE programmes was only 4% below target (a shortfall of some 500 students nationally). This is favourable when compared to recruitment for secondary programmes that were 15% below targets overall; the greatest shortfall was in mathematics where 1198 places were left unfilled (Foster, 2019, p. 8). Clearly, maintaining teacher numbers is not only about a healthy recruitment rate, but also about the retention of existing teachers. According to the parliamentary briefing paper 'Teacher recruitment and retention in England' (2019), 35,645 teachers left the state sector (for reasons other than retirement or death) in 2018. While this was 400 less than in the previous year, it was around 11,000 more than in 2011. This presents a worrying trend, but of more relevance to this study is the finding that 22.5% of newly-qualified entrants to the profession in 2016 were not recorded as working in the state sector just two years later (Foster, 2019, p. 9). To investigate the reasons why this might be, the DfE carried out a study of former teachers, the results of which were published in 2018. It comes as little surprise that excessive workload was the most prevalent factor that influenced a teacher's decision to leave the profession. Additionally, the study found that a number of factors that accumulated over time often drove the decision to leave the profession while for some, there was a specific, identifiable cause (Foster, 2019, p. 9). In 2018-19, the government accepted the School Teachers Review Body's (STRB's) recommendation that they should increase the pay of early career teachers by 3.5% in a clear attempt to persuade them to stay in the profession. This reaction appears to be a strange one and not in keeping with the government's usual approach. Where, in the past, a societal issue has seemed serious enough, remedial measures have been imposed on schools as a means to addressing the problems before they arise. For example, a huge focus on behaviour arose following the Summer Riots of 2012; a healthy eating agenda in education coincided with growing concerns over an obesity crisis; rising debt and unemployment resulted in financial education making its way into the curriculum for secondary schools. In a similar vein, Great Britain's impressive showing at the London 2012 Olympics resulted in a release of additional funding to schools for the specific purpose of promoting sports (to ensure further success in subsequent Olympic competitions). In short, if the government wants to truly understand the reasons for the teacher retention issue that it faces, it too must look to the education of the teachers and try to tackle the roots of the problem.

While teaching is undoubtedly a complex and stressful occupation, I propose that one of the factors that contributes to the poor retention rate of teachers is the emphasis placed on certain aspects of their initial teacher preparation. Here, I use the term 'preparation' because I believe that the clear emphasis on 'training' students in schools (i.e. providing them with opportunities to practise teaching) rather than teaching them to teach and how to promote effective learning (i.e. educating them in a more formal sense) means that they join the profession with a limited set of skills that does not afford them sufficient protection in the face of increasing professional and intellectual challenge. In Chapter 2, I drew a clear distinction between ITT and ITE because I believe that *educating* a teacher involves a deliberate intention to teach them about learning whereas *training* a teacher merely involves allowing them to practice teaching in a classroom with only incidental encounters with pedagogy. Universities have been swapping between the two terms for some time. The change in title was often marked by a new government and a new educational emphasis. The DfE's choice of terminology is significant and I believe that it is at the heart of the recruitment *and* retention crisis that it is aiming to dispel.

It seems only right at this stage to address what appears to be a contradiction in my own conclusions. On the one hand, I continue to extol the many benefits of theoretical learning for students yet simultaneously, I appear to suggest that theory is not suitable for student teachers because they are yet to gain the requisite experience that, I maintain, is required in order to fully appreciate them. Similarly, I am not suggesting that students are not ready for theory because of the existence of Piagetian, qualitatively different levels of thinking. This conflict is reminiscent of many occasions in my teaching career. There have been times when I, as a teacher, have been unsure whether to introduce new concepts to the children before I am certain that they are able to understand or make use of them. On the one hand is the risk of providing a cognitive burden or worse, confusion, yet the disservice done to children if they are not even exposed to new ideas (combined with my assumption that they may not understand) far outweighs the former. In a similar way, I believe that not introducing theoretical concepts to student teachers would be to do them a disservice and would eliminate any potential for them to recognise or make use of them while they were training. For me, the issue lies in the requirement for the students to write (at masters level, no less) about theory and to be judged and formally graded on their ability to do so. This is both restrictive and fundamentally counters the very nature of learning that constructivism describes: that learning is a tentative, gradual and individual process that cannot be made to conform to extrinsic structures.

Mastery in mathematics has undoubtedly raised the profile of theory and it has exemplified its importance effectively. As well as providing procedures for mathematics teaching, it provides long-lasting ‘armour’ for students and so universities remain crucial both as a source of it and as a place where it can be discussed. Additionally, placements in schools are of equal importance as the means through which the theories are activated and made useful.

Despite the growth of employment-based routes to QTS, universities clearly still have a crucial role to play. In fact, they may actually have a further reaching role than perhaps they think. They are clearly better placed than schools to provide students with theoretical knowledge and access to literature and research. Initially, HEIs could retain some responsibility for their students once they have qualified through a rigorous ECT programme. After all, they know the students best and precisely where they are both academically and in terms of their practical classroom skills. Next, the university could play a role in providing INSET, training and research opportunities for the students as they move into their second, third and fourth years of teaching. It is this level of partnership between primary schools and HEIs that, I believe, may aid the retention crisis. Even if ECTs move away from the area of change schools, reflection tutors could still provide support using an online platform (that I shall discuss in the final chapter). In many ways, the Covid-19 pandemic has made these suggestions all the more pertinent. With schools closed at the height of the pandemic and restrictions continuing to affect a third academic year, all ECTs have been negatively affected by the pandemic and have had their initial teacher education compromised.

10.5 Research Question 5

Is there a need for adult learning theory to describe the learning of primary PGCE students?

10.5.1 Pedagogy works for adults too

While Bruner is concerned primarily with the teaching and learning of children, he does make reference to ITE and suggests that teaching young children 'concretely and intuitively in logical operations' requires specific training for teachers (Bruner, 1960, p. 89). However, he stops short of suggesting that it is the very same concrete and intuitive training that student teachers need for themselves. I propose that this *is* the case; indeed, many of Bruner's recommendations for primary and secondary education can be gainfully applied to the ways in which student teachers learn. This is illustrated by the following points:

- According to Bruner, '[Children] will flounder, however, if one attempts to force upon them a formal mathematical description of what they have been doing, though they are perfectly capable of guiding their behaviour by these rules.' (Bruner, 1960, p. 38). In a similar way, when the students were forced into viewing their practice in formal (theoretical) terms prematurely, they too floundered and seemed unable to link them to their practice.
- 'Where grades are used as a substitute for the reward of understanding, it may well be that learning will cease as soon as grades are no longer given – at graduation.' (Bruner, 1960, p. 51). For the majority of the students, completing the essay to a satisfactory standard was the main aim of their

use of theory. When the essay was complete, the students could see little point in returning to the theoretical ideas. Indeed, some of the students that I interviewed were unable to remember the theories that they had engaged with for their assignment.

- Bruner expands on the point above and suggests that arousing sufficient interest in the learner is essential for lasting learning to ensue. He argues that, ‘Short-run arousal of interest is not the same as the long-term establishment of interest in the broader sense’ and that it is when attention and interest are gained that a teacher can, ‘…establish that active autonomy of attention that is the antithesis of the spectator’s passivity.’ (Bruner, 1960, p. 72). The short-lived dabble with theory that characterises the students’ use of it did not, in the most part, maintain their interest, so all too quickly, what they had learned from them fell by the wayside.
- Lastly, Bruner highlights the popular perception of intellectualism where society has ‘idealised the thinker’ (Bruner, 1960, p. 74) and created a discord between theory and practice. This too is true of the students involved in this study. On the whole, they viewed theory as the preserve of academics and were unable to make the link between their own learning and the children’s learning.

The way in which students are taught about theories at university has a significant impact on their ability to make use of them. As discussed throughout the thesis, Bruner’s theoretical framework of the ‘Modes of Representation’ and its subsequent re-branding as the CPA approach is possibly the most prevalent educational theory in modern, mathematical discourse and has become a heuristic of the mastery curriculum. Bruner (1967, p. 6) uses it to describe the three ways in which people learn: ‘…through doing it, through a picture or image of it, and through some such symbolic means as language.’ In describing the ideal scenario for their own learning, the student teachers whom I interviewed suggested that this approach mirrored the way in which they wanted to be taught to teach mathematics. The general sense was that the university needed to do more in terms of demonstrating precisely how the theories they taught could be translated into specific approaches to teaching or manifested in the children’s work. Indeed, in her interview, Tara felt that she might have benefited from being taught at a ‘mastery level’ herself. This could be achieved firstly through exploration of tools and techniques for teaching, then through modelled example of 'mastery' teaching (where their tutor teaches the students as though they were teaching a class of children), and finally the students would be given opportunities to practise on their own through their own classroom teaching practice. This serves to reignite the pedagogy/andragogy debate and brings into question whether university tutors need an understanding of andragogy at all. After all, the principles of Bruner's pedagogy were what the student teachers themselves perceived to be the best way of learning. Despite this, my work has demonstrated that, in fact, student teachers receive the polar opposite of Bruner's recommendations – they begin with the 'abstract' activity of reading and writing about theory and end with exploring them in practice. In order to adhere to Bruner's principles, student teachers should begin with their teaching practice and encounter theory at a much later date.

Aspects of pedagogy could therefore be gainfully applied to the ways in which the student teachers, as well as children, learn. In many ways, this is a new pedagogy that is neither truly pedagogical or andragogical in nature. I have chosen to refer to this as a matryopraxis approach to learning and as I shall summarise in the following chapter, it is a contribution that the thesis makes.

To conclude, I must reiterate the idealistic nature of some of the recommendations that have been made in this chapter. They are made as an outsider and are meant to portray an ideal scenario. As an insider, I recognise the organisational and financial implications that may make them impractical. However idealistic, this chapter has presented my findings and recommendations and the following chapter summarises the contributions that the thesis makes.

Chapter 11: Conclusion – the contributions that the thesis makes

In Chapter 10, I directly addressed each of my research questions in order to define something of the gap that exists between theory and practice in ITE. In doing so, I drew out the specific reasons why PGCE students who were developing a strength in mathematics were not always able to use and apply the theoretical aspects of their training while they were on teaching practice.

In this final chapter, I shall summarise and make clear the theoretical, methodological and practice-based contributions that the thesis makes and well as the impact of the study on my own development and thinking.

11.1 Summary of contributions that the thesis makes

1. Contributions that the thesis makes to scholarship

1.1) This thesis has found that student teachers possess a complicated, triadic identity. At different points during their PGCE, they must be student, teacher and self. I suggest that each of these identities is sufficiently different to create conflict and that students find it difficult to switch between them.

1.2) The triadic identity of student teachers gives rise to a phenomenon that is unique to teacher education and is exemplified by the matryoshka effect that shows the different layers of identity. Being a student teacher involves a simultaneous interpretation of what they are taught and their own teaching and what they have learned and the children's learning. The thesis has identified that the matryoshka effect is central to how students experience their PGCE.

2. Contributions to the existing body of theory

2.1) I have found that for student teachers, theory and practice are understood as being separate entities – their own learning is their primary concern and this delays their ability to consider the children's learning at the heart of their endeavours.

2.2) Aspects of pedagogy can be gainfully applied to the ways in which student teachers, as well as children, learn. The thesis finds that, in primary teacher education, andragogy is neither a desirable or viable concept.

2.3) A new pedagogy that is both pedagogical or andragogical has been identified and explored in the thesis. Student teachers begin their teacher education with preconceived ideas about teaching before they learn and understand theory for themselves. Only then are the students able to apply theory to their own teaching although this takes precedence over the application of theory to the children's mathematical learning. Matryopraxis extends Korthagen et. al's (2008) 'congruence principle', and makes explicit the similarities between the aims of teacher education and children's learning in school.

3. Methodological contributions

3.1) I have demonstrated that being both an insider and outsider is immensely powerful in educational research and my position as teacher, school leader, teacher educator and researcher enabled me to simultaneously access the students' *student*, *teacher* and *self* identities. With my insider's knowledge and interest, my own voice became part of the story of the students.

3.2) The thesis makes the case for telephone interviews when carrying out research with student teachers. As well as giving the students freedom to respond as student, teacher and self, they also negated the organisational issues associated with face-to-face interviews.

4. Professional Contributions

4.1) My research suggests that school-based mentors need extensive training before they are able to adequately support the student teachers placed at their schools. Students developing a strength in mathematics need to have a quality mentor who is trained and knowledgeable about the content of the taught elements of the PGCE (including a firm understanding of the works of theory that their student will learn about at university).

4.2) A network of maths specialist primary teachers could fulfil the role of ‘reflection tutors’ and carry out tutorial-type reflection sessions with students with the sole purpose of discussing their mathematics teaching with them. Based on the success of the telephone interviews that I carried out, I suggest that this could be done virtually as a regular, online session throughout a student’s teaching practice. Applications such as Skype, Zoom and Teams are now well-understood and in frequent use for both social and professional meetings. Students could ‘meet’ with their reflection tutor frequently and, as with a telephone conversation, have the flexibility to meet for any length of time. A further advantage is that online meetings can be arranged with little notice so they could be held in response to episodes of mathematics teaching that have gone well or to support a student’s planning for an up-and-coming unit of work. As they are quick and easy to arrange and participate in, online reflection sessions are also a more sustainable approach to supporting student teachers. In the endnote that follows, I will refer to the implications for the remote support of students, particularly within the context of the changes that the Covid-19 pandemic has brought to recent working practice.

In the endnote that follows, I draw together what I have learned from this research and describe the scenario that, I believe, could be created by the mobilisation of my recommendations. It builds upon the findings that I have compiled in this chapter and provides a creative (if optimistic) look at the gap between theory and practice in ITE.

11.2 Endnote

This endnote concludes the thesis and discusses some of the further-reaching implications that this research has given rise to. In many ways, it is visionary and arguably idealistic. In doing so, I draw upon my own multifaceted identity to discuss how I think that teacher education could, through my recommendations, be improved. Following this, I present personal reflections on my own development as a teacher, teacher educator and educational researcher. This final section goes on to discuss the strengths and limitations of the study before finally identifying potential areas of further research to arise from the thesis.

The gap between theory and practice is indeed a tangible entity that is characterised by a mismatch between the aims of the university-based elements and the school-based elements of the PGCE. At university, the students are *educated* (ITE) while in schools, they are *trained* (ITT) and for the reasons put forward in the thesis, the two aspects of training remain discrete. Nobody could argue that the aim of the PGCE (and indeed any teacher preparation programme) is the development of knowledgeable, competent and reflective classroom teachers. To achieve this, students need both university and school-based input - not as separate entities - but as a coordinated and collaborative intervention. I acknowledge that closing or even narrowing the gap between theory and practice is idealistic, however, operationalising my recommendations may create an epistemological oasis between the immovable and seemingly inflexible entities that are theory and practice. Replacing the written assignment with a reflective journal would stop forcing theory on the students too soon. Ensuring that mentors know about the students' university-based learning would soften the stark shift in emphasis from 'education' to 'training'. Online, reflection tutors could help the students to reflect on their practice by discussing their maths lessons with them and helping them to use theory to explain what was working well.

I believe that children should be at the heart of all of the professional endeavours of teachers. I also believe that children should be the focus of the endeavours of student teachers and teacher educators although I acknowledge that this is not always the case. The primary concern of the former is their own development and of the latter, the development of the students themselves. This is due, in part, to what I have called ‘the matryoshka effect’ where learning about learning and being taught about teaching means that students find it difficult to maintain a focus on the children’s learning. Rather than ignoring the matryoshka effect or trying to work against it, I believe that student teachers and their tutors should embrace it and make it explicit. If students began their PGCE by exploring the ways in which they learn and developed an awareness of metacognitive processes, they may be better able to make links to the ways in which the children learn from the beginning of the programme.

I feel strongly that partnership between HEIs and schools could work toward the description of an educational theory, an *‘andra-pedagogy’* perhaps that applies specifically to student teachers – not pedagogy or andragogy, but something between them that embraces the matryoshka effect and the congruence principle in order to make students’ tacit knowledge about teaching and learning explicit. With this established, student teachers could be taught not purely as the children are or purely as autonomous adults are, but as adults who are specifically being taught to teach children. I believe that an awareness of matryopraxis, with successive, interrelated layers of learning, may support a move toward this aim.

As for the theory taught to student teachers, I feel strongly that it could have a longer-term impact that moves beyond merely passing an assignment. From a constructivist perspective, knowledge can never be a representation of the real world. Instead, it is a collection of conceptual structures that happen to be viable within an individual’s range of experience. Each and every student teacher has their own reality, part of which is formed by the schools in which they practice teaching. Once this is acknowledged, it becomes apparent that a ‘one size fits all’ approach to theory simply cannot work because students experience a different subjective reality from each school in which they are placed. For theoretical constructs to become viable, they cannot simply be inserted into a student’s experiential world. It needs to be presented tentatively to students and phased into CPD for qualified teachers. This could reinsert some intellectualism into the profession so that teachers are interested in education as a subject in its own right, as an exciting phenomenon and something to be embraced and studied. I firmly believe that this could empower teachers and enable them to see beyond their own classroom walls.

With the rise of Covid-19 throughout 2020 and into 2021 when this thesis was being completed, schools and universities had to quickly adapt to new ways of working. This was not easy. Education was (quite rightly, in my view) deemed too important to simply pause, so universities and schools had to operationalise technology to enable learning to continue at home. Indeed, the government's trust that this would continue despite the closure of schools enabled them to make the highly controversial decision to reopen public houses in England before schools. Meetings and teaching occurred with some success online and this (albeit forced) change to recent working practices has strong implications for the way in which students could be supported in the future.

11.3 Personal reflections

One of the reasons why I chose to carry out this research was because I was concerned that training to teach in primary schools had become thin and anti-intellectual. I perceived a lack of reading and genuine engagement with theory as a contributing factor. I was concerned that theory was used by students in an inherently superficial way that was verging on a disrespectful abuse of the ideas. I felt strongly that modern, simplified versions of theory gave students a warped sense of the original ideas that were almost insulting to both the theories and the students themselves.

Through the course of my studies, it has become apparent that my perception and opinion has changed. While I still believe that students engage with theory in an inherently superficial way, I now understand that this is wholly appropriate for their stage of development. While they are completing a masters level qualification, PGCE students are novices and new to the field of education. In fact, the proliferation of books that present simplified versions of theory enable students to access the theories and provide part of the bridge between theory and practice. As I have demonstrated, part of this is due to the nature of knowledge and the interpretation of interpretations. Learning about learning is complex and a constructivist perspective emphasises that the linear nature of language can never truly convey the intricate, mutual dependencies that authors endeavour to describe or that exist in an individual's lived experience. While the students found sequential, developmental accounts of ideas easier to understand, they were invariably unable to access the full extent of original, theoretical ideas. In addition to this epistemological complexity, the students' lack of genuine engagement with theories was principally a question of timing. Quite simply, theory is not what the students needed at the beginning of their PGCE – classroom management skills must be the priority and theory can come later.

I have become conscious that, I too possess a multifaceted identity that, in some ways, parallels that of the students that I have studied. It is actually possible that I may have a more complex set of identities to juggle than the students do. In addition to my teacher, teacher educator and self persona (that mirror those of the students), I am also a senior leader and an educational researcher. A final layer of the matryoshka doll comprises the constructivist metanarrative that runs through this work. As I have more teaching experience than the students, it is possible that, in constructivist terms, I am better able to draw upon my different personas at different times and that cognitive assimilation occurs more readily, however, it seems likely that I too am subject to 'the matryoshka effect'. Indeed, with additional layers to my matryoshka doll, I must admit to sometimes finding it difficult to see the children at the heart of all my endeavours. This is particularly true when I am carrying out some of the administrative tasks associated with my teacher educator and senior leader personas.

This study will have an impact on my own practice as a teacher, school leader, mentor and teacher educator. I will ensure that I, and the mentors under my direction, will be fully aware of the content of the programmes that the students are following. I will pay more regard to students' areas of interest and specialism and, in my leadership capacity, ensure that they are placed with teachers with specialism (or at least interest) in their chosen subject areas. Finally, I will not shy away from discussing theory at my school and with the student teachers in my care where it becomes relevant. However, I will also ensure that theory is offered tentatively and not as a way of *doing*, but as a way of *thinking*.

As I have acknowledged, there are a number of parallels between my own learning journey and that of the students who participated in this study. I hope that this thesis reflects my own learning and development both in terms of my findings and as a novice researcher. At this point, it seems apt to discuss my perception of the strengths and weaknesses of this study and what I might have done differently with the benefit of hindsight.

11.4 Strengths of the study

For me, the clear strength of my work lies in the quality of the interview data that I was able to collect. Without a doubt, this was made possible by my insider/outsider stance. As a teacher and a teacher educator, I was able to relate to the students that I interviewed in both an intuitive and fundamentally meaningful way. Indeed, the interviews rapidly became more like a conversation between two teachers with a special interest in mathematics rather than a more formal interview. As an insider, I was aware of the ethical issues relating to the safeguarding of the participants and I was able to discuss mathematics using terminology (including abbreviations and jargon) that were familiar to the students. The conversations seemed to be mutually beneficial; as well as providing me with a rich source of data, the interviews provided an opportunity for the students to reflect upon their maths teaching and learning. This was a significant opportunity for them as they were able to speak freely and honestly about both university and school in a way that could not have been possible with a university tutor or a school mentor. For me, it ensured rich data because I was able to access the full extent of their triadic identities and speak to them as students, teachers and themselves.

11.5 Limitations of the study

There are a number of areas that I could have approached differently in hindsight. In isolation, they may have strengthened the quality of the data and as a whole, they may have made a greater personal contribution to my understanding of educational research.

The generalisations that I have made about student teachers are based on a single cohort of PGCE students at one, medium-sized university. A cross-case analysis of different teacher training routes at different universities would have been both interesting and more revealing in terms of how students understand and make use of the theory that they are taught. Cheng et. al. (2012) investigated the gap between theory and practice among BEd students, but a comparison between 1 year and 3-year ITE programmes would give a clearer idea of whether experience improves understanding of theory or not. Clearly, this would have made for a much larger-scale project altogether.

Within the parameters and scale of this study, carrying out a second interview with each of the students may have given a better idea about the impact of time on their understanding and use of theory. I carried out interviews after the students had been taught about theory and written their theoretical assignment. An interview at the beginning of the programme (while they were learning about theory) and one toward the end of the PGCE would have made for a more measurable comparison and would have better identified the *progress* that they had made in their understanding.

11.6 Potential areas for further research

1. It would seem a natural progression to follow a cohort of students involved in the study into their ECT induction period to evaluate the impact of their special interest in mathematics (and their study of theory) on their classroom practice as qualified teachers. Ascertaining at what point progressive ideas are ‘washed out’ (Zeichner and Tabachnick, 1981) would be both fascinating and have serious implications for the training and professional development of teachers.

2. In Chapter 4, I question whether experienced teachers interpret educational texts differently to students. This would be a useful investigation to carry out and it could be of benefit to universities in their selection of texts for students to engage with.

3. In Chapter 6, I discussed the question of whether or not being a competent mathematician is a prerequisite for being an effective primary mathematics teacher. This would be fascinating to pursue and investigating the foundation of knowledge with which students pursue a strength in mathematics for their PGCE, and the extent to which they perceive it to be useful, would again have far-reaching implications for the recruitment and training of prospective teachers.

4. In Chapter 10, I proposed that students may have encountered educational theories without them being taught explicitly at university. It would be interesting to discover the extent to which this can be the case and whether the theories that I have explored in this thesis really are embodied in the consciousness of qualified teachers and manifest themselves in ‘good practice’.

5. In the technological world in which we live and the recent, global pandemic giving rise to online working, it would also be of great interest to pursue the idea of online mentoring. In recent months, schools and universities have been making use of web-based conferencing tools to enable learning to continue. It has caused me (any many others, I am sure) to question the efficacy of frequent, face-to-face meetings with others when online sessions reduce travel time and cost and could enable sessions to be held more frequently and at shorter notice. This could be a significant advantage for student teachers as tutorials could be more responsive to their needs rather than having to stick to pre-arranged, face-to-face meetings that may or may not be truly necessary. The longer term benefit and sustainability of online tutorials and mentoring is definitely an area that requires further research.

11.7 Final reflection

Working in an infant school, I have, on countless occasions, had the privilege of watching children play. Unsurprisingly, the children often choose to play ‘teachers’ and observing their behaviour during such games is both fascinating and insightful. For them, the teacher sits or stands at the front and acts with authority; they ‘tell children off’ and point to things on the board or in books; they say things slowly and deliberately and ensure that everybody is sitting smartly and paying attention – they often take the register! For want of a better adjective, they pretend to be teachers by being ‘teacherly’. I suspect that, if you asked any 5 year old from the Western World to pretend to be a teacher, they would exhibit similar behaviours and ‘teacherly’ traits. I also suspect that, if you asked any adult (without classroom experience, of course) to ‘teach’ a class, they too would fall back on the same set of ‘teacherly’ traits that they believe characterise teaching or that they remembered from their own schooling. Indeed, Britzman (1991, p. 4) argues that those who are not yet teachers perceive a teacher’s role as being solely concerned with ‘custodial moments’ (such as enforcing rules, marking work and imparting scripted knowledge) and that pedagogy is not deemed to be an essential element of a teacher's work.

I propose that, in fact, student teachers do likewise when they are placed before a group of children. They focus on the procedural moments like the management of behaviour and the organisation of children that are, in reality, only the tip of the teaching iceberg. In short, students have naïve preconceptions about what it means to be a teacher and the school-based aspect of their training does little to challenge them. Wubbels (1992a) argues that these ideas are firmly rooted in students' consciousness before they even begin teaching and that they are based, in part, on their memory of their own schooling. Lasley (1980) adds that student teachers may also gain their ideas about teaching from stereotypes portrayed in films and on television. Wubbles (1992a, p. 137) refers to these as 'world images' and he suggests that challenging 'world images' and enabling students to see alternative ways of doing things can be immensely challenging and he points to the promotion of theoretical ideas from skilful teacher educators as the key to breaking down this barrier. I believe that world views, in part, constitute a student's 'self' identity. I also believe that, without theory, the ability to think critically and without adequate, intellectual support at school, students practice 'being teacherly' and little else. Their skill set is therefore limited and while it may enable them to survive in the classroom and even impart some knowledge in the short term, this is a superficial veneer that wears off with time. Stokking et. al. (2003) present the concept of 'practice shock' that is symptomatic of the 'washing out of progressive attitudes'. They suggest that often, the reality of being a classroom teacher, and the responsibility and accountability that goes with it, can both shock and disturb a student teacher when they qualify. They have nothing to fall back on when the children struggle to understand something they have taught. In effect, this superficiality at the training level leaves them vulnerable and floundering when the skills run out and times become tough. Furlong and Maynard (1995, p. 168) support this and suggest that, '…although it is possible to 'act like a teacher' simply by following routines and recipes established by others, becoming an effective teacher demands a deeper understanding of the processes involved in teaching and learning.'

In short, without theory, teachers are not teachers at all, but merely administrators of schooling and whether knowingly or unwittingly, *this* is what is eroding standards and causing disillusionment among teachers. The education system itself has made theory exclusive and the preserve of academics and researchers rather than for the betterment of outcomes for children. The strict standards agenda inflicted and enforced by Ofsted is the very thing that precludes change. As the theory/practice divide remains, we would do well to remember that an improvement in educational standards can only be mobilised through the expertise of dedicated and intelligent teachers and that this begins with their initial teacher education. If the best outcomes are sought for children, then they must therefore be sought with the same eagerness for student teachers.

ITE programmes are characterised by a number of rigid conventions and learning theory has become one of them. However, the study of theory is neither regressive nor nostalgic but rather, it is central to the development of teachers. Without theory, we are in danger of creating a generation of teachers devoid of philosophy and pedagogical motivation or a desire to engage critically and thoughtfully with educational issues.

This thesis began with Piaget's description of the symbiotic relationship between theory and practice with knowledge being 'tied to' action. It seems apt, therefore, to conclude by returning to Piaget who wrote,

> … to know an object implies its incorporation in action schemes, and this is true on the most elementary sensorimotor level and all the way up to the highest logical mathematical operations. (Piaget, 1971, p. 17)

As the word 'incorporation' implies, Piaget's ultimate goal is not to narrow or even to close the gap between theory and practice but for theory and practice to become subsumed into one another and develop into a single entity. This should, perhaps, also be the case for ITE where theory and practice combine and manifest themselves in effective and inspirational teachers who can manage their own learning and that of the children in their care.

List of Appendices

Appendix 1: The PGCE mathematics strength module reading list

Askew, M. (2012) *Transforming Primary Mathematics*. Abingdon: Routledge

Briggs, M., and Davis, S. (2008) *Creative Teaching Mathematics*. London: Routledge

Carruthers, E. (2006) *Children's Mathematics: making marks, making meaning.* 2nd ed. London: Paul Chapman

Cockburn, A., Littler, G. (2008) *Mathematical Misconceptions*. London: Sage Publications

Donaldson, J., Field, J., Harries, D., Tope, C., and Taylor, H. (2012) *Becoming a Primary Mathematics Specialist Teacher*. Abingdon: Routledge

Grigg, R. (2010) *Becoming an Outstanding Primary School Teacher*. Harlow: Pearson Education Ltd.

Hansen, A & Vaukins, D. (2011) *Primary Mathematics Across the Curriculum* Exeter: Learning Matters

Lee, C. (2006) *Language for Learning Mathematics.* Maidenhead: OUP

Pound, L (2006) *Supporting Mathematical Development in the Early Years.* Maidenhead: Open University Press

McGregor, D. (2007) *Developing Thinking Developing Learning.* Maidenhead: OUP

Rowland, T. (2009) *Developing Primary Mathematics Teaching.* London: Sage

Ryan, J., Williams, J. (2007) *Children's mathematics 4-15*. Maidenhead: OUP

Thompson, I. (2003) (ed) *Enhancing primary mathematics teaching and learning*. Buckingham: Open University Press

Turner, S. and McCullouch, J. (2004) *Making Connections in Primary Mathematics.* London: David Fulton

Appendix 2: *The questionnaire given to the students*

Dear Students,

I am a primary school teacher, mathematics subject leader and doctoral student currently engaged in some research concerned with educational theory and mathematics education. I have designed this questionnaire to find out more about the ways in which educational theories are used by PGCE students both in their own mathematics learning and in their mathematics teaching.

Please answer all of the questions as fully and honestly as possible. Thank you.

What is your gender?

☐ Female

☐ Male

☐ I'd rather not say

What is your age?

☐ Under 26 ☐ 26 – 30 ☐ 31 – 35 ☐ 36 – 40

☐ 41 – 45 ☐ 46 – 50 ☐ 51 – 55 ☐ Above 55

What is your undergraduate degree subject/s? (please write in the space below)

____

Did you engage with any theories as part of your undergraduate degree?

☐ Yes ☐ No ☐ Not sure

If yes, which areas of theory did you encounter?

____

In your own words, what is your understanding of the term 'educational theory'?
(please write in the space below)

For the purposes of my research, 'educational theories' are defined as conceptual frameworks that describe how information is absorbed, processed and retained when children are learning. In this questionnaire, 'educational theory' refers to the broadly constructivist, significant works of those such as Dewey, Vygotsky, Piaget and Bruner. It also includes the more contemporary works of Skemp and Askew that relate directly to mathematics.

1. **Please rank the following definitions of 'educational theory' from 1-5 with 1 being your favourite definition and 5 being your least favourite definition.**

- ☐ Educational theories are ideas that describe how children learn effectively.
- ☐ Educational theories are complicated ideas about teaching and learning.
- ☐ Educational theories are ideas that describe how to teach effectively.
- ☐ Educational theories are ideas about teaching from long ago.
- ☐ Educational theories are ideas about teaching that people learn about while they're training to be teachers.

For the following question, please rank the statements from 1-5 with 1 being your most likely course of action and 5 being your least likely course of action.

2. **What do you do when you are unsure about how to teach a mathematical concept?**

- ☐ I ask the teachers at my placement school.
- ☐ I ask the mathematics subject leader at my placement school.
- ☐ I ask my university tutors.
- ☐ I look for ideas in books.
- ☐ I talk to other student teachers about what they have done.

For the following question, please rank the statements from 1-5 with 1 being the most true and 5 being the least true.

3. **In what ways do you learn the most about teaching mathematics?**

- ☐ When you get to teach concepts for yourself.
- ☐ When you observe more experienced teachers teaching.
- ☐ When you're in maths sessions/seminars at university.
- ☐ When you read about maths teaching.
- ☐ When you talk to your mentor/teachers at your placement school.

For the following question, please rank the statements from 1-5 with 1 being the most true and 5 being the least true.

4. Which people's ideas about mathematics teaching do you listen to?

- ☐ Teachers who are more experienced than you.
- ☐ Teachers who have talked to you about educational theories.
- ☐ University tutors who have lots of practical suggestions for improving your lessons.
- ☐ University tutors who have talked to you about educational theories.
- ☐ Teachers who have good ideas about how to improve your mathematics teaching.

5. On which of the following occasions have drawn upon the educational theories that you have learned? <u>Please tick (✓) all that apply to you</u> and leave blank those that do not apply to you.

- ☐ When you are planning your mathematics lessons.
- ☐ When you are marking/assessing children's work.
- ☐ When you are writing your university assignments.
- ☐ When you are evaluating your mathematics lessons.
- ☐ When you are deciding how to pre-empt or address children's misconceptions in mathematics.

6. Does your knowledge or understanding of any of the following disciplines support your understanding of teaching and learning mathematics? <u>Please tick (✓) all of the following that apply to you.</u> Please leave blank those that do not apply to you.

☐ Psychology	☐ Ethics	☐ Theology
☐ Sociology	☐ Philosophy	☐ Child development

☐ Any other discipline (please state)

7. **Please tick (✓) all of the following statements that apply to you. Please leave blank those that do not apply to you.**

- ☐ Educational theories help me to decide how to teach concepts.
- ☐ Educational theories help me to manage children's behaviour.
- ☐ When I have a good idea about teaching a concept, I try to find theories to back it up.
- ☐ I talk to the teachers/my mentor at my placement school about educational theories.
- ☐ The children's behaviour prevents me from trying out my ideas about educational theories.

Please circle the extent to which you agree with the following statements.

8. **Educational theory is something that I will learn once and never learn again.**

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

9. **My school-based mentor knows a lot about educational theory.**

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

10. **The 'Concrete, Pictorial, Abstract' approach to teaching mathematics is based on educational theory.**

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

11. **The mathematics that is taught in Shanghai and Singapore is effective because it is based on significant educational theories.**

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

12. **Knowledge of educational theories makes me better at teaching mathematics.**

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

13. Constructivist theories of learning suggest that group work is important for children when they are learning in mathematics.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

14. Knowledge of educational theories helps me to understand 'mastery' better.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

15. Learning about educational theories has had a significant impact on the way that I teach mathematics.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

16. Educational theories are more useful when I teach younger children in KS1 than when I teach older children in KS2.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

17. Educational theories are something that I can create for myself.

I am certain that I disagree	I mostly disagree	I mildly disagree	I have no opinion/I don't know	I mildly agree	I mostly agree	I am certain that I agree

18. Which significant educational theory have you found the most useful in your training to date? Please write your answer in the space below.

19. Which of these books (taken from your reading list) do you recognise and have you found useful either when writing your assignment or when on teaching practice?

Please tick (✓) all those that you recognise and/or have used in the columns provided.

I recognise this text	I have used this text	
☐	☐	Askew, M. (2012) *Transforming Primary Mathematics*. Abingdon: Routledge
☐	☐	Briggs, M., and Davis, S. (2008) *Creative Teaching Mathematics*. London: Routledge
☐	☐	Carruthers, E. (2006) *Children's Mathematics: making marks, making meaning.* 2nd ed. London: Paul Chapman
☐	☐	Cockburn, A., Littler, G. (2008) *Mathematical Misconceptions*. London: Sage Publications
☐	☐	Donaldson, J., Field, J., Harries, D., Tope, C., and Taylor, H. (2012) *Becoming a Primary Mathematics Specialist Teacher*. Abingdon: Routledge
☐	☐	Grigg, R. (2010) *Becoming an Outstanding Primary School Teacher*. Harlow: Pearson Education Ltd.
☐	☐	Hansen, A & Vaukins, D. (2011) *Primary Mathematics Across the Curriculum* Exeter: Learning Matters
☐	☐	Lee, C. (2006) *Language for Learning Mathematics.* Maidenhead: OUP
☐	☐	Pound, L (2006) *Supporting Mathematical Development in the Early Years.* Maidenhead: Open University Press
☐	☐	McGregor, D. (2007) *Developing Thinking Developing Learning.* Maidenhead: OUP
☐	☐	Rowland, T. (2009) *Developing Primary Mathematics Teaching.* London: Sage
☐	☐	Ryan, J., Williams, J. (2007) *Children's mathematics 4-15*. Maidenhead: OUP
☐	☐	Thompson, I (2003) (ed) *Enhancing primary mathematics teaching and learning*. Buckingham: Open University Press
☐	☐	Turner, S. and McCullouch, J. (2004) *Making Connections in Primary Mathematics.* London: David Fulton

20. Are there any other texts or authors that you like/have found useful? This could include journal articles or websites that you have seen. Please write any in the space below.

If you would be happy for me to contact you later this year about the possibility of being interviewed by me to help with my research even more, I'd be really grateful if you could write your email address in the space below.

Thank you for taking the time to complete this questionnaire.
I am really grateful for your support.

Appendix 3: *Students' interview information and consent document*

<u>Information Sheet</u>

Title of the research:
The Gap Between Theory and Practice in Primary Mathematics: student teachers' perspectives on 'teaching for mastery'.

The aims of the research:
1. How does the mathematics course literature accessed by primary PGCE students compare with the original sources of learning theory to which it relates?
2. In what ways and to what extent do primary PGCE students draw upon theories of learning in the planning, delivery and evaluation of their mathematics lessons within the context of a mastery curriculum?
3. What are the enabling and constraining factors that primary PGCE students face when using theories of learning in their mathematics teaching?
4. What are the implications for the continued role of universities in the education of primary mathematics teachers?
5. Is there a need for adult learning theory to describe the learning of primary PGCE students?

The role of participants in the research:
Participants are asked to take part in one, semi-structured, telephone interview with the researcher. It is anticipated that interviews will take approximately 40 minutes and they will take place at a time of the participants' choosing. Where consent is given, audio recordings of telephone interviews will be made.

The nature of participation in this research:
Participation in this research is completely voluntary and participants are at liberty to withdraw at any time without prejudice or negative consequences.

Confidentiality:
Recordings and transcripts of recordings will be used by the researcher to meet the aims of the research. Recordings will be stored electronically and will not be shared with anybody. Pseudonyms will be used to protect the identify of participants where transcripts or excerpts of transcripts appear in any part of the thesis.

Potential risks, harms and benefits to participants:
Participants in this research are at a negligible any risk of incrimination or harm as a result of their participation in this research. Participants will not be identifiable as individuals in the thesis and references made to schools and colleagues in the transcripts will be described in general terms and using pseudonyms as appropriate.

Contact details:
Both the researcher and research supervisors can be contacted at any time to answer any questions that participants may have. Contact email addresses are below:

Name	**Position**	**Contact email address**
James Goodland	Researcher	
Dr. Jenny Fryman	Research Supervisor	jafryman@glos.ac.uk
Prof. Alison Scott-Baumann	Research Supervisor	alisonscottb@gmail.com

I am very grateful for participants' contributions and for giving up their time to help with this research.

James Goodland, April 2018

<u>Informed Consent Form</u>

Title of the research:

The Gap Between Theory and Practice in Key Stage One Mathematics: student teachers' perspectives on teaching calculation.

Name and contact address of Researcher:
James Goodland

I, the undersigned confirm that (please initial box as appropriate):

1.	I have read and understand the information sheet for the above named research.	
2.	I have had the opportunity to ask questions about the research and my participation in it.	
3.	I understand that my participation in this research is voluntary.	
4.	I understand that I am free to withdraw from participation within three months of the date below, without giving reason.	
5.	I agree to the interview being audio recorded.	
6.	I agree to the use of anonymised quotes in publications.	
7.	I understand that any information which might potentially identify me will not be used in published material.	
8.	I agree to participate in this research as outlined to me.	

Thank you very much for giving up your time to contribute to this research.

Name of Participant ______________ Date ______________ Signature ______________

Name of Researcher ______________ Date ______________ Signature ______________

Appendix 4: *The interview schedule*

<u>Discussion Areas/Prompts for Interviews</u>

<u>Discussion Area 1</u> – What is educational theory? *<u>Prompt 1.1</u> – Why did you choose maths as your 'core strength'?* *<u>Prompt 1.2</u> – What was the focus of your 'Core Strength' assignment?* *<u>Prompt1.3</u> – Why did you choose this?* *<u>Prompt1.4</u> – Did you learn about theories as part of your UG degree?* *<u>Prompt1.5</u> – Do you consider that educational theories are mostly concerned with your teaching or the children's learning?* *<u>Prompt1.6</u> – Do you think you will use educational theories once you have qualified?* *<u>Prompt1.7</u> – How has learning about educational theories helped you to become the teacher you are now?*	
<u>Discussion Area 2</u> – Current discourses in mathematics education – how has learning about educational theories helped to prepare you for teaching in the current educational climate? *<u>Prompt 5.1</u> – What, in your view, are the key features of a mastery curriculum?* *<u>Prompt 5.2</u> – Does the CPA approach work?* *<u>Prompt 5.3</u> – Have you seen examples of any of the theories that you've learned played out in the classroom?* *<u>Prompt 5.4</u> – Has learning about educational theories prepared you for teaching for mastery in your own class from September?* *<u>Prompt 5.4</u> – Will they help you to manage your class effectively? In what way?*	
<u>Discussion Area 3</u> – How do you use educational theories? *<u>Prompt 2.1</u> – Can you recall a time when an educational theory was useful to you on placement?* *<u>Prompt 2.2</u> – Did it help with your lesson planning?* *<u>Prompt 2.3</u> – Did it help with the way that you organized the children (groupings etc)?* *<u>Prompt 2.4</u> – Did it help with the choice of the resources that you chose to use?* *<u>Prompt 2.5</u> – Did it help with your assessment of the children's learning?* *<u>Prompt 2.6</u> – Do you think it was more useful because you were teaching KS1?* *<u>Prompt 2.7</u> – How often do you refer to educational theories in your conversations with others about your maths teaching?*	

<u>Prompt 2.8</u> – Have you encountered any classroom management issues when teaching maths? Have educational theories helped you to manage the situation?	
<u>Discussion Area 4</u> – How useful was the course literature on your reading list? (Provide the participants with a copy of their reading list for them to refer to) *<u>Prompt 3.1</u> – Which texts did you find the most useful and why?* *<u>Prompt 3.2</u> – Were there any texts that you read but didn't find useful?* *<u>Prompt 3.3</u> – Have you referred to any texts since writing your 'Core Strength' assignment? Why yes? Why no?*	
<u>Discussion Area 5</u> – What do you do when you need help with the practical aspects of teaching mathematics? *<u>Prompt 3.1</u> – Who do you talk to when you need advice about how to teach a mathematical idea to children in KS1? Why them?* *<u>Prompt 3.2</u> – When do you learn the most about teaching maths? At university? At school? During private study?*	

Appendix 5: *Reading frame analysis*

Askew, M. (2012) ***Transforming Primary Mathematics*****. Abingdon: Routledge**			
Theories in Index/Contents? Contents: 'Variation Theory' Index: Variation Theory Bruner Piaget Vygotsky	**Theories mentioned in text?** Piaget Vygotsky (1986) ZPD/Communities of Learners/Physical and Psychological Tools	**Original sources quoted?** No Piaget Bruner (1996)	**Theories in recommended/further reading?** p. 18 Vygotsky recommended through 'Vygotsky and Pedagogy' by Harry Daniels "While nothing can replace reading a good translation of Vygotsky directly…." 'Schools for Growth' by Lois Holzman (Vygotsky 'in practice' in schools in the USA and Russia.
Original sources in bibliography? No Piaget Ausubel (1968) Bruner (1978) Bruner (1986) Bruner (1996) Dewey (1956) Vygotsky (1978) Vygotsky (1986)	**Critique/challenge offered?** p. 5 suggests that Piaget was diluted and used to add weight to existing (practical) maths practices (Walkerdine, 1984) Goswami and Bryant (2010) against Piaget's staged development.	**Notes** *'Pedagogy' and 'ZPD' were both in the index.*	
Briggs, M., and Davis, S. (2008) ***Creative Teaching Mathematics*****. London: Routledge**			
Theories in Index/Contents? None	**Theories mentioned in text?** None	**Original sources quoted?** No	**Theories in recommended/further reading?** N/A
Original sources in bibliography? Skemp (1979)	**Critique/challenge offered?** N/A	**Notes**	
Carruthers, E. (2006) ***Children's Mathematics: making marks, making meaning.*** **2nd edn. London: Paul Chapman**			
Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further**

Index: Vygotsky Piaget Bruner	Piaget (1958) Object permanence. Vygotsky – MKO (1978)	Vygotsky and Bruner Not Piaget	**reading?** No – not even following a chapter on learning theories.
Original sources in bibliography? Vygotsky (1978) Vygotsky (1982) Vygotsky (1983) Vygotsky (1986) Piaget (1958) Bruner (1971) Bruner (1996)	**Critique/challenge offered?** A little - reference to Athey's research that builds on some of Piaget's ideas.	**Notes** *Useful chart comparing differing theoretical stances p. 21.*	
Cockburn, A., Littler, G. (2008) *Mathematical Misconceptions*. London: Sage Publications			
Theories in Index/Contents? Index: Piaget	**Theories mentioned in text?** Piaget as underpinning the cognitive conflict approach to teaching (1. misconception, 2. elicit relevant correct knowledge, 3. raising awareness of the contradiction.	**Original sources quoted?** No	**Theories in recommended/further reading?** No
Original sources in bibliography? No	**Critique/challenge offered?** No	**Notes**	
Donaldson, J., Field, J., Harries, D., Tope, C., and Taylor, H. (2012) *Becoming a Primary Mathematics Specialist Teacher*. Abingdon: Routledge			
Theories in Index/Contents? Index: Skemp Askew Bruner	**Theories mentioned in text?** Bruner's 3 modes of representation and it mentions the 'spiral curriculum'. Skemp's instrumental and relational learning.	**Original sources quoted?** No No	**Theories in recommended/further reading?** No

Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Bruner (1974) Bruner (1996)	No	*The Cockcroft Report is listed in the index.*	
Grigg, R. (2010) *Becoming an Outstanding Primary School Teacher*. Harlow: Pearson Education Ltd.			
Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further reading?**
Index: Bruner Dewey Piaget Skinner Vygotsky	Bruner's 'spiral curriculum' (revisiting concepts) Dewey – experiential learning Piaget – cognitive development Vygotsky – ZPD, 'cultural tools'	No No No No – diagram of the ZPD.	None
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Vygotsky (1978) Mind in Society Piaget (1976) The Child and Reality Bruner (1960) The Process of Education	Piaget's questionable methods (Child, 2004)	*This is not a specific mathematics book, but a general education studies text that is on the maths specialist reading list.*	
Hansen, A & Vaukins, D. (2011) *Primary Mathematics Across the Curriculum* Exeter: Learning Matters			
Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further reading?**
Index: Piaget	Piaget and Inhelder – Conservation of amount Piaget – stage theory Piaget - transitivity	No Referenced via Babai, 2009. No	No
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Piaget and Inhelder (1974)	No	*'Theory practice gap' in the index p. 166*	
Lee, C. (2006) *Language for Learning Mathematics.* Maidenhead: OUP			

Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further reading?**
Contents: Chapter 6: The source of the ideas – delving into theory. Index: Vygotsky Piaget Bruner	Bruner Vygotsky Piaget	Vygotsky (1981)	N/A
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Vygotsky (1962) Vygotsky (1978) Vygotsky (1981) Bruner (1996)	No	*'Theories of learning' is in the index (p. 85)*	
Pound, L (2006) *Supporting Mathematical Development in the Early Years.* Maidenhead: Open University Press			
Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further reading?**
Index: Vygotsky Piaget Skinner Bruner	Vygotsky - scaffolding	Bruner (1983)	N/A
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Bruner (1983) Child's Talk Bruner (1986) Actual Minds Bruner and Haste (1987) Vygotsky (1978) Mind in Society Vygotsky (1986) No Piaget	Merttens (1996) attack on Piaget as undervaluing the role of adults in children's learning. Donaldson (1976) against Piaget	*Cockcroft Report in index* *Piaget only mentioned.*	
McGregor, D. (2007) *Developing Thinking Developing Learning.* Maidenhead: OUP			
Theories in	**Theories mentioned**	**Original sources**	**Theories in**

Index/Contents?	**in text?**	**quoted?**	**recommended/further reading?**
Index: 'Vygotsky and Piaget' (clumped in together p. 72-3) 'Constructivist learning theory' ZPD	The interplay between Piaget's view of cognitive growth and Vygotsky's ZPD. Piaget (1950) accommodation and assimilation	Piaget – no Vygotsky (1986, 1978) lots on the importance of language in social constructivism Bruner (1986) Bruner (1990)	No
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Ausubel (1968) Educational Psychology Bruner (1966) Bruner (1986) Bruner (1990) Bruner (1996) Dewey (1910) Dewey (1928) Piaget and Inhelder (1958) Piaget (1926) Piaget (1929) Piaget (1950) Piaget (1951) Piaget (1973) Vygotsky (1978) Vygotsky (1981) Vygotsky (1986)	No	*This is not a specific mathematics book, but a general education studies text that is on the maths specialist reading list.*	
Rowland, T. (2009) *Developing Primary Mathematics Teaching.* London: Sage			
Theories in Index/Contents?	**Theories mentioned in text?**	**Original sources quoted?**	**Theories in recommended/further reading?**
Index: Bruner Skemp	Bruner – modes of representation	No	Bruner (1974) Representation in Childhood Skemp (1986) The Psychology of Learning Mathematics
Original sources in bibliography?	**Critique/challenge offered?**	**Notes**	
Bruner (1974) Skemp (1976) Skemp (1986) Ausubel (1968)	No		
Ryan, J., Williams, J. (2007) *Children's mathematics 4-15*. Maidenhead: OUP			

<table>
<tr><td><u>Theories in Index/Contents?</u>

Contents:
Chapter 9: Learning and Teaching Mathematics: Towards a theory of pedagogy

Index:
‘Vygotsky and Piagetian tasks’

Piaget</td><td><u>Theories mentioned in text?</u>

Vygotsky – law of cultural development
ZPD</td><td><u>Original sources quoted?</u>

Yes

No Piaget</td><td><u>Theories in recommended/further reading?</u>

N/A</td></tr>
<tr><td><u>Original sources in bibliography?</u>

Vygotsky (1978)
Vygotsky (1981)
Vygotsky (1987)
Piaget (1970)
Piaget and Inhelder (1974)
Bruner (1966)
Bruner (1986)
Bruner (1990)
Bruner (1996)</td><td><u>Critique/challenge offered?</u>

Challenges behaviourism with socio-culturalism.

Mentions Piaget’s underestimation of what children are capable of.</td><td><u>Notes</u>

Very heavy on theory – a whole chapter dedicated to it.</td><td></td></tr>
<tr><td colspan="4">Thompson, I (2003) (ed) Enhancing primary mathematics teaching and learning. Buckingham: Open University Press</td></tr>
<tr><td><u>Theories in Index/Contents?</u>

Index:
Vygotsky
Piaget</td><td><u>Theories mentioned in text?</u>

Piaget – progressive organization of geometric ideas</td><td><u>Original sources quoted?</u>

Vygotsky (1996)</td><td><u>Theories in recommended/further reading?</u></td></tr>
<tr><td><u>Original sources in bibliography?</u>

Vygotsky (1996)</td><td><u>Critique/challenge offered?</u>

Piaget criticised</td><td><u>Notes</u>

Cockcroft Report in index</td><td></td></tr>
<tr><td colspan="4">Turner, S. and McCullouch, J. (2004) Making Connections in Primary Mathematics. London: David Fulton</td></tr>
<tr><td><u>Theories in Index/Contents?</u></td><td><u>Theories mentioned in text?</u></td><td><u>Original sources quoted?</u></td><td><u>Theories in recommended/further reading?</u></td></tr>
</table>

No contents None mentioned in the index	Doesn’t seem to		No
<u>Original sources in bibliography?</u> Vygotsky (1978) Mind in Society Skemp (1991) Mathematics in the Primary School Liebeck (1990) How children learn mathematics	**<u>Critique/challenge offered?</u>** No	**<u>Notes</u>** *“A practical guide” in the title.* *Cockcroft in index*	

Appendix 6: *Initial coding of interview data*

Interview 1 - Emily

P1) Lots of theory in undergrad degree
P1) Clear distinction between maths-specific theories and more general theory.
P1) Out of the habit of talking about educational theory, but you can get back into it.
P3) Sees link between psychology and sociology and educational theory.
P6) Chose maths to make her ‘stand out’
P7) Applying the CPA approach sounded simple but wasn’t
P7) No link between Bruner and CPA
P7) Differentiation a barrier to using theory.
P9) Mastery conflict with using theory.
P9) Excited by the idea of theory but insufficient time to embed.
P9) Confined by broadness of daily timetable
P10) Insufficient power to embed theory as a student
P11) Ideas linked to Spiral Curriculum without prompting
P11) CPA more useful in KS1 – older children not used to it
P13) No memorable books – used more from undergrad
P14) Familiarity with Bruner made her more comfortable
P14) Referred to original Bruner – a lot of ‘jargon’ in original sources – preferred simplified compilations
P15) Hard to focus on maths-specific theory only
P18) Tried to fit practice to theory
P21) Tried to implement theory but it ‘didn’t work’
P22) Focus on standards inhibits mastery

Interview 2 - Tara

P1) Enjoys maths and finds it easier to teach than English or science
P2) Prefers theory that aligns with preferred teaching style
P2) Insufficient curriculum time to implement theory
P4) Concrete resources more prevalent in KS1
P5) Focus on standards inhibits mastery
P6) Maths specialist teacher at school enabled/encouraged innovative thinking
P6) Students are better at new ideas (mastery) because they have fewer preconceived ideas.
P7) University didn’t go into theory enough – relied on her private study.
P8) It was important to see which theories she ‘got’ – Piaget too complicated
P8) Read about Piaget from other books (not originals)
P9) Theorists need to be high-profile now in order to have credibility (Bruner)
P9) Chose Vygotsky (scaffolding) because it’s what she does most of
P10) Gap between maths-specific theory and generalised theory
P12) Didn’t talk to CT ‘much’ about theory but not afraid to bring it up herself (P13)
P13) Focus on standards inhibits mastery
P14) Beginning to theorise herself about multiple representations.
P15) Teaching practice more useful than university
P15) Wanted more examples of practical classroom ideas from university – model lessons
P15) Seminars were too long
P16) Importance of how good the school staff were at maths
P16) Know lots about theory from the assignment, not from what she taught – THE GAP!!
P17) Hasn’t returned to reading since writing the assignment.
P17) Sees theory as out of date BUT acknowledges that ‘new’ ideas can also be theory (P18)
P18) Links her ability to theorise with being well-read
P19) Drew upon Bruner without thinking about it consciously
P19) Reflects on/evaluates practice in terms of theory

P20) Focus on a few theorists too narrow, but still improved her as ‘a mathematician’ P22) Theory might provide the necessary weight to push ideas forward as an NQT – theory gives you credibility
Interview 3 - Eve
P10) Chose maths because she ‘likes the logic behind it’ P10) Maths is easier to teach than English/science P11) Concrete resources more useful in KS1 P11) Couldn’t remember her core strength assignment – ‘long time ago’ and ‘no time to think or reflect’ P13) Placement school inhibited use of theory P13) Students are better at new ideas (mastery) because they have fewer preconceived ideas. P15) Unable to define what a mastery curriculum is P16) University didn’t provide enough practical examples P18) Piaget featured in undergrad degree P19) Theory more useful to learning than teaching P19) Sees theory as becoming embedded I her practice – not explicit P20) Sees theory as already embedded in her practice P20) Did my interview unwittingly provide the reflection time she needed? Methodological contribution? P21) Theory most useful when planning P22) CPA provides an assessment opportunity – insightful P23) Placement school was prioritising phonics, not maths P23) P6) Maths specialist teacher at school enabled/encouraged innovative thinking P25) Negative attitudes among adults toward older children using CPA inhibits it P25) Never discussed theories at school P26) Discussed theory with university link tutor, no school staff P26) Thinks theories are so embedded in qualified teachers’ practice that they don’t have to mention them explicitly P27) Able to recall practical advice from university but not theory – is this THE GAP? P27) Little access to maths SL at school – didn’t feel she could approach them. P29) Learns most about maths from teaching it – school context is important and there’s a GAP between the general advice from uni and the reality of the specific classroom. P30) Only used course literature for assignment P31) Sees theory as out of date
Interview 4 - Fran
P2) Chose maths because her own ability in the subject is good but thought it’d be good to choose because her knowledge is almost too well-embedded to unpick for children P3) Unclear about what her core strength assignment was to begin with P3) Chose Skemp because it seemed easier to implement at school P6) Beginning to theorise herself (multiple representations) P7) Really buys into the concept of mastery P10) Able to relate social theory from undergrad (sports) degree to teaching and learning P11) Primary teaching more about relationships than subject knowledge P12) Only saw the value of theory in the context of her prior experience in schools as a TA – theory first would have been useless and she wouldn’t have known where to apply it P12) Boring lectures P12) Insufficient time on the PGCE to reflect on things properly P13) Valued observing experienced teachers teach over learning theory – theory was an ‘annoying distraction’ P13) Insufficient curriculum time to implement theory – might use it later in her career when there’s less pressure – SHOULD THE THEORY COME LATER IN ONE’S CAREER THEN? P14) Sees theory as an interesting extra – not essential ‘Interesting not useful’

P14) Mastery useful, but would have come across it at school anyway (without it being covered at university)
P15) Thought theory should be part of Bed not PGCE because there's more time – IS THE SHORTNESS OF THE PGCE AN ISSUE
P15) Scanned texts looking for quotes to support her pre-existing thoughts – SANDBAGGING
P15) Didn't like 'big, fat, boring books' – preferred shorter articles – IS THIS A CASE FOR EXCERPTS OF 'POTTED' THEORY?
P16) Wouldn't talk to university tutors – would approach school staff or fellow students.
P16) Used texts only to 'pass'
P17) Valued experience with children rather than qualification – TAs over teachers
P17) Values practical experience over lectures
P21) Unclear on CPA and didn't see value – too many approaches confuse the children
P23) Didn't know theories well enough to see them in action – no time – theory was 'at the bottom of the pile'

Interview 5 - Owen

P3) Chose maths because he's good at it
P4) Skemp and Bruner chosen for assignment
P4) The work of more recent authors is more credible/desirable
P5) Theory that relates to personal teaching style is more desirable
P5) Struggled to recall the name of his chosen theory
P6) Sees scaffolding as crucial
P7) Values theory because of background in psychology
P8) Suggests he'll theorize for himself once qualified
P8) Suggests he'll take comfort from theory when recently qualified and that afterwards, it will become embedded in his practice
P9) Sees theory as a stop-gap until his confidence has improved
P9) Saw learning about theory as a chore but also relevant and therefore worth it.
P10) Experience required to see theories in action – this is needed in order to internalize them
P11) Used learning theory when choosing how to group children
P12) Theories are adaptable for different age groups
P13) Wouldn't plan to discuss theories, but they did crop up in conversation
P14) Cotton, Haylock and Askew key authors
P15) Doesn't relate to Vygotsky because he doesn't fit with his teaching style.
P15) Used online resources to back up his points in the essay
P15) Still refers to texts for planning ideas
P16) Goes to CT first – suggests that SL may have better ideas
P16) SLs offer quick fixes rather than the ability to help himself
P17) Guidance needed for pitching lessons correctly
P17) Learns most while teaching but the ideas/inspiration came from university
P18) There's a gap between learning about maths teaching and knowing how to do it
P19) Placement was too short to implement CPA approach
P20) Progressive rather than retrospective nature of CPA
P20) Teachers that are set in their ways are a barrier
P20) Placements are too short
P20) Easier to implement mastery with an RQT
P21) Young teachers less afraid to implement new ideas
P21/22) Theories enable you to think critically about specific approaches to teaching
P22) The prospect of theory could put people off
P23) Sees the value of talking to people that have also done the PGCE

Interview 6 - Leanne

P2) Well-principled reasons for choosing maths
P3) recognises the importance of maths in 'real life'

P4) Couldn't immediately remember essay subject
P4) 'Higher up school' = 'more complex side of maths'
P4) Essay based on Bruner (CPA)
P5) Forced to consider MKO because of the practicality of having to share resources at school
P5) Suggests that MKO is at odds with mastery
P6) Specific instance of the need for concrete resources
P7) Does university present a 'cutting edge' view of maths that schools may not be able to keep up with?
P7) Experienced teachers are 'behind' in their thinking
P8) Concrete is more beneficial for KS1 and that it makes life easier
P9) Problems with a lack of understanding of theory on the part of teachers and lack of quality early experiences of maths for children.
P10) Finance a barrier to implementing theory at school through quality resources.
P11) Use of concrete resources can have an adverse effect on behaviour
P12) 'External factors' can inhibit use of theory
P12) Learning theories are too idealistic
P12) Theory is about children learning better
P13) Theories not used for practical ideas but as 'food for thought'
P14) Used MKO to develop children's use of mathematical vocabulary
P15) Has never referred to theories in conversations about maths teaching.
P16) Askew a key author because it's easy to read
P17) Askew bridged the gap between theory and her own classroom
P18) Theory = how, NC = what (uni fills THE GAP between them
P19) Theory leads to practice – having an interest in maths is important when implementing the theory
P20) With experience, her engagement with Vygotsky improved
P20) Suggests an understanding of theory is essential for parents
P21) Learning about theories hasn't supported her understanding of mastery – more about practical, classroom experience
P23) Learned most about maths teaching through 'uni practicals' and teaching it – uni provides a guided opportunity to practise (P24)
P25) THE GAP isn't just a void between theory and practice, it's an actual thing.

Interview 7 - Molly

P2) Enjoys the challenge and open-ended nature of maths
P3) Used Skemp, Bruner and Vygotsky for essay because they fitted best with her teaching style
P6) Did some theory for u/g degree – separated theory and practice
P7) Theories are based on how you teach
P8) Suggests theory will become embedded in her understanding
P8) Theory useful for choice of teaching resources
P9) Critical of mastery approach
P9) CPA works, but not enough C
P11) CPA more useful in KS1
P12) Suggests that theories manifest themselves in really good teaching
P13) Has seen scaffolding 'in action' but only realised it on reflection afterwards
P13) Theories can come naturally in time
P14) Schools' position with regard to mastery may inhibit the use of theory.
P14) Differentiation is a barrier to implementing a mastery curriculum.
P14) Mastery is only any good for EXS+ children
P15) Made use of scaffolding on teaching practice
P15) Relational understanding important for children understanding why they're doing something
P15) Theory used to support planning initially but also 'in the moment' (for more/less scaffolding)

P16) Theory can also support lesson structure/timing
P16) Theory can guide choice about resource type, but not specific resource
P17) Theory of equal use in KS1 and 2 although CPA more useful in KS1
P18) Theory discussed at school albeit in implicit terms
P18) CT approached for support in the first instance
P19) Positive relationship with CT enabled conversations about maths teaching.
P19) Learned most about maths teaching while teaching although uni inspired engagement with ideas
P20) Askew – favourite book
P20) She sought a text on theory not on the reading list
P20) Used a potted version to establish a basic understanding
P20) Her perception is that original sources of theory are complicated.
P21) Do simplified versions fill THE GAP?
P22) not referred to any books since writing essay - prefers teaching practice
P23) Internalised theory enables truer reflection
P23) Theories underpin teaching so you may encounter them accidentally.
P24) Some of the theories could work in other areas – but not behaviour management
P25) Mastery inhibited by being placed in a mixed class

Interview 8 - Sarah

P1) Sees theory as the basis of how children learn and 'the best' method for allowing access to teaching.
P2) Most of her ideas about theory came from Steiner and her previous ob.
P6) Referred to theories (Dienes, Bruner, Vygotsky and Piaget) without prompting.
P6) Sees NC as based on theory (particularly in maths – too much?)
P7) Sees all theories as the same/building on each other.
P7) PGCE didn't go into theory enough – limited time
P7) Didn't do as much reading as she wanted
P8) Has her own, clear ideas about maths pedagogy already – too soon to teach columnar calculation.
P9) Referred to Skemp's Relational Understanding without prompting.
P9) Cross-referenced her own ideas to ideas of theory without prompting.
P10) Critical of the NC – doesn't allow enough time to be spent on mastery.
P10) Suggests that theories are about teaching to begin with and that they therefore become about learning.
P11) Will not read about theory once qualified – because access to original sources is difficult.
P11) She's put off by paraphrasing of ideas by others.
P12) Find Piaget confusing and is critical of his methods (sample size).
P12) Suggests that theories are difficult to relate to modern practices and the requirements of the current curriculum (out of date?)
P13) Theories are embedded in thinking so they happen without direct effort or intention to do so.
P13) Sees theory as 'good practice'.
P13) Theories require a modern, contextual lens through which to view them – Boaler, Askew and Liebeck provide this. THE GAP!!
P14) Critical of the possibility of adopting ideas just because somebody else has said them.
P15) Skemp's relational understanding is the most useful theory – she uses it all of the time.
P15) She's never discussed theories with other teachers.
P16) Not possible to read them all books on list. Time?
P16) Haylock, Hansen, Cotton, Askew were most useful .
P17) Wished she had more time to engage with books.
P18) Approaches class teacher for help I the first instance.
P19) Learns most at school – trying out ideas

P20) Workload inhibits implementation of theory.
P21) CPA does work but doesn't fit NC
P21) CPA supports behaviour management
P22) Critical of Vygotsky's MKO
P22) The GAP consists of other people's views about theory.

Appendix 7: *Thematic analysis matrix*

	Emily	Tara	Eve	Fran	Owen	Leanne	Molly	Sarah	Total
Good at maths/maths easier to teach		P1	P10	P2	P3		P2		**5**
Maths theory and general theory is different	P1, P15	P10							**2**
Theory is out of touch with modern practices (inc mastery)	P9, P22	P13			P4	P5, P12. P21	P14	P12	**6**
CPA more useful in KS1	P11	P4	P11		P12	P8	P11, P17		**6**
Original sources of theory are difficult to understand	P14	P8, P9		P15	P22	P16	P20	P12	**7**
Placement schools help/hinder use of theory		P5, P16	P13, P23		P16	P5, P7, P10	P14, P25	P20	**6**
Mentors help/hinder use of theory		P6, P13, P16	P23, P25, P26, P27	P13, P16	P13, P16, P20, P23	P7, P9	P18, P19	P18	**7**
Students are better at newer ideas		P6	P13		p21				**3**
Theories are outdated	P7	P9, P17	P31		P4			P13, P21	**5**
Insufficient time to implement theory	P9	P2	P20	P12, P13, P15, P23	P19, P20		P13	P7, P10,P 16, P17, P20	**7**
School experience more useful than university-based learning		P15,	p29	P14, P17	P17	P23	P19	P19	**7**
Students beginning to theorize for themselves		P14, P18		P6	P8	P14		P8	**5**
Sees links between prior, UG learning and theory	P3, P11, P14		P18	P10	P7		P6	P2	**6**
Insufficient power to embed new ideas as a student	P10	P22							**2**
Inductive/deductive approach to theory	P18			P12	P10	P19	P7, P23	P9	**6**
Theories are idealistic	P21			P21		P12			**3**

The National Curriculum is overcrowded		P2		P13				P10	**3**
Prefers theories that align with personal teaching style		P2, P8, P9			P5, P15		P3		**3**
Dissatisfaction with university content/programme		P7, P15, P20	P16	P12, P15	P17			P7, P16	**5**
Assignment ‘forced’ students to engage with theory		P16, P17	P30	P3, P15, P16	P15		P22		**5**
Evidence of theory being embedded with time	P11, P14	P19	P19, P20		P8	P20	P8, P23	P6, P9, P13	**7**
There is a gap between theory and practice			P27, P29		P18	P17, P18, P25	P21	P13, P22	**5**
Unable to recall key elements of the PGCE course			P11	P3	P5	P4			**4**
Theory improved students’ maths, not their teaching		P20	P19			P12		P10	**4**
Theories are interesting but not essential				P14, P23	P9	P13			**3**
The PGCE is too short				P12, P15	P19, P20			P7	**3**
Evidence of use of theory other than the assignment			P21		P11, P15	P5, P6	P13	P15	**5**
Has a favourite author/s	P14				P14	P16	P20	P13	**5**
Theories provide reassurance/help you to think critically		P20			P9, P22		P15, P16		**3**
Never referred to theories in conversations about maths						P15	P18	P15	**3**
Sees theory as good practice		P19	P26		P21/22		P12	P1, P13	**5**
Literature can bridge the gap between theory and practice		P8				P16	P20, P21	P11	**4**

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