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An exploratory study of Professional Identity in Mathematics Teacher Educator-Researchers: Applying Davey's framework as a methodological tool

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Abstract

This research explores the identities of Mathematics Teacher Educators and Researchers via a framework of five lenses - *becoming*, *doing*, *knowing*, *being and belonging*, proposed by Davey (2013). The framework is used throughout the research, firstly to conduct a systematic review of the research into mathematics teacher educator-researchers covering the past ten years. This reveals a diversity of research examined through each lens, much of it done by the teacher educators themselves, reflecting on their own practice. It also reveals the gaps in our knowledge about UK professionals.

Davey's framework supported the creation of an online survey of 144 professionals at different stages of their career, together with follow-up interviews with 27 respondents involved in the Primary phase of mathematics teacher education.

This research concludes that, in the UK at least, there is a well-qualified, committed and highly experienced workforce of professionals, often recruited with identities as established teachers of mathematics, but *becoming* teacher educators over a period of years, often trying to balance conflicting demands of the role. Their professional identity rests on core beliefs and values: that they can "make a difference" to the mathematics education of pupils by educating future generations of teachers, and also by being part of communities, with colleagues from schools, universities, associations, other educators and researchers. For a substantial number of these professionals, the identity formation of mathematics teacher educator researcher is a career-long journey.

Contents

Chapter 1: Introduction

This study arises from my personal and professional interest, spanning a period exceeding thirty years, in the field of mathematics teacher education and research. The thesis has a specific focus on the 'professional identity' of those engaged in the field. In the chapters that follow, what is understood by the term 'Professional Identity' is considered. By way of an introduction here, it is useful to note that 'professional identity', specifically in relation to teacher educators, is a complex of ideas, but can be summarised as:

> "… how we construe and construct our own biographies and prior experiences, our values, beliefs, attitudes and dispositions, our motivations and aspirations, our specialist knowledges and abilities, and our group affinities and affiliations."
>
> (Davey, 2013, p. 163)

In her paper, 'Teacher Educators: hidden professionals?', Livingston (2014) asserts the need to better understand this group of professionals. Teachers are acknowledged as important because of the crucial role they play in educating children and young people. Surely then, she argues, it should follow that teacher educators' roles are also valued given the responsibility for educating generations of teachers.

What follows in this introductory chapter is a brief overview of my professional context and an insight into the rationale for the thesis focus. This is followed by brief synopses of the content of each subsequent chapter.

As part of my Initial Teacher Education (ITE) during the period, 1985-1989, I studied mathematics at degree level, and held a continued interest in the subject, taking responsibility for it in the three primary schools in which I taught (1989-1997). Subsequently, through various roles within three

universities (1997-present), I prepared student teachers to teach primary mathematics in school through undergraduate and postgraduate routes into teaching, led teams of mathematics education tutors and mentored new colleagues, inducting them into the role of 'primary mathematics teacher educator'. Whilst my university roles have included leadership at subject (primary mathematics education), programme (undergraduate and postgraduate) and department levels all within initial teacher education (ITE), more latterly my senior roles have become more diverse in nature with additional leadership and management responsibility and accountability, and less direct involvement in mathematics education. My interest in the field over the years however has nonetheless remained significant.

When I became a Mathematics Teacher Educator in 1997, I followed a route which I perceived to be a fairly well-established way of teachers moving into Higher Education: 'specialists' in subjects such as mathematics became known through their work in schools and through attending courses and sometimes contributing to them. By the time I came to University, I already had a reasonably clear idea of the role of teacher-educator, and had already begun to establish my professional identity within mathematics education. There was a transition to be made however from primary mathematics leader/specialist within the context of a single school, to the role of mathematics teacher educator within a university setting. Whilst I certainly saw myself as a teacher with expertise in, and a passion for, mathematics, I did not necessarily consider at the time the notion of 'professional identity' at a metacognitive level.

It has only been in more recent years, when reflecting on associated academic research along with observations of the impact of external influences on those in mathematics teacher educator roles, that I have personally begun to appreciate the notion of 'professional identity' and

recognised its significance, hence my choice of this as an area for academic study and investigation.

The brief overview given above serves as an introduction to professional identity in relation to my own story. From this brief personal pen-portrait, it can be seen immediately that there are some features which raise questions, and which can act as pointers as to how the research into the professional identity of MTERs might proceed.

While recognising that the route by which I came into Teacher Education may have been relatively common twenty or more years ago, today the context has changed significantly. There has been an increase in the number of initial teacher education routes available, including for example, Teach First, School Direct and School Centred Initial Teacher Training (UCAS, 2019a) fulfilling many, but not all, of the roles which had primarily been the domain of universities during my initial years in the field. Given these changes, colleagues' roles within my current university have broadened particularly with the expectation to manage the varied range of relationships with partner schools.

The above raises some important preliminary questions:

Firstly, do the people who are currently undertaking the Mathematics Teacher Educator role see themselves as having an "identity" as a Mathematics Teacher Educator in similar ways to that I did in the past? If so, is there any consistency to this identity, and how is it currently acquired?

Secondly, in my experience, the main role of the university Mathematics Teacher Educator at the time of taking up my first appointment was to

prepare student teachers to teach mathematics in the primary classroom whilst also contributing to their wider knowledge of education. As Mathematics Teacher Educators, my colleagues and I were primarily consumers and appliers of research rather than producers of it. The extent to which teacher educators have been expected to engage in and publish research has differed in each of my three settings; the recent proposed changes to the national Research Excellence Framework (REF, 2019) have also impacted on expectations in relation to this matter. This raises the question of the extent to which "Professional Identity" remains stable over time, or whether it changes, either individually as a person progresses through their career, or collectively as to how the profession responds to external factors.

Thirdly, mathematics as a subject has traditionally been given a level of priority on a par with English (DfES, 2006) In practice this had a number of consequences, including: greater time devoted to sessions for student teachers than they received in other curriculum areas; in schools, regular assessments of mathematics teaching were conducted; and, when the Office for Standards in Education, Children's Services and Skills ("Ofsted") inspected ITE courses, there was invariably a focus on provision in mathematics and English. The importance given to mathematics as a core subject in the National Curriculum for schools has continued to be greatly significant, evidenced for example by the setting up of Mathematics Hubs across England (NCETM, 2021). This raises a further question of the extent to which the "Professional Identity" of those engaged in Mathematics Teacher Education may be similar or different to those in other fields.

Finally, some of the changes in ITE practices noted above, have arisen as a result of criticisms levelled at university departments of initial teacher education (Ward, 2014). This raises another crucial question as to whether

these changes have impacted on the professional identity and perceived self-worth of the individuals employed within the sector.

These initial questions supported my reflections and motivated my early thinking in considering the research contained within this thesis.

For the purposes of the study, I adopt Jaworski's description of Mathematics Teacher Educators (MTEs) as:

> "professionals who work with practising teachers and/or prospective teachers to develop and improve the teaching of mathematics"
>
> (Jaworski, 2008, p. 1).

In this study, I have added the letter 'R' for researcher(s) to 'MTE' in order to include those whose main activity might be researching mathematics education as well as capturing those whose main activity may be teaching teachers and those who undertake a combination of the two. Research in Higher Education has become even more important in recent years because of the focus on the Research Excellence Framework (REF, 2019) so it is essential this is captured in the study.

The terminology of Mathematics Teacher Educator(s) and/or Researcher(s) is used throughout this study, and is simply referred to as 'MTER' or MTERs (plural). I am consistent with the term though it should be noted that authors sometimes use other terms to capture this group. Although individuals for whom this title might apply could equally well be working in schools or other settings, for the purposes of my study, I have mainly focused on those employed by universities for whom mathematics education is a significant element of their role. This and other acronyms used in this study are captured in the glossary in Appendix J1. In particular, I refer herein to student teachers as pre-service teachers (PSTs).

Therefore, I take the professional identity of MTERs as the theme of the study and, for reasons clarified in later chapters, the thesis is of an exploratory nature. I explore not only the different aspects of the MTER role, but how MTERs relate to the wider mathematics education community. In particular, I investigate several key themes: how individuals come to take on the role in the first place, and how they are inducted into it; how their roles differ across locations and with circumstance; their personal experiences of what it is to be MTERs; how they see themselves in relation to others - whether they carry out the role in isolation or whether they belong to a wider MTER community, and the extent to which they draw from that community and/or contribute to it.

In Chapter 2, the notion of MTER professional identity is more clearly defined and contextualised within the wider field of identity studies. A framework for examining MTER identity is introduced, which is then used as a basis for a systematic review of the literature on MTER identity. The chapter culminates in a rationale for the main focus of this thesis which is an exploratory study into professional identity in mathematics teacher educator-researchers.

In the rest of the study, Chapter 3 presents the series of research questions, and explains the methodology by which these questions are to be answered – a two-pronged approach using a survey (questionnaire) and a series of semi-structured interviews both using the analytical framework derived from the literature. Chapter 4 examines the sample of MTERs surveyed, providing an overview of the characteristics of the workforce of MTERs in the UK and beyond. This is followed in Chapter 5 with a more detailed look at the MTERs' characteristics, their aspirations, opinions and personal qualities, and results in a series of exploratory themes, questions and hypotheses which form the basis of the interviews. Chapter 6 takes up these questions, reporting and analysing on specific themes which arose, not just from the

survey, but in the interviews themselves. Chapter 7 summarises the findings and reviews what has been learnt, and maps out how these findings will be disseminated. The final Chapter (8) provides a brief summary of the whole with some implications including the recruitment and professional development of MTERs. Limitations of this exploratory study are noted and ideas for future research are suggested.

Chapter 2. Literature Review

2.0 Introduction

It is clear from even a brief foray into the literature that a significant amount of material on the topic of identity exists. This includes several academic journals devoted specifically to identity across a range of key themes, including, for example: Self and Identity; Journal of Identity and Migration Studies; Journal of Language, Identity and Education, to name just three. Literature concerning, and in many cases authored by, Teacher Educators across a variety of specialisms, features in numerous journals, such as: Teaching and Teacher Education; European Journal of Teacher Education. A third source of material, specifically pertinent to MTERs, exists which includes numerous additional academic journals including: Mathematics Education Research Journal and the Journal for Research in Mathematics Education, resulting in quite an extensive range of potential source material. However, what is absolutely key to this study, is that literature explicitly relating to the professional identity of MTERs is relatively sparse. The nature and extent of potential source material demands a very particular approach to the literature review for this exploratory study – one which is selective yet comprehensive.

In Section 2.1, a brief introduction to Identity and related key terminology is provided. The section refers to the nature of identity generally, with the discussion progressing to notions of professional identity and highlighting some of the contexts in which the latter is explored. An indication of the scale of research into professional identity specifically of teachers and teacher educators follows. Given the scope of this study, it was important to keep the more generic material within 2.1 to a minimum, allowing it to simply serve as background information and scene setting for the more substantive later sections which focus on the theme of this study – the Professional Identity of MTERs. Consideration is given specifically to a selection of approaches and models adopted by researchers in their quests to

investigate professional identity of key related professional groups. As part of this discussion, I introduce the Davey framework (Davey, 2013), which is one such model, and proceed to present my argument for its use in underpinning the study as a whole.

Following on from confirming my chosen model or framework, my decision to conduct a systematic review relating to MTER professional identity is considered. I argue that a systematic review of the literature provides sufficient scope to encompass recent and relevant research using a well-defined set of journals, together with a range of other key papers which address each of the concerns of Davey's framework. The justification and explanation of the systematic review format, methodology and structure is provided in Section 2.2. Effectively, I use the Davey framework (Davey, 2013) as a way to situate and contextualise the whole of my study, and to structure the substantive literature review, using it as a series of lenses through which MTER professional identity can be viewed. Thus, the remaining substantive Sections 2.3 – 2.7 form the findings from this systematic review which, for reasons clarified below, consider how the MTER literature contributes to our understanding of various aspects of professional identity, as defined by Davey (2013). Section 2.8 provides some concluding remarks, synthesising significant theoretical points and providing the necessary backdrop for the methodology chapter.

The review concludes that there is a gap in the research which my study aims to address, at least in part. The MTER specific literature review comprises a series of sections, each taking an aspect of professional identity as outlined by Davey (2013), and each ascertaining key findings concerning these respective aspects, and drawing on a diverse range of studies, not all of which are specifically focused on MTER identity. This was wholly necessary given the sparsity of specific literature directly addressing MTER professional identity in its entirety. The resultant literature review therefore fulfils the intended remit of achieving a scope which is of

manageable size yet remains pertinent and relevant; it creates a valuable overview of literature relating to the professional identity of MTERs, and a firm rationale and underpinning for the study which follows.

2.1 Brief Introduction to Identity

It is important to clarify some of the terminology used within the study: identity; profession; professionalism; and, social identity; leading to an explanation of the term, 'professional identity'; a select group of authors have been referenced in this initial section chosen for their apparent high regard in the field.

2.1.1 What is Identity?

The topic of *identity* has an extensive literature base, and, as noted in the introduction to this chapter, a number of academic journals are specifically devoted to its examination. As outlined in the Aims of one such journal, '*Identity. An International Journal of Theory and Research*',

> "… the construct of identity refers to the multiple and complex ways in which individuals come to define themselves, whether by choice or ascription …"
>
> (Identity, 2019).

This specific journal considers 'self-definitions' to include the following non-exhaustive set of possible identities: ethnic; vocational; religious; gender; sexual and those arising within the contexts of relationships, such as parent or partner.

Brooks (2011, p.2) states that, "identity seems to us a crucial knot of our thinking—a concept as necessary as it is difficult to analyse." Brooks refers to three writers, Rousseau, Proust and Freud as "inevitable points of reference" in relation to the study of identity. Rousseau in particular, Brooks says, appears to him to be "the first to make his identity the subject of a study in an identifiably modern way, and his

obsessive play of neuroses sounds peculiarly modern." Proust, Brooks continues, "orchestrates the finding of personal identity from childhood forward …", and "Freud's more speculative encounters with identity, especially his own" are what particularly interest him (Brooks, 2011, p.2).

These notions of identity all seem to invoke the idea of identity as something intensely personal, possibly unique to the individual. However, Jenkins (2014), explores a large number of issues and demonstrates the extensive nature of social identity. He points out, for example, that 'identity' is in fact the process of identification as a member of a collective, and that identity is not "… something that one can have, or not; it is something that one does." (Jenkins, 2014, p. 6). In Chapter 9, he explores this at length, discussing the relationships between individual concepts of identity, and the group with which the individual associates, in order to derive the perceived identity, pointing out that the 'identification' process involves both similarity to a particular group and differentiation from another group:

> "Group identity is the product of collective internal definition. In our relationships with significant others we draw on identifications of similarity and difference, and, in the process, generate group identities."
>
> (Jenkins, 2014, p.107)

This is a crucial point. In order to study identity, even of individuals, it appears to be important also to study the collective to which the individuals see themselves as belonging.

2.1.2 Notions of Professional Identity

Whilst as early as the 1950s, identity was extensively explored largely in relation to race or ethnicity, the notion of 'professional identity' upon which this study is focused, is a relatively recent phenomenon. Since at least the 1950s, sociologists have used the terms "professional" and "professionalism" when exploring what it

means to be a professional which is different to simply having an occupation. In a thorough review of ideas around, and exploration of definitions of, *profession* and *professionalism*, Evetts (2012) considers that there are two types of professionalism: organizational and occupational, the former linked with Weber's models of organization and the latter linked with Durkheim's model of occupations as moral communities. She also considers identity as part of professional socialization in the workplace, which involves the development and maintenance of shared professional values. These involve a range of requirements and experiences: shared educational backgrounds, professional training, vocational experiences, membership of professional associations at local, regional, national and international levels, together with shared work cultures and common values. Evetts (2012) further notes that,

> "… shared professional identity … is associated with a sense of common experiences, understandings and expertise, shared ways of perceiving problems and their possible solutions"
>
> (Evetts, 2012, p.2)

These ideas of social identity, professions and professionalism provide helpful insight when considering the notion of professional identity. Although this variety of terms is still used today, in regard to my study, I have adopted the use of the term *Professional Identity*. Professional Identity has been explored in many different contexts and in many different professions, within and outside of education. These have included for example: social work (Shanks et al., 2015) and (Beddoe, 2015); nurse academics (Baldwin, Mills, Birks and Budden, 2017); pharmacy students (Bridges, 2018); clinician-scientists (Kluijtmans, Haan, Akkerman and Van Tartwijk, 2017); safety professionals (Provan, Dekker and Rae, 2018); careers advisers/practitioners (Neary, 2014); journalists (Grubenmann and Meckle, 2017); police (Schaible, 2018); police and probationary officers (Murphy and Lutze, 2009).

Many reasons are given to justify exploring professional identity. In the case of safety professionals for example, Provan et al. (2018), argue that it is important to understand who they are and what their beliefs are in order to better understand their work practices potentially leading to change and safer working environments. This argument could likely apply to all medical and health professions. Bridges (2018) suggests that whilst there is no set definition of professional identity in relation to pharmacy or other healthcare fields, particular attributes such as integrity, compassion and attention to detail, for example, are thought important. Whilst some aspects of a role might be taught, such as communication skills, others such as values are more personal and complex. Bridges (2018) also suggests that identity is constantly changing and dependent on social and relational factors; these can be beneficial and promote a sense of belonging and involvement or may cause tensions or conflict. Gaining a greater understanding of these notions relating to professional identity is surely crucial given the importance of the professions within society.

2.1.3 Professional Identity in the Context of Education

Professional Identity of teachers has been well researched over the last twenty years or so (Connelly and Clandinin, 1999; Beijaard, Verloop and Vermunt, 2000; Gee, 2000; Beijaard, Meijer and Verloop, 2004; Sachs, 2005; Flores and Day, 2006; Watson, 2006; O'Connor, 2008; Erickson and Pinnegar, 2017; Yuan and Burns, 2017; Schultz and Ravitch, 2013). The attention Professional Identity receives, signifies its importance to how teachers view their roles and the ways in which they perceive the nature of learning and teaching. This impacts on how they identify themselves, their work behaviours, their effectiveness and their sense of well-being (Rus, Tomşa, Rebega and Apostol, 2013).

Identity appears not to be restricted to one component, a singularity; rather it appears to be multi-faceted in nature or to be comprised of sub-identities (Beijaard

et al., 2004; Klecka, Donovan, Venditti and Short, 2008; Swennen, Jones and Volman, 2010). Neither does it appear fixed in time but viewed as changing and evolving over time (Beijaard et al., 2004; Beauchamp and Thomas, 2009; Sutherland, Howard, and Markauskaite, 2010). Because of this latter notion of identity as evolving, many studies focus on the formation of professional identity. The perceived association with professional development and learning provides a clear rationale for giving due consideration to teacher identity, the premise being that an understanding of teacher identity supports greater clarity when considering teacher development (Korthagen, Kessels, Koster, Lagerwerf and Wubbels, 2001; Hoban, 2007; Olsen, 2008). Several researchers perceive teacher learning as synonymous with identity learning or formation (Geijsel and Meijers, 2005; Beijaard, 2019; Garner and Kaplan, 2019; Ye and Zhao, 2019; Schaefer and Clandinin, 2019; Leeferink, Koopman, Beijaard and Schellings, 2019). This apparent synonymity is of particular relevance to teacher educators.

Understanding teacher identity and formation in relation to how this might support and enhance pre-service and in-service teacher education practices is clearly of use, and this line of inquiry has been considered by a number of researchers (Beauchamp and Thomas, 2009; Thomas and Beauchamp, 2007; Sutherland et al., 2010); Brown and McNamara, 2011; Connolly, Hadfield, Barnes and Snook, 2018). Examples of this can be found specifically in relation to teachers and PSTs (Sutherland et al., 2010; Losano, Fiorentini and Villarreal, 2018; Beltman, Glass, Dinham, Chalk and Nguyen, 2015). In many instances, these take the form of longitudinal studies which present researchers with the opportunity to engage with the same individuals at different points in time. In theory, this enables the researcher to consider how professional identity may change or develop or form over a period of months or potentially years. If this can be adequately captured at each point with some understanding of the journey travelled in between capture points then one can see the value in this approach.

The detailed study of mathematics PSTs which was undertaken at a UK university (Brown and McNamara, 2011) provides such an example. Hong, Greene and Lowery (2017) followed five PSTs over a period of four years extending beyond their initial teacher education into their first teaching posts. One rather unique longitudinal study was undertaken of one individual whose professional identity was explored at two points almost two decades apart (Lutovac and Kaasila, 2018). The significance in this particular study is the role of crisis in identity development and the use of a biography-stimulate recall methodology.

Despite the extensive literature base, reviews of the literature suggest there is inconsistency in many of these studies as to how identity is defined and in some cases no definition is offered at all (Beijaard et al., 2004; Izadinia, 2014, Darragh, 2016). Identity is clearly a complex concept (Beauchamp and Thomas, 2009) however Darragh (2016) offers some helpful insight in the context of identity in mathematics education. Findings from her significant review - 188 articles from 85 journals spanning two decades - suggest identity is considered from two main perspectives: identity as an action, corresponding with a sociological paradigm; or, identity as an acquisition, corresponding to a psychological frame.

Akkerman and Meijer (2011) add a particularly useful contribution to the challenges of conceptualizing teacher identity. They suggested that the prevailing manner in which teacher identity was being addressed at the time was to consider it as dynamic and evolving, relational and comprised of multiple elements or sub-identities. This position very much reinforces that already referenced above (Beijaard et al., 2004). However, they criticised the fact that, what they term as, "these radically new perceptions of identity" were not being considered fully alongside previously held views of identity, that is those of singularity, continuity and sameness. As a means by which to address this they turned to the relatively new psychological theory of dialogical self. This approach they argue allows for a more intricate consideration of teacher identity which allows it to be "conceived of

as both unitary and multiple, both continuous and discontinuous, and both individual and social" (Akkerman and Meijer, 2011, p.308). Their study is given greater consideration in Section 3.1.5 where I provide a rationale for my own chosen framework.

Given teacher educators' significant responsibility in developing future generations of teachers, I would however reiterate the importance previously highlighted of enhancing our understanding of the professional identity of this group in its own right (Livingston, 2014; **Margolin, 2011**; Boyd and Harris, 2010). Research into teacher educator identity has become more prevalent although perhaps not so extensively as that of teacher identity. Izadinia (2014) in her review of literature suggested that teacher educator identity is under-researched. Whilst there has been some work in this area, as will become clearer, this is much less the case where it concerns MTER professional identity explicitly. In fact, despite the extensive nature of Darragh's review (Darragh, 2016), there is no specific consideration of MTER professional identity contained within it, adding more weight to the argument that an investigation of the sort I propose is much needed.

Where it is perceived to be useful, issues raised within the body of generic research on teacher educator identity by key authors (for example, Murray and Male, 2005; Loughran, 2006; Boyd and Harris, 2010), are made within the substantive MTER section of this literature review so as to contextualise the MTER specific findings. This strategy helps to avoid over-duplication of material as well as providing, at more appropriate points, some useful background context in regard to the wider teacher education community whilst still retaining the MTER focus.

2.1.4 Possible Frameworks for studying Identity

In determining an approach for this study into the Professional Identity of MTERs, an essential undertaking was to consider the models or frameworks utilised by

other researchers in their quests to investigate professional identity. First, it may be useful to clarify my interpretation of the semantics in this context. I found Nilsen's (2015) paper was helpful in this regard, and in the discussion below, I have used it to clarify concepts and terminology.

2.1.4.1 Theoretical Positions, Theories, Models and Frameworks

Following Nilsen (2015), I interpret a theoretical position as a philosophical stance, a worldview which sets agendas and is informed by one's interpretations of ontology (nature of reality) and epistemology (nature of knowledge). This philosophical stance informs a researcher's approach and guides what questions to ask and how research might be conducted.

Theories may be constructed based on observations in an attempt to understand and explain various phenomena within the world. Models or frameworks with theoretical underpinning may prove useful in supporting further investigations into these phenomena. (Nilsen, 2015). However, as Nilsen goes on to point out: "*Models are closely related to theory and the difference between a theory and a model is not always clear.*" (Nilsen, 2015, p. 1). Generally, models may offer simplified explanatory and predictive structures, which seek to explain why and how things occur and enable us to generate further hypotheses. Frameworks, however are descriptive devices, which seek to categorise a topic of study or particular phenomena, to make them more readily accessible or understandable (Harvey, 2017). There is clearly some overlap between the two, and in common usage they are sometimes used interchangeably.

Clearly then, philosophical positions are required in order to generate theories, frameworks and models, and such positions inform us how these devices should be investigated or tested, what data to collect in order to do this, and how any analysis should be carried out. Models in particular rely on sets of assumptions which are

normally arrived at via an underlying theoretical position, and such models can often operationalise a theory (Harvey, 2017). Furthermore, theoretical models can actually suggest further models as part of their theoretical account of how the world is, or how the world should be investigated. (Nilsen, 2015). However, this correspondence is not exact: one theoretical position can generate different models, some of which may conflict, and a particular model or framework may sit just as easily within one theoretical position as another.

The philosophical position underpinning my research is given due consideration within the methodological chapter of this thesis. At this point, however, I consider the models or frameworks employed by a selection of researchers and confirm my choice of framework around which to situate my research.

2.1.4.2 Selecting a Framework for the Study

Prior to any formal review of the literature, as notes in Section 2.0, my searches had revealed that the literature base on MTER identity was going to be widely dispersed, and in many studies the topic of identity was incidental to other material which often formed the core topic of the paper. I therefore needed a framework or model which could serve as an organisational toolkit to collate and categorise this material, and possibly help with its analysis. The framework also needed to have the potential to be used in the rest of the study, to aid in developing methodology, and even the collection and analysis of data.

At the time of reviewing the literature and considering the methodology for this research, studies relating explicitly to the professional identity of MTERs were found to be extremely limited and those containing a model or framework even fewer. One such study has recently been published, (**Goos and Bennison, 2019**), which is actually included in the "100-set", which forms the core literature base for this

study. At the time I was seeking a framework to use, the paper was not available, so I have not provided a detailed analysis here. However, even if it had been available, it is unlikely that it would have been a strong contender. The model concerns itself with the dynamic aspects of identity construction, and while it is useful in terms of understanding how identity develops, it is less useful in terms of providing a viable structure for organising the literature on MTER identity.

Given the diverse character of the literature base, of particular interest were studies concerned with models designed to support investigations into the professional identity of related groups: teacher educators; teachers; mathematics teachers; and, academics in universities.

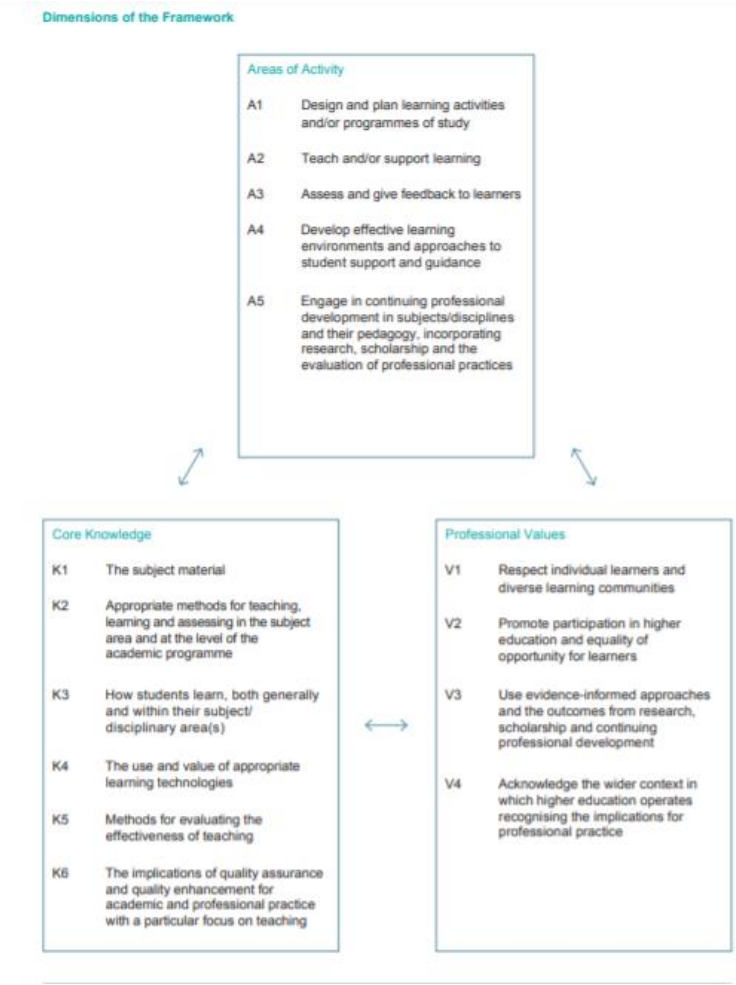
Below, I consider three such models in detail, and why they were rejected, before moving onto Section 2.1.5 in which I introduce the framework that I have selected to support my study. The models are:

- The UK Professional Standards Framework (UKPSF) (Advance HE, 2011);
- The Swennen et al. (2010) model;
- The Beijaard et al. (2004) model.

2.1.4.3 The UK Professional Standards Framework (UKPSF)

One organising framework which should be given at least some consideration is one with which some UK academics may be familiar – The UK Professional Standards Framework (UKPSF) for teaching and supporting learning in higher education (Advance HE, 2011) is shown in Fig. 2.1 below:

Fig 2.1 The UK Professional Standards Framework*



*The diagram above summarises the UK Professional Standards Framework (UKPSF) for teaching and supporting learning in higher education (Advance HE, 2011., p. 3)

Academics in higher education in the UK may be obliged by their universities to seek fellowship of what was previously the Higher Education Academy (HEA) and is now Advance HE (Advance HE, 2020a); by way of example, well over 80% of those with academic contracts in my current university possess such fellowships. Fellowships are awarded at four levels (associate; fellowship; senior fellowship and principal fellowship) dependent on experience and evidence of effective practice against the criteria contained within the UK Professional Standards Framework (UKPSF) (Advance HE, 2020b).

Although the model is well-known within the sector, and readers of this study and participants within it might be familiar with it, there were several reasons for rejecting this as a potential model through which to study professional identity in MTERs:

- The framework is hierarchical in nature with four levels as noted above. It was not my intention to set out within my research, in any manner, a suggested hierarchy or anticipated projection in regard to career paths or personal and professional development;
- Participants in the study with different levels of fellowship or with different levels of prior engagement might feel at a disadvantage and possibly uncomfortable with their understanding of the different levels, or their lack of familiarity or engagement with the UKPSF.
- The framework might have associations with accountability in relation to some roles in universities including contractual requirements, expectations in regard to promotions and potentially termination of contract where a member of staff has failed to meet the criteria for fellowship where it is a condition of post. I was keen not to complicate my study with any confounding ethical issues.
- Whilst this framework might be familiar to some MTERs, it is not necessarily the case that all will have encountered it. Its use therefore may be perceived by some as somehow potentially disadvantaging some participants.
- The model presents a predetermined set of activities, knowledge-bases and values for Higher Education academics to which applicants for fellowship are expected to refer. There are two main issues with this:
    - My starting point would not be to have a pre-defined set of attributes of an MTER but to utilise a more grounded approach and to let issues emerge from my investigation.
    - The model is designed for academic colleagues across a significant range of disciplines representing university provision. However, it is

> unclear the extent to which the model is appropriate for those academic educators from professions such as nursing, teaching, police, social work and others, which are a subset of university academics, and of which MTERs are an even smaller subset.

Although it is interesting to consider this model, it was never seriously a contender for the research upon which I was about to embark. However, given its status within the university sector its inclusion here is necessary, and it is indeed it is worthy of consideration. As a result of this, in clarifying the reasons for rejection, the type of model required becomes clearer. Interestingly, however, as will be noted in Appendix F1.3, the reformulated model developed at the end of this study contains a core which consists of elements remarkably similar to structure above incorporating “activity”, “knowledge” and “values”.

The second model I have considered is that of Swennen et al. (2010).

2.1.4.4 The Swennen model

One of the research questions of Swennen et al. (2010, p.132) seeks to examine the sub-identities constituting the overarching identity of teacher educators, together with their implications for teacher educator professional development. The premise arises from a view that identity is multi-faceted (Klecka et al., 2008) or a construction of sub-identities (Beijaard et al., 2004). The authors note their agreement with Cochran-Smith (2003) that the identity of teacher educators has to be defined before their professional development can be given due consideration.

To provide more context, Swennen et al. (2010) undertake a literature-based study identifying 25 relevant articles from their defined source base and examine these to determine what these sub-identities might be in the case of teacher educators. They conclude that there are four such sub-identities: schoolteacher/first order

teacher; teacher of teachers or second-order teachers; teacher in Higher Education; and, Researcher (see Fig 2.2 below).

Fig 2.2 The Swennen Model*: Sub-identities of teacher educators in the context of teacher education

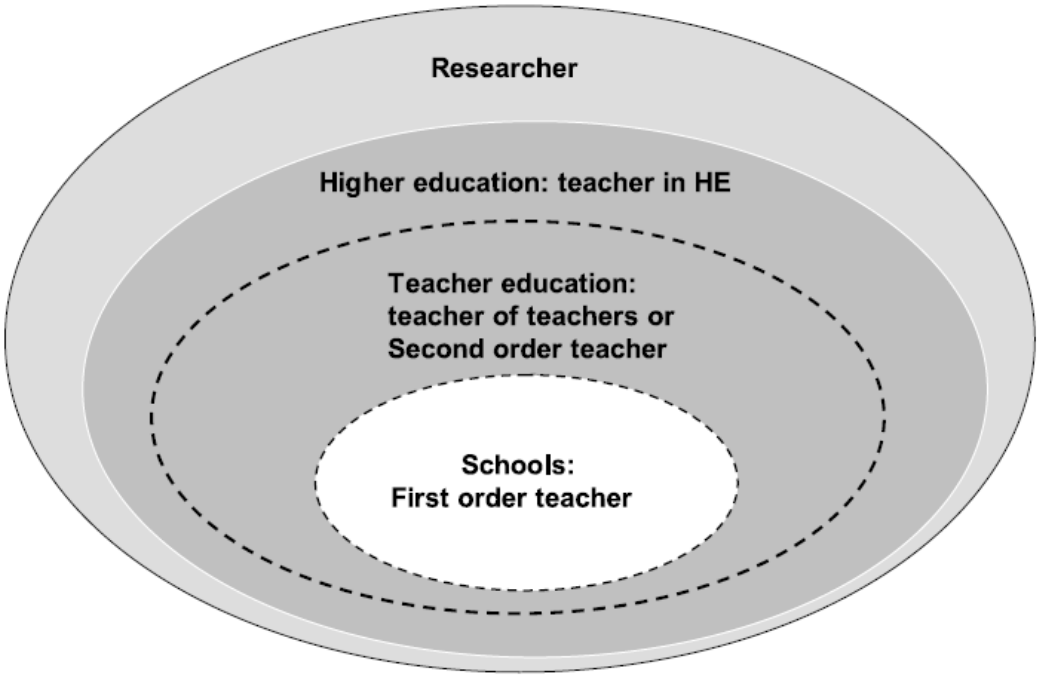


*Figure from Swennen et al., 2010, p. 144

These sub-identities noted by Swennen et al. (2010) are likely recognisable to experienced teacher educators in the field, and perhaps it should be reiterated that that the authors' classification of these sub-identities arose from a review of literature in the field –both theoretical and empirical, rather than being based on their personal understandings or assumptions.

The authors present this as a tentative model representing the connection between the sub-identities and the contexts in which teacher educators find themselves. They are influenced by writers such as Klecka et al., (2008) whose work suggests that there are five facets to teacher educator identity: teacher; scholar in teaching; collaborator; learner; and leader. A further influence is Beijaard et al. (2004) who undertook significant work over decades in relation to teacher identity, and whose work clearly has influenced the authors to consider the notion of identity consisting of sub-identities. One model created by Beijaard et al. (2004) is considered briefly as a third possibility (see below).

Another significant influence on the view of identity held by Swennen et al. (2010) is the work of Holland, Lachicotte, Skinner and Cain (1998) on figured worlds. Urrieta (2007) provides an insight into this concept.

> "Identity and Self are concepts that are not only constituted by the labels - ''smart girl'', ''delinquent'', ''incompetent'', or ''beloved teacher''—that people place on themselves and others, especially in schools. Identity is also very much about how people come to understand themselves, how they come to ''figure'' who they are, through the ''worlds'' that they participate in and how they relate to others within and outside of these worlds."
>
> (Urrieta, 2007, p. 107)

The work of Swennen et al. (2010) adds to our collective understanding of teacher educator identity however, as the authors acknowledge, much more is needed to understand professional identity of teacher educators and what would constitute appropriate professional development for this group.

Whilst this is a helpful model in that it provides clear recognition that teacher educators' roles are highly complex, it was not suitable for the purposes of my study for a number of reasons:

- Although 25 articles formed the evidence base for this work, this is potentially still a relatively small number on which to base the identification of these sub-identities.
- The model has arisen from a literature base and is still "theoretical", in that it has not been tested in the field. The authors acknowledge this and state, *"We need to know more about the sub-identities teacher educators themselves experience or desire and whether these sub-identities are the same as the sub-identities that emerged from the literature"* (ibid., p.145).
- There is little guidance on how the model might be applied in investigations of teacher educator professional identity, nor indeed what sorts of elements comprise the sub-identities;
- The authors also question whether or not the role of a subject specialism has a part to play in shaping professional identity.

For these reasons, I have rejected the Swennen model. However, again it should be noted that some of the features of the sub-identities do in fact emerge from this study.

The third model considered is that of Beijaard et al. (2004) alluded to above.

2.1.4.5 The Beijaard Model

As noted above, Beijaard's work clearly influenced the paper by Swennen et al. (2010) above. The model in Fig 2.3 below appears one of his earlier papers, in the context of a study of teacher professional identity (Beijaard et al., 2004)

This study also used a literature review-based approach, and suggested that there are four features of professional identity:

- It is an ongoing process of interpretation and re-interpretation of experiences.

- It implies both person and context.
- It consists of sub-identities which more or less harmonize" and that these relate "to teachers' different contexts and relationships", some being "core" and others' "peripheral".
- Agency is an important element of professional identity - teachers have to be active in the process of professional development.

Beijaard et al. (2004, p.122)

Fig 2.3 The Beijaard Model*: Representation of professional identity formation from a teacher's knowledge perspective

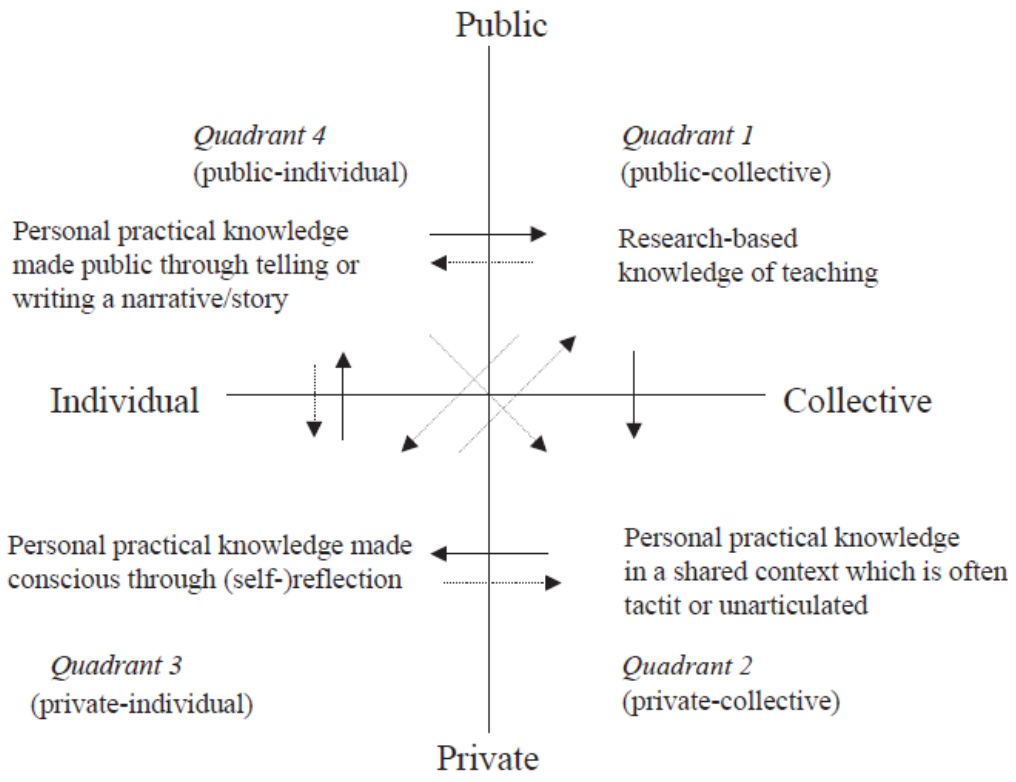


*Diagram from Beijaard et al., 2004, p. 124

The model derived by Beijaard et al., (2004) presents a differently-focused model to the one presented by Swennen et al. (2010) above. The representation of professional identity formation is viewed from a teacher's knowledge perspective.

Whilst this is an interesting model, and in fact does contain some elements which appear within this study, one of the issues here is that on the surface, this model seems to make assumptions about knowledge flows to and from individuals. Beijaard et al. (2004) recognise this, and note that these processes are more complex than appear on the diagram. Using this in an exploratory study therefore could be problematic, in that I would not wish to presume at the start how an individual acquires knowledge, nor the type of knowledge which is held collectively or individually as this would be one of the lines of inquiry. The central drawback with this model, however is that it is clearly focused on only one potential aspect of identity, and does not seem to encompass the breadth of the other two models already considered. For that reason, this model was also rejected.

If nothing else, the variety of models presented here demonstrates that there is little consensus in what might be the most appropriate way of investigating professional identity. What these considerations have also revealed is that for a model to be useful for the purpose intended here, it must potentially be capable of encompassing all aspects of identity, must not pre-judge relationships between elements, and certainly should not impose hierarchies upon them. Furthermore, the model needs to be fairly straightforward to use as a research tool.

In the next section, I introduce the Davey framework (Davey, 2013) and justify why it represents my choice of framework to use as a basis for this study.

2.1.5 Davey's Framework for analysing Professional Identity in Teacher Educators

In this section, I introduce the framework created by Davey (2013) and justify my decision to adopt it for use within my study. Davey's book, *The Professional Identity of Teachers*, (Davey, 2013), which is largely based on her doctoral thesis (Davey,

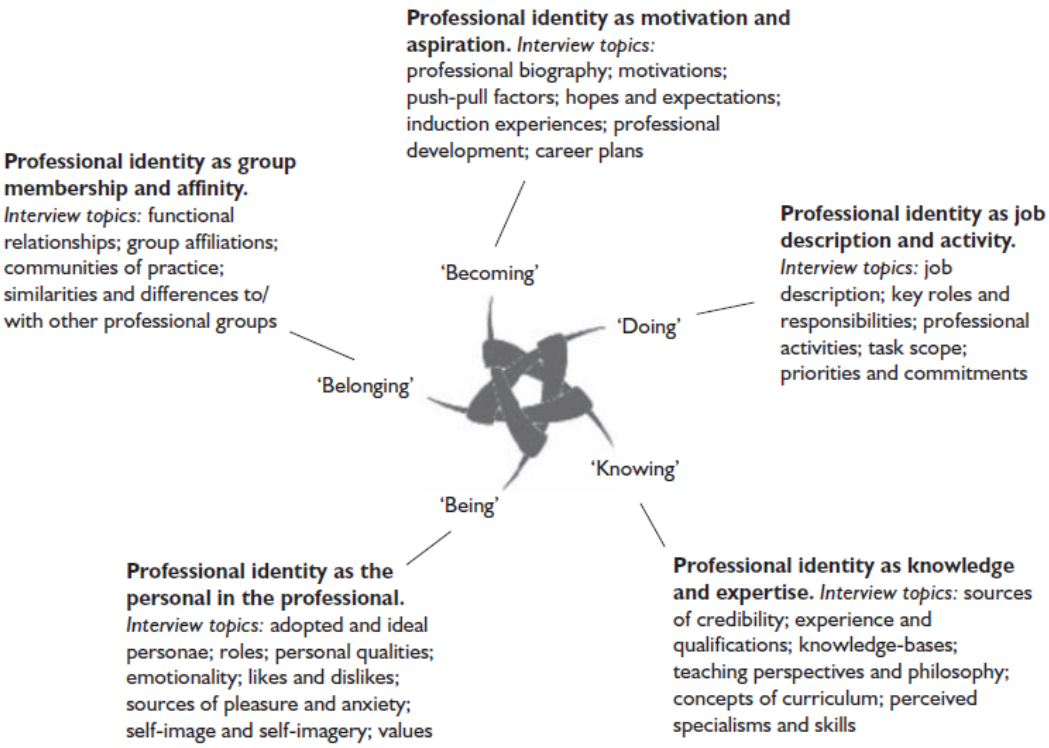
2010), represents a significant contribution to the field of teacher educator professional identity. This is one of the more substantial and comprehensive pieces of work in this area, and provides a detailed exploration of professional identity of teacher educators in New Zealand. It also outlines the comprehensive framework she created in order to undertake her investigation.

Davey suggests that there are five lenses through which Professional Identity can be viewed. She describes Professional Identity as: 'motivation and aspiration' ('*becoming*'); 'job description and activity' ('*doing*'); knowledge and expertise ('*knowing*'); the personal in the professional ('*being*'), and; 'group membership and affinity' ('*belonging*') (Davey, 2013, pp.38-39). Davey provides more detail for each of these lenses, as follows:

> "The *Becoming* lens […] centres on the teacher educators' intentions and aspirations in regard to becoming teacher educators, their motivations for taking this step, and their initial induction experiences in teacher education.
>
> The Doing lens focusses on their daily experience of the 'work' of teacher education and the professional tasks involved.
>
> The *Knowing* lens considers the various knowledge-bases they felt they had or needed, as teacher educators, and the pedagogical dispositions that they saw as distinctive to teacher educators.
>
> The *Being* lens focusses on their self-image and affective aspects of how they experienced teacher education – the socio-professional personae they adopted, and their emotional positioning of themselves in relation to these personae.
>
> The *Belonging* lens centres on the particular communities of interest and practice that they saw themselves being aligned/not aligned to, and how they saw themselves fitting into the wider professional cultures of which they are a part."
>
> (Davey, 2013, pp.38-39)

Davey presents her framework in the following diagrammatic manner.

Figure 2.4: Methodological Framework for investigating professional identity



(Davey, 2013, p.38, Figure 3.1)

Davey (2013) arrived at her framework after consideration of the literature concerning identity drawing on psychological (Mead, 1934; Erikson, 1968), socio-cultural (Wenger, 1998; Bourdieu, 1983) and post-structural (Zembylas, 2003; Sfard and Prusak, 2005) theories of identity and social identity.

Her framework creation also involved 18 months of conducting pilot interviews and the subsequent analysing of preliminary data. From this she identified the key areas required in order to elicit a sense of professional identity from her participants. Davey's approach to utilising her framework involved exploring through dialogue, in the form of one-to-one interviews with participants, the areas identified within it. Davey focused on eight teacher educators from secondary English/Drama backgrounds at various stages of their professional journeys. As an

outcome of her work, Davey creates a narrative, giving voice to a professional identity which she labels as going 'beyond the stories'. Davey stays true to her intention of valuing the narrative of her participants through whose stories theoretical sense of their experiences and identity is sought, advocated by researchers such as Clandinin and Connelly, (2000), whilst also investigating the implications for an evolving landscape of teacher education, hence the notion of 'going beyond'.

Davey also achieves her aim to …

> "establish a practical research methodology for 'getting at' the elusive, often referred to but seldom analysed concept we call professional identity."
>
> (Davey, 2013, p. 7)

As she intended, Davey's framework appears to cover a range of elements that might, when explored, provide an overall sense of identity and is presented in such a way as to not suggest any sense of hierarchy, career structure or professional development pathway which may be present in both the Swennen et al. (2010) model and the UK Professional Standards Framework (Advance HE, 2011). Davey's framework does not deny the existence of sub-identities but does not suggest these explicitly as with the Swennen et al. (2010) model.

The framework is not overly prescriptive, providing instead aspects to explore. Having conducted interviews, Davey's data was entirely qualitative and she draws upon the traditions of phenomenology, a discipline founded by philosopher, Husserl, and defined as "the study of structures of consciousness as experienced from the first-person point of view" (Stanford Encyclopedia of Philosophy, 2013). This approach underpins the analysis of her findings, using what Geertz (1983), calls 'thick description', and drawing on the work of Van Manen (1997) and Bentz and

Shapiro (1998) to utilise a hermeneutic approach. This involved Davey in deep interpretation of the text, analysing this both in textual detail and holistically, and through her experience in the field of teacher education she is able to contextualise and bring perspective to develop meaning and understanding.

This latter point in regard to her own role in the process, she acknowledges, can also be viewed as both helpful and problematic in terms of validation of findings. Given my own role within Education, and the possibility of interviewing colleagues and networking contacts, these are important questions to ask of my role within the research, and such questions are returned to and addressed throughout the thesis.

As noted previously, my primary concerns as I approached the literature on MTERs, were twofold: the apparent lack of direct discussion of MTER professional identity, and the sheer volume of material which resulted if the search were widened to consider all material which had indirect or tangential references to identity. Given this, it seemed to me that the main issue was how I would be able to capture the breadth of the literature relating to MTER professional identity while at the same time as maintaining coherency around a core of areas which managed to capture its essence. The Davey framework offered the opportunity to do this in a structured way by providing distinct lenses through which to view the subject in hand.

The framework itself is clearly flexible enough to be utilised not just to categorise an unwieldy and diverse literature base, but offers the potential to support a range of possible data collection methods. For example, Davey used this in interviews. However, with adaptation the categories could become a survey or even an observation schedule. My eventual decision to utilise a mixed method approach (specified in Chapter 3) did not pose any serious challenges to the framework as it proved flexible enough to support each of the research tools, and although Davey had used it primarily on the context of qualitative data, I could see clear pathways

by which the framework could be adapted to yield a variety of quantitative data, which seemed to be absent from the literature.

I would therefore argue that this framework represents a sound underpinning of this research, both in theoretical and practical terms. The framework is used consistently throughout the thesis; firstly, to frame the MTER-specific literature review, secondly, to support the creation of the research tools as detailed in the methodology chapter, and reported on in Chapters 4 and 5, and finally, with some slight modification, to structure the discussion chapters which follow. It should be noted however, that this framework has not been used uncritically; while this represents a valuable series of lenses through which to examine the whole notion of identity, there are shortcomings which need to be noted. In particular, it is clear that the framework is not a series of mutually exclusive categories; in Davey's words, they are "both differentiated and overlapping" (Davey, 2013, p. 163). This does present some challenges at the point of reflecting on the views produced by the lenses, and in drawing findings together. Nonetheless, the framework provides a very helpful starting point, at least, for an exploratory study.

On a final note, looking back to the categorisations offered by Nilsen (2015), it should be immediately apparent from the description of the structure provided by Davey, that it is a descriptive framework, rather than a model. It merely seeks to categorise, rather than to explain or predict. To use it to do either of those things would take it far beyond Davey's intentions. In this study, the framework lenses are used as organising devices, which together provide a methodological tool for categorising the literature, a structural underpinning for a survey and interviews, and a way of focusing the analysis which follows. Thus, in the rest of this study will refer to Davey's categories as "lenses" through which aspects of identity can be inspected, rather than using the framework to explain how identify develops, or to predict what attitudes a specific group of people might exhibit.

2. 2 A Systematic Review of Mathematics Teacher Educator Identity

2.2.1 Justification for taking a systematic review approach

Identity as a topic has been extensively researched. A search of the word using the University's NuSearch facility yielded a return of over two and a half million results with approximately 230,000 of these written in the last year. Investigation of the results from just last year alone indicated that around 24,000 results were returned for identity and race, and 44,000 returned for identity and gender. Over 30,000 results were returned following a search for "Professional Identity" with just over 10% of these from the last year.

However, despite the growing body of research relating to teacher educators, there seems to be relatively little in the literature explicitly related to the professional identity of mathematics teacher educators. A search for "Professional Identity" and "Mathematics Teacher Educator" resulted in only 14 results. Only one of these was explicitly related to the subject (**Goos and Bennison, 2019**).

The remaining articles were a mixture of: those concerned with aspects of MTER professional identity without mentioning the term explicitly; ones only identifiable as partially relevant by a detailed reading of the text; those concerning mathematics teachers or non-mathematics-specific teacher educators; and, three with no relation to MTERs or even mathematics education. A less-constrained search of "identity" and "mathematics teacher educators" returned 64 results however, again under further investigation, the same issues of irrelevancy arose.

From these earlier inquiries and several other search attempts using terms which I took from Davey's framework, I realised that searches related to MTERs, no matter how apparently well-targeted, were always going to yield results which were either

too broad to be relevant, or too narrow to be meaningful, and would run the risk of rejecting as irrelevant some of the important sources.

Given the issues above, I decided that a more targeted approach was needed to address the issues of narrowing the literature down to those papers which were directly pertinent, yet at the same time making the search criteria broad enough to encompass papers and topics which were both important and of relevance. In order to do this, I chose to adopt the methodology of a "systematic review", looking specifically at those parts of the literature concerned with mathematics teacher educators and their identity. This was certainly no less time consuming; in fact, the ensuing activity ultimately took longer however, systematic reviews of literature are useful as they are intended to be more focused than more traditional literature reviews and less susceptible to researcher bias in regard to what is included and/or omitted (Gough, Oliver and Thomas, 2017). I was further encouraged that, from the earlier wider review of literature, I had gleaned that several authors (Beijaard et al., 2004; Swennen et al., 2010; Trede, Macklin and Bridges, 2012) had undertaken systematic approaches in order to conduct their studies. A systematic approach, it was clear to me, was by far the most appropriate way forward. At the end of the process, I was also more confident that, within the bounds of the search, it was less likely that any relevant papers had been missed.

2.2.2 Systematic Search Methodology

Systematic can be described as *"undertaken according to a fixed plan or system or method"* (Gough et al., 2017, p.5). "The key features of a systematic review or systematic research synthesis are that:

- explicit and transparent methods are used
- it is a piece of research following a standard set of stages
- it is accountable, replicable and updateable
- there is a requirement of user involvement to ensure reports are relevant and useful."

(EPPI-Centre, 2019)

In order to conduct the search, my working title or literature review question was, "What does the research tell us in regard to the professional identity of Mathematics Teacher Educators-Researchers?"

As with Trede et al. (2012), who found a dearth of Professional Identity development research within the higher education literature, very few papers in the earlier MTER searches had been returned which were expressly dedicated to a holistic consideration of professional identity of MTERs. Following the methodology of Trede et al. (2012), it was clear any systematic search would need to extend the criteria specifically to include those articles more tangentially related to aspects of MTER Professional Identity whilst not losing sight of the actual focus. I had become aware of how writers were using terms such as, "Becoming" or "Being" in titles or abstracts, and that the content was related to aspects of professional identity although the term professional identity was not always mentioned. This language used in many titles or abstracts resonated with me, reinforcing the view that the Davey (2013) framework was indeed a useful approach to take to explore the field.

A strategy was adopted, which drew on knowledge gained from the previous searches, and consisted of:

(1) Devise the criteria to be used in a systematic search.
(2) Determine the set of journals to be explored through the systematic search.
(3) Determine the time period for publications for inclusion in the search.
(4) Conduct the search using the *BrowZine* library system to access journal articles in chronological order.
(5) Create a spreadsheet detailing all articles meeting the criteria.

2.2.3 Devising the search criteria

Devising the criteria took several iterations and the terms which would see articles meet the criteria for inclusion grew as my understanding of the related literature

developed. This resonated with a grounded theory approach (Glaser and Strauss, 1967; Strauss and Corbin, 1990). The terms added later are referred to in Addenda 1 and 2 in the table below which clarifies my checks in determining the inclusion or otherwise of each article.

Table 2.5. Criteria for the Systematic Search of the Literature

The Article is	1. Authored by, or concerns, an MTER or several MTERs
ADDENDUM 1	Variations on the role title included, MTE or MER and didactician
AND	2. LINKS with notions of identity of the MTER/MTERs through explicitly using the language of IDENTITY or PROFESSIONAL IDENTITY
OR	3. LINKS with IDENTITY of an MTER or group of MTERs less explicitly through the use of language such as: a. *Becoming* an MTER b. *Being* an MTER c. *Doing/undertaking* the role of MTER d. *Knowing / knowledge* of an MTER e. *Belonging* as an MTER f. The *Community* of MTERs
ADDENDUM 2	g. *Values / perspectives / dispositions /beliefs* of an MTER /MTERs h. *Professional development* or *professional learning* of an MTER/MTERs

NOTE:

The five verbs in (a-e) above, represent the five lenses of the framework (Davey, 2013) and their utilisation was therefore an obvious choice. The word community is also noted in Davey's framework within the belonging aspect, and is related to communities of practice, a phrase which is well known in academic literature (Lave and Wenger, 1991; Wenger, 1998); more information in relation to this is provided in the context of the results of the systematic review specifically in Section 2.7 of this Chapter.

From the body of literature already examined, it was clear that widening the search to consider MTER values, perspectives, dispositions and beliefs may also provide further illumination on the matter. Similarly, professional development and

professional learning have been very closely linked with professional identity, as was noted in Section 2.1.3 above. For these reasons, these additional areas were included within the systematic search.

2.2.4 Targeted Journals and time period under investigation

The criteria for selection of journals were as follows:

- A well-known, higher-impact mathematics education journal;
  or
- A teacher education journal or education journal cited more than three times in the 'most relevant' 150 articles found within the earlier NuSearch.

In some ways the time period under investigation had to be decided on pragmatic grounds. The inclusion of 16 journals meant that the task of checking through multiple issues was going to be significant so the period from 2008 to present (2019) was determined. This included checking for relevant material in the Articles in Press for each journal. It was considered that earlier papers of significance could be identified through their regular mention in the papers under scrutiny.

The systematic search yielded a final total of 100 papers from 16 journals. The yield of 100 was purely happenstance. These papers are listed separately as the "100-set" in Appendix A2 however they only occur in the References where they have been directly referred to within the thesis. In the body of the text within the thesis, the papers from the "100-set" are identifiable by the references being emboldened. Those papers not ultimately considered in the thesis but contained within the "100-set" are marked accordingly in Appendix 2.

A spreadsheet was used to summarise the information from the papers. The details of the spreadsheet together with screenshots are provided within Appendix A2. Four types of information were captured from the papers:

- Factual details such as author and date.
- Text from the abstract, related to the focus, type of research and main findings.
- Classifications of the research type and scope.
- Davey Framework Analysis.

This latter bullet point, 'Davey Framework Analysis' refers to the chosen article's perceived link within the Davey framework. It was particularly useful to note the links as this naturally supported the aggregation of findings necessary to write up the literature review according to the five areas of the framework.

Appendix A2 also contains a table summarising the selected journals and their respective number of articles, and subsequent tables relating to research type and scope.

2.2.5 Interim Concluding Remarks and Introduction to Sections 2.3-2.8

This section concludes the introductory element of this literature review. Contextual background has been provided within the preceding sections in preparation for the succeeding sections which form the substantive element of the chapter – the systematic review concerning the professional identity of MTERs.

The scene has been set. The extent of literature on identity across a diverse range of themes is vast and is acknowledged. However, in regard to MTERs specifically, the necessity to explore sources which appear only to address aspects of their professional identity has been explained. Hence, what follows in Sections 2.3 to 2.7 inclusive is the result of an exploration of the 100-set in regard to Davey's five lenses: *becoming, doing: knowing; being; and, belonging*. Section 2.8 concludes the literature review chapter summarising some key points and specifying particular implications for the ensuing study.

2.3 *Becoming* a Mathematics Teacher Educator-Researcher (MTER)

Becoming can be explored as an aspect of professional identity by considering matters such as "*professional biography; motivations; push-pull factors; hopes and expectations; induction experiences; professional development; and, career plans*" (Davey, 2013, p.38). This section reports on the literature identified within the *100-set* that builds a picture of MTERs *becoming.* However, articles meeting the criteria for inclusion and linking with Davey's notion of *becoming* (Davey, 2013) are predominantly associated with professional development, and offer only limited aspects of professional biography, with very few studies yielding quantitative data concerning MTERs' qualifications. Making comparisons can be challenging as routes into the MTER role may vary between countries, as do programmes of teacher education. Similarities and differences are explored only where relevant to professional identity and where supporting data is available.

2.3.1 MTERs' background qualifications and teaching experiences

Murray, Czerniawski, and Barber (2011) assert that most teacher educators in English institutions of Higher Education have entered the profession as successful teachers of the age-phase(s) appropriate to programmes for intending teachers of that phase and predominantly have little or no research experience beyond possibly small-scale practitioner research. No nationally-set standards are required in England, but such standards exist in other countries such as the USA and the Netherlands (Murray and Male, 2005). Individual university requirements also vary: I have encountered different role descriptions in each of the three UK universities in which I have worked, all particular to the individual institution.

Three papers in the *100-set*, **Wu, Hwang and Cai (2017)**, **Masingila, Olanoff and Kwaka (2012)** and **Tatto, Lerman and Jarmila (2010)**, provide direct or indirect insights into the prior experiences, qualifications and characteristics of MTERs on a larger scale. The latter paper is part of a significant study, the Teacher Education

and Development Study in Mathematics (TEDS-M Report) (Tatto, Peck, Schwille, Bankov, Senk, Rodriguez, Ingvarson, Reckase and Rowley, 2012; Tatto, 2013; Krainer, Hsieh, Peck, and Tatto, 2015), which technically falls outside the *100-set*. However, given the relevance of the TEDS-M report to this study, reference to it is included here, and a selection of data tables from the study is also included in Appendix A4.

A study of MTERs in China targeted 95 secondary MTERs; 68 responses were included in the set for analysis (**Wu et al., 2017)**. 85% of their sample worked within mathematics rather than education departments, and length of careers as MTERs varied from just over a year to over 40. Just over half (53%) had worked as mathematics teachers in secondary schools. For the 27 MTERs with 20 or more years' experience, 20 had Master's degrees and 7 had Bachelor degrees as their highest qualification. The authors explain the absence of doctorates by the fact that it is only relatively recently (1983) that PhDs could be undertaken in China. While the paper does not state this explicitly, it can be concluded that a maximum of 41 MTERs had PhDs (60%). Analysis of the courses studied by the 68 MTERs at undergraduate level showed 90% had an emphasis on mathematics or "applied mathematics", a specific term used to indicate the programme was teacher oriented (**Wu et al., 2017**).

In the United States, PSTs undertake separate programmes in mathematics 'content' and mathematics 'methods' (i.e. pedagogy). A study by **Masingila et al. (2012)** enquired into the academic qualifications and the teaching experience of those providing content courses for elementary PSTs in four types of institution. The main points are summarised below:

- Over 50% of course supervisors had doctoral degrees either in mathematics (24.3%) or mathematics education (28.7%); only 28.9% had elementary school teaching experience;
- For course instructors in schools without postgraduate provision - 34.1% had doctorates in mathematics and 27.1% had doctorates in mathematics

education; however, for course instructors in schools with master's provision 43.5% had mathematics doctorates and 40.9% had mathematics education doctorates.

Overall, only between 15.8% and 21.7% of the instructors had taught in elementary schools. The authors note that the majority of instructors of these courses do not have elementary teaching experience and significantly,

> "… likely have not had opportunities to think deeply about the important ideas in elementary mathematics, and most institutions do not provide training and/or support for these instructors"

(**Masingila et al., 2012**, p.357).

The inference here is that while the majority of those teaching content courses appear highly-qualified academically, they lack overall experience of teaching in the age-phase for which the prospective teachers intend to teach. Of course, it should be noted that this was a survey of those who teach 'content' courses and no equivalent data was available on those who teach 'methods' courses.

Tatto et al. (2010) present findings from the 'International Commission on Mathematical Instruction (ICMI) Study 15' into mathematics preparation courses for prospective teachers across more than 20 country/regions, providing a useful comparison of programmes; this significant study was announced by Ball and Even (2004). Of relevance for this thesis is the section on teacher-educators:

> "for the most part, mathematicians teach mathematics courses, (e.g., Australia, Brazil, Canada (French), China, Czech Republic, England, France, Germany, Israel, Spain, Uganda, USA and Venezuela. In some cases, these courses are taught by mathematics educators. For the most part, pedagogy courses are taught by educators or in some cases (such as Israel) mathematics educators, who may have backgrounds in psychology, sociology or philosophy, or may be experienced teachers"

(**Tatto et al., 2010**, p.319)

This identifies MTERs differently in different countries but with very little detail provided to fully understand these differences.

Data on the characteristics of mathematics teacher educators is presented in the TEDS-M report, arising from the first international and comparative Teacher Education and Development Study in Mathematics (Tatto et al., 2012, p.111**)**. This study analysed data from 14 of 17 participating countries (the UK was not a participating country). Only data from 10 countries was considered to be reliable because of low response rates.

Mathematics teacher educators were categorised into three groups:

- Group A – Mathematics (M) and Mathematics Pedagogy (MP) educators (this included those teaching either M or MP or both);
- Group B – General Pedagogy Educators (not teaching M or MP); and
- Group C – Educators teaching M or MP and also teaching general pedagogy.

The potential overlaps between these groups makes teasing out inferences challenging. However, data provided in the report shows that those teaching M or MP and general pedagogy were a minority (Tatto et al., 2012, p.115).

Data presented in the TEDS-M study relating to teacher educators' qualifications in each of the above groups presents a varied picture. For those in Group A, over 60% held doctoral degrees in mathematics in Chinese Taipei, Georgia, Germany, Oman and Poland, with the figure for other countries less than 50%. In terms of doctoral degree in mathematics education; the highest percentage was Georgia (42%), with other countries ranging from 31% down to 0%. Very few of those in Group C held doctorates either in mathematics (Poland highest with 24%) or mathematics education (Russian Federation highest with 22.6%).

While the TEDS-M data provides valuable insights into MTERs' qualifications and prior experiences and is the key available data set on this scale, the statistics provided are disappointing in that data from only ten countries was deemed reliable. This leaves Spain and Poland as the only confirmed European comparators; data from the US was excluded and the UK was not involved. In addition, there appear to be some anomalies within the data sets. The potential therefore to use published data from the TEDS-M or any other study for direct comparison with my research is unfortunately very limited.

2.3.2 MTERs' transition into the role

In the wider TER literature, a number of studies explore the transition from school teacher to TER, and in particular the perceived shift in identity (Zeichner, 2005; Murray and Male, 2005; Boyd and Harris, 2010; Carrillo and Baguley, 2011, Hartog, 2018). In her study, the language of 'identity shock' is used to describe the experience of some teacher educators during this transition period (Davey, 2013, p.58).

Helliwell (2017a; 2017b), writing in her second year as an MTER, illustrates this transition by considering her own learning as she changes role from secondary teacher to MTER. She examines her contributions to a discussion with secondary teachers during a research project, drawing significantly on the discipline of "noticing", a concept much explored by Mason (1996; 2002; 2015), and employed by many other MTERs as noted later. **Helliwell (2017b)** examines transcripts of her interactions, identifying salient moments via multiple perspectives: her own; those of participant colleagues at a mathematics education conference; and, her PhD supervisors. Helliwell explores how the *layers of voices* (perspectives) add to her *awakening* which provides her with the capacity to consider more deeply her convictions and possible "*future ways of being*" in her interactions with teachers and PSTs. In another paper, **Helliwell, (2017a**) further reflects on *noticing* and how

she uses this to support her learning while transitioning through the early stages of becoming an MTER. Helliwell's papers serve to demonstrate how other aspects of Davey's lenses are interwoven in her *becoming* narrative – those of *being*, in relation to questioning her convictions or values, and *belonging*, in the context of her collaborations with teachers.

2.3.3 Constant *becoming* – continuing professional development

Davey (2013, p.65) refers to "a journey of constant becoming" rather than a time-constrained period linked with the early stages. Ibarra (1999) suggests individuals adapt through experimenting with provisional selves before fully developing their professional identities. In view of these notions, papers from the *100-set* relating to the professional development are discussed within this section.

2.3.3.1 *Becoming* a Researcher

Several writers (**Reys, 2018; Liljedahl, 2018; Andrà and Brunetto, 2017**) identified within the *100-set*, refer specifically to the *becoming* stages of the Researcher aspect of the MTER role and the challenges associated with this 'journey', particularly for example, relating to becoming an independent researcher. The results of a phenomenological study undertaken in Turkey with eight doctoral students suggested that independence is only achieved after engagement in collaborative research activity (**Haser, 2018**). **Liljedahl (2018**), based on his work with 15 research students in Canada similarly concluded that building networks and a community of peers was important. Moving from a supervised doctorate to publication is an important next step. **Reys (2018)** writing in the USA, argues for strong research competencies in Mathematics Educators, but notes that even though the largest majority of doctoral graduates go on to pursue careers in higher education, less than half of them produce publications related to their theses. In all these cases, graduates were in positions which did not require, encourage or reward research (**Reys, 2018**). **Hill and Haigh (2012)** discuss creating a culture of

research in teacher education, with a focus on learning the processes. More broadly, a contextualisation of the issues for teacher educators as researchers, suggesting what is needed in regard to expertise: as consumers of research; in conducting research into one's own practices; and, in determining which questions are empirical and which are based on values and beliefs is provided by Cochran-Smith (2005). Wilson (2006) suggests that preparing teacher educators to understand, consume and engage in research which uses 'sophisticated quantitative methods' is important in supporting the full range of research activity necessary in the field.

2.3.3.2 Collaborative planning and teaching with other MTERs

Several MTERs report on the professional growth which occurs when working with peers in an attempt to improve their PSTs' learning or experience (**Erbilgin, 2019; Coles and Brown, 2016; Huang, Su and Xu, 2014**). As illustration, a study by **Zhou and Kim (2010)** reflects on such growth during the process of collaboration. The study located in New York initially focused on how PSTs' perspectives on an integrated curriculum, with the MTER working alongside colleagues with music and science specialisms. The paper provides useful insights into how collaboration between colleagues occurred, and what benefits accrued. Perhaps as important here as the collaboration itself was the study's methodology: collating and coding notes and commentaries from both PSTs and tutors, and narrative reporting on teacher educators' collaborations. These, together with regular planning meetings, co-teaching and subsequent evaluations formed an extensive self-reflective backdrop to the project. The authors reported that the "*three instructors stepped into this course with enthusiasm about curriculum integration and finished it with advanced knowledge of its meaning, design and implementation*" (**Zhou and Kim, 2010**, p. 135).

2.3.3.3 Using technology and other resources

Three papers from France and Greece explore the novel use of online tools with MTERs to develop their practice. **Psycharis and Kalogeria (2018)** tasked novice MTERs with utilizing newly-acquired skills and knowledge in digital tools in their practice of teaching teachers. Their paper highlights the importance of opportunities to reflect on learning both from training and their own teaching sessions as well as to observe the practices of other teacher educators. A similar theme emerged from an earlier paper (**Kynigos and Kalogeria, 2012**) which considered how professional development of newly trained MTERs might be enhanced via collaboration within an online community. Professional development occurred through the analysis of online discussions around '*scenarios*' and '*half-baked microworlds'* (authors' term). *Scenarios* referred to the MTEs' activity plans which included their pedagogical intentions; half-*baked microworlds* included artefacts or resources created using for example, CABRI Geometre or Turtleworld or Geogebra. Crucially, the activity plans and resources were used to enable pedagogical discussions around their use in the classroom, and were simply triggers for discussion and further development by the online community. The importance of such online communities and how these can be hugely supportive of learning is a key point of the paper.

Similar themes are replayed in a paper by **Gueudet, Sacristán, Soury-Lavergne and Trouche, (2012)**, which also focuses on the MTERs' use and adaptations of online materials, assessing their existing skills and the development of new ones. Overall, **Uerz, Volman and Kral (2018)** suggest that more research is required particularly in teacher educators' competencies in the use of technology and related pedagogy.

2.3.3.4 Working with teachers

The papers in this section all indicate that the interaction of MTERs with teachers is a crucial way of developing in the role. In an editorial piece in **2010, Goos and**

Geiger posed the question, 'what do university-based researchers learn from working with teachers?' (ibid, p. 499). Within the *100-set* , one answer is provided by (**Wake, Swan and Foster, 2016)** as part of a wider project involving MTERs and a community of teachers from several schools, in which the MTER authors engaged in a collaborative design of problem-solving lessons. This was ostensibly a professional development activity for teachers but provided the MTERs with learning opportunities including understanding how *"didactical design intentions are realised in implementation*".

Potari, Sakonidis, Chatzigoula and Manaridis (2010) report on four years of collaboration between two (later three) secondary school teachers and two academic researchers (MTERs) constituting an emerging Community of Inquiry. They detail the transformation of the participants' behaviours; in particular the researchers' shift to becoming more 'interaction-conscious', moving from an evaluative stance involving dissertation supervision and classroom practice commentary to a co-inquiry stance. This and several other papers focus on the development of *communities of inquiry* and are further considered in the *belonging* section (**Hunter, 2010; Sakonidis and Potari, 2014; Goodchild, 2014a**).

The significance of mutual respect and engagement of MTERs and teachers is also noted by **Goos (2014)** while exploring the perceived research-practice gap, and examining the working relationships of teachers and researchers seeking to enhance their practical and theoretical knowledge of mathematics education. In a similar study, a detailed account is provided of the design of a mathematics community continuum (MCC) which "*expands and redefines the traditional relationship among schools of education, colleges of arts and sciences, and school districts"* **(Benken and Brown, 2008, p.63).**

In the UK, **Brown and Coles (2010)** refer to the collaborations between teachers and researchers (MTERs) giving a specific example of how one such group met on an annual basis over the period, 1988-2006. Here, three of the teachers from the teacher– researcher pairs subsequently became MTERs themselves - an interesting observation relating to consideration of MTERs' backgrounds and experiences prior to commencing in MTER roles.

The studies here demonstrate that in being with teachers, MTERs are able to understand the continuing and changing contexts of schools, as well as reap the developmental benefits from engaging in research about and with teachers, on learning and teaching. Krainer, Chapman and Zaslavsky (2014) suggest that these benefits accrue from the reciprocal nature of understanding and improvement.

2.3.3.5 The Professional needs of MTERs

The material above in this subsection has given an indication of professional development activities and their benefits to individual MTERs. The larger-scale studies referred to earlier in Section 2.3.1 provide information gleaned about MTER professional needs at a collective level. Wu et al. (2017), categorise the four main areas of work for MTERs in China as teaching problem solving, teaching college mathematics courses, teaching pedagogy courses and supervising student teaching. The last two of these appeared to cause the MTEs most challenge. From their analysis of the strategies their sample of 68 MTERs identified to address their perceived challenges, the authors elicited five themes for the Professional Development (PD), including 'mathematical content knowledge' (derived from Shulman's categories of teacher knowledge (Shulman, 1986 and 1987)) and 'pedagogy of teaching college-level mathematics'. Over one third of the respondents suggested that 'self-reflection' was a necessary activity for MTERs, together with 'indirect classroom experience', suggested by over 40% of the respondents. The most prominent theme, suggested by 62% of the sample was 'developing and using teaching cases', which cuts across both content and method.

Masingila et al., (2012) suggest that the ideal background for an instructor (MTER) is a minimum of a mathematics degree along with experience of teaching in elementary school, noting that there is "*no substitute for mathematical knowledge*" but that the lack of elementary mathematics teaching experience could potentially be compensated by other experiences of teaching combined with "*careful study of elementary mathematical ideas*" (**Masingila et al., 2012**, p. 355). Having discovered a lack of PD for those MTERs responsible for teaching content courses across the States (over 50% had none), the authors concluded that PD was necessary in order to better prepare and support the MTERs so as to break the cycle of college experience having little impact on prospective teachers' mathematical understanding. The PD, they suggested, could be achieved through collaboration, the creation of *communities of practice* on sites where multiple instructors teach, and across sites where instructors are more isolated, and through online and conference-style support from professional organizations. They provide limited detail however, in regard to what the content or focus of this professional development might be though they do refer to the importance of collaboration around tools, task experimentation, classroom interaction and *practices* (**Masingila et al., 2012**, p. 356), in a similar manner to studies discussed above (**Gueudet et al. (2012), Kynigos and Kalogeria, 2012; Psycharis and Kalogeria 2018)**.

Zaslavsky and Leikin, (2004) refer to the lack of programmes to develop potential new MTERs and the limited research in this area. To counter this to some degree, they present a useful insight into their community of practice comprising three groups of mathematics educators: mathematics teachers (MTs); MTEs; and, MTEEs (the latter being educators of MTEs). Through examination of a professional development programme intended for MTs becoming MTEs, much is learnt during the process about the growth of MTEs.

Further insight is provided by **Even (2014**). Utilising the term "didactician" to refer to those MTERs who focus on the development of practising teachers, she notes the

inconsistency of language to address the particular group as indicative of the lack of systematic understanding of their practices and professional development needs beyond what can be gleaned from the largely reflective pieces of individual practitioners in the field.

2.3.4 Some Reflections on *Becoming*

Section 2.3 has focused on viewing the literature on professional identity of MTERs through Davey's *becoming* lens. Through this lens, it has been possible to get a sense of *becoming,* by considering each of the elements noted at the very beginning of this section, though the extent to which it has been possible to examine each one is variable, and not all have been fully studied within a mathematics specific context. In particular, studies which might provide insights on motivations for *becoming* an MTER or their career plans appear to be absent.

It is also the case that a range of different research methods have been employed to study the different elements. For example, in regard to MTER professional biographies, for material relating to their qualifications and prior teaching experience, this section has been able to draw on a small number of quantitative surveys which have offered some limited insights about MTERs' characteristics in different countries. On the other hand, details about aspects of professional development have largely been based on summary reports of aspects of projects, not necessarily concerned with MTER professional development in the first instance, and often using different research underpinnings and different methodologies.

The studies which can be seen to have clearest methodological similarities are those which yield quantitative data. Disappointingly, these paint a mixed and not always readily decipherable picture of MTER qualifications and backgrounds, made even more complex in the TEDS-M comparative study by the different ways in which

mathematics teacher education is structured in different countries (**Tatto et al., 2010**; Tatto et al., 2012; Tatto, 2013; **Masingila et al., 2012**; **Wu et al., 2017**). I do not attempt to summarise the actual data here other than to state the significant variability in qualification levels between MTERs in different countries ranging from a small number in the samples with Bachelor degrees as their highest qualification (**Wu et al., 2017**) to MTERs possessing a mix of master's and doctoral level qualifications.

In regard to these higher degrees, it is not always clear whether the qualifications being stated are the participants' highest level of qualification or whether where they have both master's and doctoral level; this is not fully captured in the data tables. The issue of qualifications is further complicated by the focus of MTERs' degrees and whether these are mathematics as a subject discipline or focus on aspects of mathematics education. These are very different in nature, although clearly there may be potential for some overlap in some instances. This also affects the level of preparedness of an MTER coming from a strong subject discipline background versus one from a strong mathematics education background. This is certainly an interesting discussion point, and one which **Masingila et al. (2012)** raises about the system in the United States, noting that for those with no teaching background there is a likelihood of having little understanding of the complexities involved in teaching mathematics and yet there appears to be little support in place to address those concerns.

In contrast, it has been suggested that in the UK, most teacher educators enter teacher education following a period of teaching in schools; this was certainly the case in their study of 28 teacher educators in their first three years in role (Murray and Male, 2005). **Masingila et al. (2012)** suggest it is easier to substitute experiential knowledge as there is "no substitute for mathematical knowledge". This appears to be a significant and potentially contentious claim. Masingila's university profile shows that she herself has an undergraduate mathematics

discipline degree with both her higher degrees in mathematics education (Syracuse University School of Education, 2019), so may well be speaking on the basis of personal and professional experience rather than empirical evidence derived from this specific study.

Davey suggested a state of constant *becoming* may be the case and this was certainly evidenced in the literature. The early stage of the 'transition' into the MTER role was approached by **Helliwell (2017a; 2017b**) via self-examination of her own practice rather than by means of any formal induction processes. In the wider literature, Boyd and Harris (2010) identify the transition from school teacher to university lecturer as an issue broadly across teacher education. They concur with other authors such as Murray and Male (2005) and Zeichner (2005), about the need to have informal activity to support those new in role. In addition, they suggest a role for teacher education departments in more formally inducting their new colleagues into their emerging roles as academics (Boyd and Harris, 2010). They are aware of a tendency, in some instances, for new TERs to hold on to their previously held teacher identities; and therefore stress the importance of professional development related to scholarship and research (Boyd and Harris, 2010). The value of role models is also seen as a supportive mechanism in enabling new TERs to make this identity shift (ibid., 2010).

A second 'transition' is this journey from teacher to researcher, with several authors noting the importance of collaboration in research practice before reaching a stage of confidence as an independent researcher (**Reys, 2018; Liljedahl, 2018; Andrà and Brunetto, 2017; Haser, 2018**). This mirrors the professional growth obtained through collaboration in planning and teaching with other MTERs (**Erbilgin, 2019; Coles and Brown, 2016; Huang et al. 2014**) or with other related professional groups, including in particular, teachers (**Goos and Geiger, 2010; Wake et al., 2016; Potari et al., 2010; Hunter, 2010; Sakonidis and Potari, 2014; Goodchild, 2014a;**

Goos, 2014; Benken and Brown, 2008; Brown and Coles, 2010). Mutual respect and engagement were considered important features in these studies.

What can be concluded from the specific studies on, and by MTERs, supported by reference to key authors in the wider teacher education field, is that MTERs appear to experience *becoming* as a process, guided by specific aims as to where their journeys are taking them. Although in some instances there are elements of self-reflection and reflexivity, very often these journeys appear to be shaped, challenged and supported through collaborative endeavours. **Margolin (2011)** refers to the importance of safe transitional spaces in supporting teacher educator development. Notions of community and collaboration are revisited in Section 2.7 which considers *belonging* in more detail.

In fact, very few papers in the *100-set* refer explicitly to this early period of the journey, the first steps towards *becoming* an MTER, in contrast to the many examples which indicate how MTERs might engage in continuing professional development and indicating what might be required for role development. One paper which might have addressed this issue was that of **Brown and Coles (2010)** cited above, which indicated an interesting potential model for entry into the profession, but did not go on to explore this in detail.

Overall, there are clear gaps in this part of the literature, particularly in relation to the more factual aspects relating to MTER backgrounds. Furthermore, many papers are very limited in scope, referring only to small scale or individual studies. Nonetheless together, they provide some ideas and potential resolutions to tensions that MTERs face both in the early stages of their journey and as they develop into their roles, and this provides a useful backdrop for my research.

In regard to the direction of this study, if these processes of *becoming* are to be understood, then it is important to document not just the journey of an individual MTER, as in the case of **Helliwell (2017a; 2017b**), but the destinations towards which the individual is heading, and the support that they get along the way. That is going to require an understanding of the community of MTERs and how the individuals within it relate to one another. While quantitative studies such as that undertaken in the USA (**Masingila et al., 2012)**, have provided some useful data about qualifications and experience, they tell us little about the collective knowledge, beliefs and values of MTERs, which might go some way towards understanding how interactions between MTERs might help with the career transitions noted here and development issues identified by **Even (2014**).

2.4 Viewing MTERs' Professional Identity through Davey's *Doing* lens

Davey (2013) refers to the *doing* aspect of Professional Identity as 'job description' suggesting that various themes can be drawn out of its exploration. These include, for example: experiences of *doing* teacher education; *tasks undertaken*; and*, perceptions of what the job entails* (Davey 2013 p.68). Whilst none of the articles in the *100-set* provides an explicit exploration of *doing*, this section draws together insights gained into the role of the MTER from papers in the set in which MTERs analyse aspects of their own or other MTERs' roles. Such studies typically use self-study, professional inquiry and other forms of reflection on practice (Williams and Ritter, 2010; Lunenberg, Zwart and Korthagen, 2010; Loughran, 2005; Schuck and Russell, 2005; Hamilton, Smith and Worthington, 2008). In examining the content studied, it is possible to build a picture of the types of activities undertaken by MTERs, which will inevitably be partial and selective. The papers have been grouped into loose sections around key activities which are reflected upon by MTERs with the aim of improving their practice.

2.4.1 Using Self-study and other Reflective methods to examine *Doing*

In many of the papers in this, and across the other 'lenses', MTERs use self-study or autoethnography as a research method. It is therefore worth examining how these and other related methodologies are of particular value to MTERs, and the perceived benefits to them, not just as research methods, but as a way of improving *doing*, i.e. carrying out their practice.

Self-study has been widely used in the context of teacher education, having formally originated in 1993 through the formation of The Self-Study of Teacher Education Practices (S-STEP) Special Interest Group of the American Educational Research Association (AERA) (LaBoskey, 2004; LaBoskey and Richert, 2015). Its defined process is characterised as: self-initiated and focused; aimed at improvement; interactive; inclusive of multiple methods which are mainly qualitative; and, is trustworthy (LaBoskey and Richert, 2015). The idea behind self-study is to use practical inquiry as a means to study one's practice, enabling personal theories to be developed and corroborated (LaBoskey and Richert, 2015). Self-study builds on the related themes of reflection, action or inquiry research, practitioner research and the work of key writers such as: Stenhouse (1975); Schön (1983 and 1987); McNiff and Whitehead (2006); Kemmis & McTaggart (1988).

The wider literature suggests some potential difficulties in terms of interpretation of the term 'self-study'. Loughran (2005) notes that the term 'self-study' appears to suggest a solitary activity whereas, he clarifies, it should exceed 'personal reflections' and 'constructions of meaning' in order that, when shared, the learning achieved might be deemed meaningful to others in the field (ibid., p.6). Lunenberg et al. (2010) refer to the focus on "I" in self-study and draw parallels with autoethnography which uses personal narratives to seek out overarching cultural, political, or social meanings. In self-study methodology, individuals relate their

personal experiences to the literature through analysis and interpretation, giving it context and wider meaning.

Lunenberg et al. (2010) identify issues in supporting self-study in a project with a group of teacher educators, one of whom was an MTER. While a key success to the initiative was the generation of a sense of group *belonging*, they note that this could have been even more beneficial if participants had had more time to read and respond to others' self-studies.

This issue is addressed in a number of studies in which TERs comment on the practice of others, such as that of **Nicol, Novakowski, Ghaleb, and Beairsto, (2010**). **Rapke (2014**) offers a particularly interesting and 'alternative' insight here. Her paper focuses on duoethnography, a methodology which typically involves a dialogue between two researchers who explore their histories and identities. Rapke adapts this in a way which she argues brings potential benefit to the communities of mathematicians and educators, referring to these as her competing and complementary perspectives, through which perspectives and beliefs can be reconceptualised, taking away the expectation of the metanarrative approach of autoethnography and an expectation to align with a particular protagonist. Rapke's adaptation creates a fictional conversation in which two identities, a mathematician and an educator converse over a piece of mathematics. This is unusual but also powerful. Rapke suggests duoethnography could be used to explore mathematical processes and enable mathematicians and educators to better understand each other's perspectives and motivations.

The detailed study of the practices of one very experienced MTER (named X) **(Yang, Hsu, Lin, Chen and Cheng, 2015)** offers a potential model for exploring the 'educative power' of MTERs (the term coined by Jaworski (2001) refers to the combination of mathematical and pedagogical powers used to enhance the

education of teachers). Complementing the self-study approach as X reflects on X's practice, with a case-study method as the four researchers undertake thorough analysis of the practices of X, the authors conclude that at the core of the MTER's educative power were the deep understandings of mathematical subject matter and PST/teacher learning enabling X to instigate "at-the-moment" actions (Watson and Mason, 2007). This theme resonates with others explored within this section and is revisited briefly within the knowledge section of the review.

The work on enactivism by **Brown (2015)** and other researchers merits special attention here. Enactivists argue that cognition arises through dynamic interaction, and in the paper cited, Brown reflects on how she developed as an enactivist researcher and proceeds to explore the principles for researching as an enactivist. The work of **Coles and Brown (2015)** is part of a series of short communications relating to specific moments in practice (praxis) which constitutes a shared focus on different aspects of MTER actions (**Boylan, Brown, Nolan, Braathe, Portaankorva-Koivisto and Coles, 2015; Braathe, 2015; Boylan, 2015; Nolan, 2015b; Portaankorva-Koivisto, 2015**). Underpinning their practice is the belief that what happens in classrooms of PSTs during their courses will have a direct impact on the learning experiences of the students they will teach in the classroom (**Boylan et al., 2015**).

Taking an entirely different methodological stance, **Roth (2012)** considers the role of cultural-historical activity theory (CHAT) in mathematics education. He notes the prevalent use of constructivist theories within the field of mathematics education, notably social constructivism. In fact, this is evidenced in this literature review as the predominant approach taken by papers which appear in the *100-set*. **Roth (2012)** is critical of constructivist approaches and claims that CHAT offers new ways to theorise phenomena that emphasise cultures, relations and histories. Using CHAT tools, research by two MTERs (**Ellis and Childs, 2019**) involved analysis of archived documents and interviews with colleagues (some former), and sought to

contextualise, within a multi-layered social system, how the teacher education internship was developed in Oxford. Given the success of the internship programme, research into its roots was considered important as a way of understanding how an innovative practice in teacher education was conceived. It should be noted that CHAT as a theory was not conceived of as a means by which to investigate identity.

While this subsection has largely concerned itself with methodology, it has also brought into focus the fact that types of activity that MTERs and others have chosen to study via these methods are diverse and wide-ranging, and in some cases very personal. The rest of this section will consider two specific topics which may be common or at least of some import to all MTERs.

2.4.2 School Practicum

Practicum is a significant aspect of a Prospective Teachers' programme of initial teacher education (ITE). In England and Wales, the requirement for a three-year undergraduate and a one-year postgraduate ITE programme is a minimum of 120 days spent in school (DfE, 2019). Structure of practicum and expectations during school practicum vary across countries and even at school level, however it is likely that most MTERs will engage in, or be familiar with, the process of observing PSTs as they teach, afterwards providing feedback either individually or jointly with a school-based mentor.

Nolan (2012; 2015a) and **Alderton (2008)** both use self-study methodology to examine supervisory roles during practicum. **Alderton (2008)** reflects on dialogue with a PST following a practicum observation, while Nolan uses Bourdieu's theoretical constructs to highlight a range of issues. Both authors are concerned with the tensions between theory and practice, and their papers give insight into challenges faced both by PSTs and MTERs. In both cases, the MTERs reflect

specifically on the position of the PSTs to understand their challenges, and how they can be better supported to address these. In doing this, both MTERs question the value of their own roles, and seek paths to improvements. Their analyses raise issues around MTER beliefs and values and how these are reflected, or sometimes neglected in practice when dealing with what can sometimes appear as contrasting goals for MTERs and PSTs. In Nolan's case, she notes 'failed attempts' to implement wider changes concerning teacher educators' roles during practicum. Bourdieu's social field theory is instrumental in supporting Nolan's analysis (Bourdieu, 1983; Reed-Danahay, 2005).

Fernandez and Erbilgin (2009), concerned with the disparity between university course learning and practice, examined the practices of both cooperating teachers and university supervisors during practicum, concluding that university supervisors were more likely to include mathematics-specific guidance in post lesson 'conferences' with PSTs. One conclusion was a suggested course supporting cooperating teachers' learning in this regard. Such an intervention is described by **Høynes, Klemp and Nilssen (2019),** who report on a project using video as a tool to enhance mentoring practices when supporting PSTs' practicum.

Kastberg, Lischka and Hillman (2018) studied the written feedback and exchanges between MTERs and a PST concerning their practice using the Hattie and Timperley (2007) framework, coding items as self, task, process and self-regulation/ assessment. Exchanges were recorded in the form of letters between a student and the PST. The MTERs' written feedback to the PST on the letters was used as the source material for analysis. **Kastberg et al. (2018)** concluded that the activity was valuable in providing insights into how PSTs were addressing their students' mathematics. However, from their stated radical constructivist perspective, they concluded that less effective were the instances where MTERs selected aspects of students' mathematics for comment that the PST had not addressed.

In many of the papers cited in this section, one theme is that of MTERs attempting to empathise with the teacher or PST. **Jung and Brady (2016)** explain for example, how the researcher spends time in the classroom with the teacher, talks through previous lessons, marks student work together, gets to know the students, all in an attempt to better understand the context. This point is emphasised by **Potari (2018)** in which she refers to MTERs bringing their practices closer to teachers' realities and thus bridging any perceived research/theory versus teaching practice divide.

In each of the above papers, situated in Canada, the UK, the US and Norway, there is a suggestion that one of the important roles for the MTER in relation to the practicum is for in-situ teacher professional development. **Jung and Brady (2016)**, for example focus on an MTER and teacher working collaboratively as part of such an in situ professional development, implementing mathematical modelling tasks. The format was deemed viable and useful and led, within a fairly short timescale, to substantial changes to teachers' thinking about their students' mathematical modelling.

2.4.3 University-Based Sessions

Out of the *100-set*, 14 papers relate to the MTERs' role of teaching PSTs largely situated within the university context. One theme running through these papers is the significant emphasis on professional noticing, already remarked upon in the *becoming* section (e.g. **Helliwell, 2017a; 2017b**). **Amador (2016)**, for example, argues the importance of engaging novice MTERs in professional noticing practices exemplifying the engagement of four novice MTERs through her study. A key finding here is that whilst the novice MTERs make some evaluative commentary in their *noticings*, detailed interpretive analysis of their students' mathematical thinking is lacking. **Coles (2014)** coins the phrase, 'heightened listening' which resonates with the work of Mason (1996, 2002) who refers to "heightened awareness". Using enactivist ideas to examine his MTER role in supporting learning,

Coles makes use of videos of teaching to engage teachers in noticing practices. Transcripts of teachers discussing extracts of video with Coles were subsequently analysed by Coles, and through a process of coding and categorizing he was able to further analyse his contributions. This led him to realise that establishing discussion norms was dependent on listening in a 'heightened' manner not only to what teachers say but what kinds of things they say **(Coles, 2014).**

This theme of 'examining in-the-moment' is also reflected in the piece by **Shaughnessy, Ghousseini, Kazemi, Franke, Kelley-Petersen and Sugino Hartmann (2019, p. 169)** in which a common decomposition for leading mathematics discussions ("*(1) planning, including identifying a clear instructional goal; (2) launching the discussion; (3) orchestrating interaction around the mathematics and (4) closing the discussion"*) was agreed, implemented in methods courses and subsequently analysed. Listening to teachers engage in critical reflection of others' practice as part of a project, **Males, Otten and Herbel-Eisenmann (2010)** consider implications for practice and engagement of all participants in study groups.

Using video as a tool is also evidenced in the study by **Tirosh, Tsamir, Levenson, Barkai and Tabach (2014)**, and similarly to **Coles (2014)**, a multi-stage approach is undertaken. A group of teachers recorded themselves in action in the classroom, and recordings were subsequently observed by other teachers and the MTERs and their discussion was recorded. This discussion was viewed later by the MTERs as part of this inquiry into practice.

Erbilgin (2019) provides further insight into the MTER role in her exploration of two MTERs who work collegiately to plan, prepare and reflect upon lessons they undertake with PSTs (**Erbilgin, 2019**). Erbilgin takes an inductive, thematic approach to analysing data obtained from, for example, meeting notes and reflective journals, and conceptualizes the experiences of the MTERs. Engaging in collaborative action research enabled the two MTERs to improve their practice.

Wu et al (2017) explored the challenges faced by MTERs in China. In a somewhat larger scale project than others reported in this section, questionnaire responses of 68 MTERs showed that MTERs reported more challenges in (1) teaching pedagogical courses and (2) supporting PSTs in school than when (3) teaching college mathematics courses and (4) problem solving. Possible solutions to (1) identified by MTERs (of whom 53% had taught in secondary schools) included undertaking observations in classrooms; engaging in dialogue with teachers; reflecting on reading; attending conferences; and conducting research. Solutions to (2) involved activity prior to PSTs' teaching such as mini mock teaching activities, and PSTs and the teacher synchronously planning a lesson, comparing the results and making improvements. In terms of preparing future MTEs, 62% of the participants suggested developing teaching cases as the most helpful means of enabling MTER reflection.

Schuck (2009), in reflecting on two studies, takes us outside the timeframe of Initial Teacher Education. The first study concerns her students' experiences during their PST programme, and the second after qualification at the start of their career. Schuck argues for MTERs to offer more support during their former PSTs' first year of teaching, a period which she describes as 'overwhelming', and in her reflection, forces her to confront whether or not in her own PST programme she sufficiently acknowledges the constraints of the classroom, and is possibly setting up her students to fail by promoting an idealized version of a mathematics teacher. **Trumbull (2009)** in acting as critical friend to Schuck (2009) poses crucial questions which arise when readers read the self-reflective work of others. These are issues for us all is in trying to understand the different contexts in which the authors undertake their roles as MTERs.

2.4.4 Some Reflections on *Doing*

The focus of Section 2.4 has been to review what can be understood about MTERs *doing* their role through exploration of the MTER literature base 100-set. While this

doing aspect of MTER identity was originally advertised as a 'job description' by Davey (2013) in the opening paragraph of Section 2.4, what has been revealed in this section is far more than that, and includes: *doing* teacher education; *undertaking tasks and functions*; and*, perceptions of what the job entails and what elements take priority* - all of which might have been anticipated (Davey 2013 p.68).

The only study in the 100-set which attempts to provide some sort of overview of the day to day activities of MTERs, is the study by **Wu et al. (2017)**, already referred to in the *becoming* section. This study provides a picture gained from both quantitative and qualitative data sources, of the challenges faced by MTERs in China. Questionnaire responses of 68 MTERs showed that MTERs reported more challenges in (1) teaching pedagogical courses and (2) supporting PSTs in school than when (3) teaching college mathematics courses and (4) problem solving. The main issues related largely to a lack of teaching experience on the part of the PSTs. They felt well qualified in terms of subject knowledge but lacked experience in classrooms. Various solutions were proposed by the MTERs interviewed, including discussion of video material depicting teachers in the classroom such as that noted in 2.4.3 above.

However, while none of the articles in the *100-set* has provided an explicit exploration of *doing*, such as examining job descriptions and key roles and responsibilities, we can nonetheless glean information from papers in which MTERs analyse aspects of their own or other MTERs' roles. What the articles do provide is an overview of the types of activities within the MTER role that they think important enough to write about within an academic paper. They also provide in-depth analyses of specific aspects of practice.

Considering MTERs *doing* via interrogation of such literature, however, has its limitations as it is unlikely as an approach to capture all aspects of the role, but

rather reveal only those which MTERs have chosen to write about. Despite this limitation, it has been possible to clearly identify aspects of what MTERs *do* as part of their daily roles. The range of activities is clearly not exhaustive, and includes, for example: teaching within the context of the university; using video as a tool to support learning; and, practicum support. In addition, undertaking research into one's own practice has emerged as a significant feature of what MTERs who choose to write papers, can be seen to be *doing*. The extent to which this might be commonplace across the body of MTERs is not determinable from the literature review.

However, the key finding in this section which comes through above all, is the sheer extent to which MTERs investigate their own practices. Typically, these studies use autoethnography or self-study, or reflection on practice (Williams and Ritter, 2010; Lunenberg et al., 2010; Loughran, 2005; Schuck and Russell, 2005; Hamilton et al, 2008), and the material in this section has been compiled almost entirely via such sources.

While most of the studies are by lone researchers, there are groups of researchers who tend to work within particular schools or themes. Typical of such groups is the research on enactivism by **Brown (2015)** and others, mentioned earlier in 2.4.1. Their argument, that cognition arises through dynamic interaction, drives their research, and is the core theme running through a series of papers relating to specific moments in practice (praxis), all of which contribute to a shared focus on different aspects of MTER activity (**Boylan et al. 2015; Braathe, 2015; Boylan, 2015; Nolan, 2015b; Portaankorva-Koivisto, 2015**). The central enactivist principle is that incidents in PST training directly impact on the learning experiences of the students they will eventually teach (**Boylan et al., 2015**). If this is accurate, then such research is clearly warranted, since one PST can affect many hundreds of students during their teaching career. If other MTERs learn what these are, then they may be able to determine whether they apply in their contexts.

Another issue of note highlighted by **Roth (2012**), is the prevalent use of specific theories through which the field of mathematics education is interpreted, notably social constructivism. In fact, this is evidenced in this literature review as the predominant approach taken in papers which appear in the *100-set*. While many MTERs may see this as a valid way of understanding their activities, others may hold entirely different perspectives. It is then questionable whether results obtained under one particular paradigm would transfer to a practitioner who does not subscribe to that view.

One of the issues to be considered therefore is how much attention should be given to studies by individuals of their own practice or small-scale studies of their own classrooms, or to research wedded strongly to a particular set of assumptions. Self-studies, for example, might be criticised both on the grounds of validity – the extent to which a person writing about themselves is actually capable of seeing through their own preconceptions, and whether it is possible for a person writing about their own circumstances to find generalisations which can apply to others. In many cases, studies are left as "this is what I have found", and the reader is left to draw possible conclusions about such matters. However, "the plural of anecdote is not data" (Bernstein, 1988, p.247), and it may be "misinformation" (Stea, 2020).

To avoid such charges, Loughran (2005) suggests that self-study should go beyond 'personal reflections' and 'constructions of meaning' in order that, when shared, the learning achieved might be deemed meaningful to others in the field (ibid., p.6). Lunenberg et al. (2010) suggest that in self-study methodology, individuals relate their personal experiences to the literature through analysis and interpretation, giving it context and wider meaning. In their study (Lunenberg et al.,2010) concluded that engaging with the self-studies of others may be of benefit, but that this would require reading and responding to the individual self-studier. **Trumbull (2009)** in acting as critical friend to **Schuck (2009)** poses crucial questions which arise when readers read the self-reflective work of others. These are issues for us

all in trying to understand the different contexts in which the authors undertake their roles as MTERs.

There are interesting consonances across various studies, for example, seeking *heightened listening* (**Coles, 2014**), *examining in-the-moment* activity (**Shaughnessy et al., 2019)** and having the depth of understanding to confidently initiate *at the moment* actions (**Yang et al., 2015).** Exploring MTER practices in these ways has the potential to both augment PST/teacher learning and also contribute to MTERs' own professional development by enhancing their knowledge and informing practice.

In terms of the content in this section, papers referring to practicum are to be expected and the reflection on this practice is highlighted in a number of papers (**Nolan, 2012; Nolan 2015a; Alderton, 2008; Fernandez and Erbilgin, 2009; Høynes et al., 2019).** There are other papers related to this area but which fit more neatly within other sections so are considered elsewhere, for example, the impact on MTER knowledge of the Knowledge Quartet work (**Rowland, Turner and Thwaites, 2014)** which is considered in Section 2.5.

Matters have also arisen which impinge on other lenses in the Framework, for example, value-related themes appear relating to understanding the class and classroom context when working with PSTs (**Jung and Brady, 2016);** and, the question of supporting PSTs in their first year of teaching, a period **Schuck (2009)** describes as 'overwhelming'. These issues will be picked up in later sections of this review.

Overall, the *doing* lens has brought into focus several important topics – not just the day to day activities of a "job description", but an examination of the kinds of research that MTERs choose to do about themselves. Inevitably under a heading such as *doing*, literally everything an MTER does or says might be incorporated,

which is why here, I have chosen to focus on two core elements, the practicum and the sessions, and provide an overview of the research methods typically used by MTERs to study their own work. Other material from the studies cited here will fall more naturally within the other lenses. In doing this, I have taken a careful approach to pull together a coherent picture of an MTER *doing* their role, however, the sheer diversity of the material has imposed limitations.

There are implications for the present study here. First of all, as we have seen there is no shortage of studies of individual practices of MTERs or self-reflection by MTERs. What is absent from the literature is any study which provides any kind of overview of MTER activity, and tells us which activities are more crucial. Importantly, none of the studies above addresses the tensions within the role – the aspects of the role which make competing demands on time, expertise and resources. These issues would allow real insights into the imperatives and choices made by MTERs when *doing* their role.

2.5 *Knowing* as a Mathematics Teacher Educator Researcher

The literature in this section on *knowing* is varied and extensive, although **Beswick and Goos (2018)** suggest MTER knowledge is still under-researched. Presented below is a summary of some of the discussions concerning the potential knowledge-base components for an MTER. This is sometimes referred to as mathematics knowledge for teaching teachers (MKTT) which differs from MKfT which is Mathematical Knowledge for Teaching (**Stylianides and Stylianides, 2010; Silverman and Clay, 2009**).

2.5.1 Mathematics Knowledge for Teaching Teachers (MKTT)

A simple Venn diagram created by Jaworski (2008, p.336) in Fig. 2.6 serves to show that knowledge is shared by MTERs and mathematics teachers but that each also has their own specific knowledge-base, and rejects a hierarchical view of MTERs 'passing on' their wisdom to teachers to utilise in their classrooms. Unpicking MKTT however, is far from simple (Castro Superfine and Li, 2014).

Figure 2.6 Jaworski's knowledge-base of the teacher and teacher educator

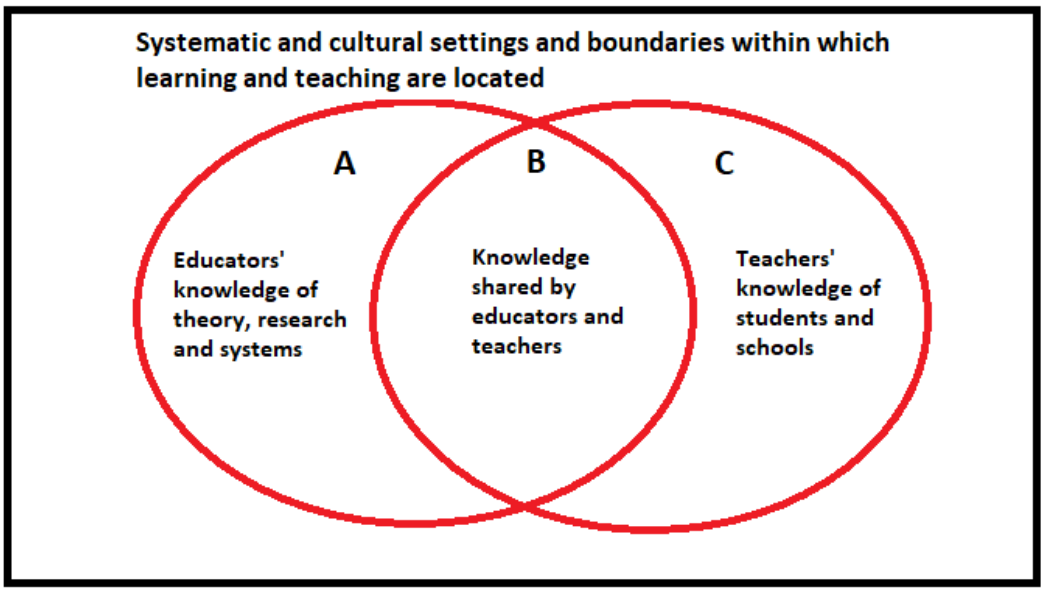


Diagram adapted from:
Jaworski, B. (2008) *The Development of The Mathematics Teacher Educator and its Relation to Teaching Development*

(Jaworski, p. 2008, p.336)

As an MTER, Tzur (2001) was responsible for mentoring developing MTERs and thus concerned with knowledge and professional development. Tzur proposed a non-linear, recursive framework, illustrated in the diagram below, the arrows representing reflection which is key:

Figure 2.7 Tzur's four-foci model

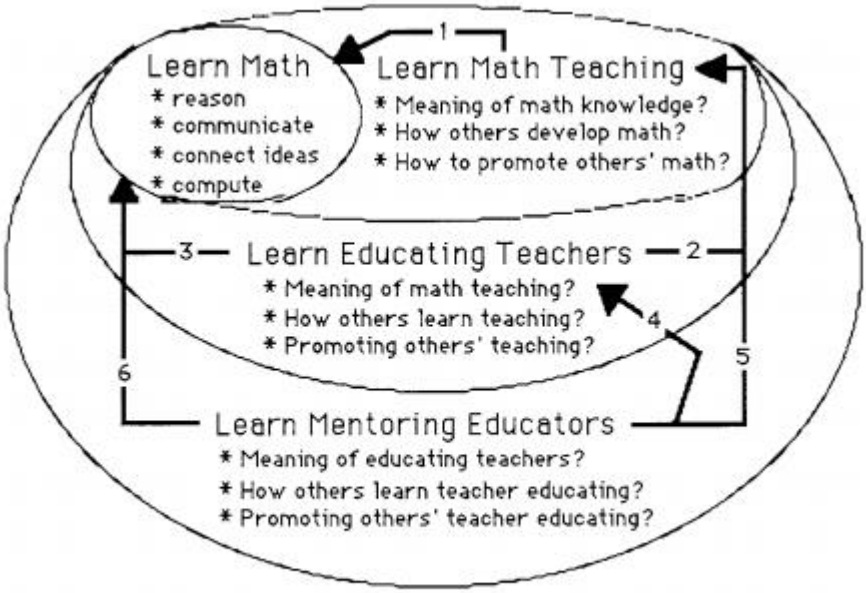


Figure 4. A four-foci model of teacher education.

(Tzur, 2001, p. 274)

The diagram gives a way into thinking about development at the levels of learner, teacher, MTER and MTER-M (mentor of MTERs). The reflective process at a particular level involves "*a conceptual reorganization of practices used at the lower level(s*)" (Tzur, 2001, p. 272). These thought processes enable MTERs to develop theories which in turn will underpin their practice. (Tzur, 2001). Mason (2008, p.46) makes the point that in order to develop, teacher educators need to continue to do mathematics as well as reflect upon and refresh their pedagogy; he suggests these activities should be done both alone and through dialogue with others.

Chauvot (2008) coined the term 'Mathematics Teacher Educator Researcher Mentor (MTE-R-M)' as a more accurate way of encapsulating the varied roles and

responsibilities undertaken by the person in post. Her study based in the USA was an examination of curricular knowledge for MTERs and how growth in curricular knowledge could be facilitated. The paper links with her 2009 article reporting on self-study activity as an MTER, and reflecting on several years of experience **(Chauvot, 2009).** Chauvot explores Shulman's three notions of knowledge adding context knowledge and suggesting an overall consideration of research across each aspect. Her diagrams which show more complexity, draw significantly on the work of Shulman (1986 and 1987) and provide another way of thinking about MKTT. The diagrams refer to Subject Matter Content Knowledge (SMCK), Pedagogical Content Knowledge (PCK), Curricular Knowledge (CK) and Knowledge of Context (CXK).

Figure 2.8 Chauvot's Knowledge Map for MTERs

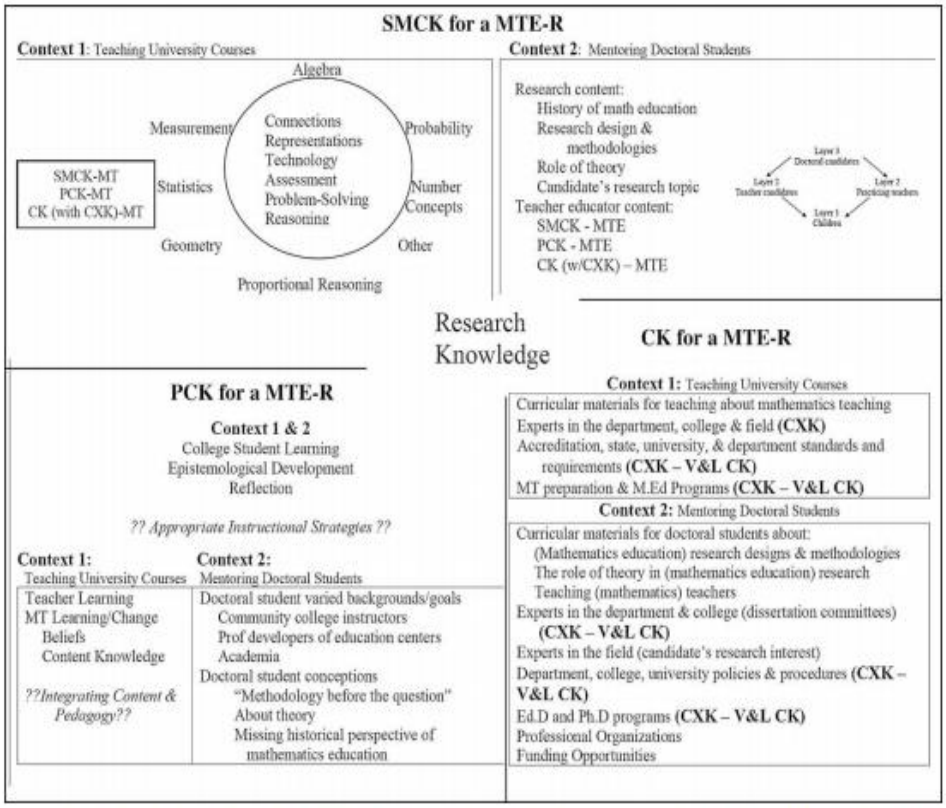


Fig. 2. Knowledge map of subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), curricular knowledge (CK), and knowledge of context (CXK) for a mathematics teacher educator-researcher (MTE-R) where V & L CK refers to vertical and lateral curricular knowledge.

(**Chauvot, 2009**, p. 363)

In an earlier paper, **Chauvot (2008)**, presented three hypothetical cases analysing what curricular knowledge would be required in each case:

Figure 2.9 Chauvot's Hypothetical cases of curricular knowledge

Three hypothetical cases of *curricular knowledge* for different contexts and roles of mathematics teacher educators.

	Case I University-based faculty and instructor of a secondary mathematics methods course for undergraduates	Case II School-based curriculum supervisor providing professional development for in-service secondary mathematics teachers	Case III University-based faculty and mentor of mathematics education doctoral candidates
1 Programs & Materials	• Models of mathematics teacher preparation programs • Textbooks/materials for secondary mathematics methods courses • Materials for teaching about [cooperative learning, equity, manipulatives, technology, etc.] in a mathematics classroom	• Models of professional development for mathematics teachers • Materials used with in-service mathematics teachers • Materials for teaching about [cooperative learning, equity, manipulatives, technology, etc.] in a mathematics classroom	• Models of mathematics education doctoral programs • Materials available for teaching about mathematics education research. • Materials/activities for teaching about the [role of theory, writing a literature review, etc] in mathematics education research
2 Indications & Contraindications	• Pros and cons of different mathematics teacher preparation programs • How pre-service teachers interact with and learn from mathematics methods curriculum materials • Research knowledge	• Pros and cons of different models of professional development for mathematics teachers • How in-service teachers interact with and learn from professional development materials • Research knowledge	• Pros and cons of different mathematics education doctoral programs • How doctoral candidates interact with and learn from materials and activities intended to teach about mathematics education research • Research knowledge
3 Lateral Curricular Knowledge	• The institution's mathematics teacher preparation program • Other courses pre-service teachers are enrolled in at the time	• The school district's philosophy, procedures and policies • Other professional development opportunities the district is providing at the time	• The institution's mathematics education doctoral program • Other courses doctoral candidates are enrolled in at the time
4 Vertical Curricular Knowledge	• The institution's mathematics teacher preparation program • Other courses pre-service teachers are enrolled in before and after the methods course	• The school district's philosophy, procedures and policies • Past and future professional development opportunities the district has provided	• The institution's mathematics education doctoral program • Past and future coursework and activities of doctoral candidates

(**Chauvot, 2008**, p.86)

Figure 2.10 Chauvot's SMCK for the MTER in two contexts

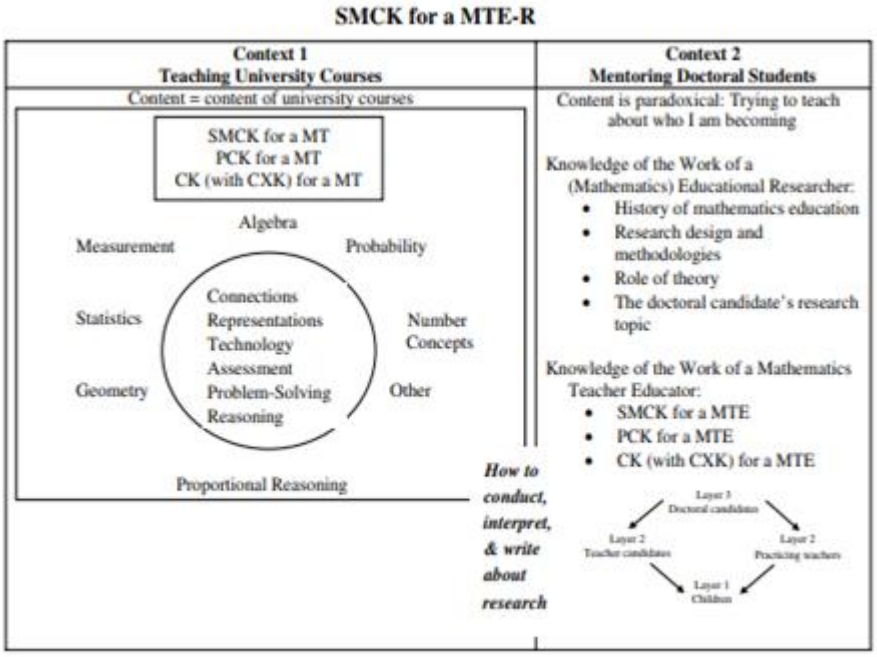


Fig. 5. Subject matter content knowledge (SMCK) for a mathematics teacher educator-researcher (MTE-R) in two contexts.

(**Chauvot, 2009**, p.365)

In each case, Chauvot considers the knowledge-type from key aspects of the role – teaching and research including mentoring of doctoral students. This diagram goes some way to demonstrating the complexity of knowledge required in the MTER(-M) role.

Figure 2.11 Chauvot's PCK for the MTER in two contexts

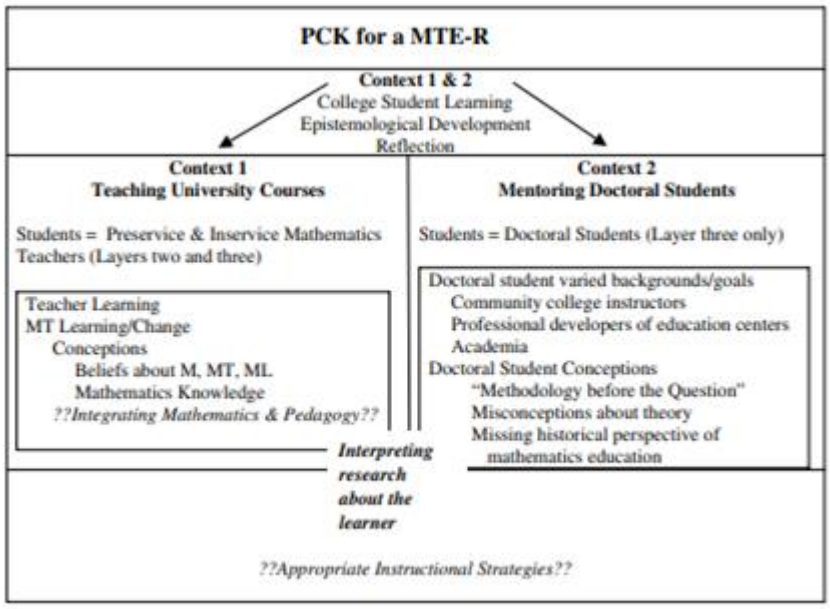


Fig. 6. Pedagogical content knowledge (PCK) for a mathematics teacher educator-researcher (MTE-R) in two contexts.

(**Chauvot, 2009**, p.366)

While **Chauvot (2009)** considers Pedagogical Content Knowledge (PCK), the diagram provided by **Chick and Beswick (2018**) is far more complex and provides greater detail. This much larger diagram is located in Appendix A5. Continuing the theme of complex layering, the authors' focus for their paper and the model they present explores the PCK required by MTERs to develop the PSTs' PCK for teaching mathematics.

2.5.2 Focusing on aspects of pedagogy

This section focuses on articles which relate to aspects of *knowing* that are concerned with pedagogy or the application of mathematical knowledge in the process of teaching. In a study involving 148 PSTs, **Jansen (2009)** explored motivation to participate in discussion in mathematics content courses. From the responses, Jansen, derived five motivational profiles to categorize participation practices and underlying values or beliefs, for example, a PST who has a strong sense of career goals, might participate to learn mathematics and to prepare for her teaching career. Her actions might include seeking feedback and asking questions during the course. Negative utility value, on the other hand, might be reflected in the actions of a PST who prefers to work alone and not to contribute. **Jansen (2009)** suggests there are implications for the Pedagogical Content Knowledge (PCK) of MTERs arising from her study.

Rowland et al. (2014) place a large emphasis on the professional learning of the MTERs, referencing their creation of the *Knowledge Quartet (KQ*), a theory of mathematical knowledge. In their paper they describe how KQ research directly impacted on their own development and led to "*new awarenesses, and enabled new approaches*" in their practices as MTERs (**Rowland et al., 2014,** p. 321). Like many others they draw on the influence of Mason (Mason, 1996, 2002) in their approaches and discussion. **Rowland et al. (2014)** describe their use of video recording and subsequent analyses of the practice of PSTs within primary (elementary) classrooms, empirical research which combined with their years of experience as MTERs led to the development of the KQ. This framework is significant here in providing a way of analysing *knowledge-in-action*, how knowledge is used in planning and teaching, which is a key consideration for MTERs in their work with PSTs and teachers. In essence, the KQ provides a tool for the MTER enabling them to more accurately identify the PST's knowledge and understanding so as to provide targeted support in relation to their teaching development. It defines four knowledge dimensions (foundation; transformation;

connection; contingency) and provides accompanying indicators as to how these might manifest themselves in practice. There are interesting parallels between the work of **Rowland et al. (2014)** and that of **Yang et al. (2015)** considered in Section 2.4. In particular, the notions of connection, contingency and being responsive to learners in the moment, are indicative of desirable practices whether this is of PSTs and teachers with their student learners or MTERs with their PST/teacher learners. Seeking to deepen understanding of these notions is supportive of enhancing the knowledge and practices of MTERs. **Phelps, Gregory and Spitzer (2012)** note that good practice for PSTs [and teachers] may also be good practice in relation to teacher education.

2.5.3 MTERs' views on the content of Mathematics Teacher Education courses

Zazkis and Zazkis (2011) explored the importance of mathematical knowledge in teaching elementary methods courses from the perspectives of five MTERs. They commence their discussion by asking the reader to consider two candidates for the post of instructor of an elementary mathematics methods course. Whilst sharing many attributes, the successful candidate transpired to be the one who had the higher mathematics subject qualification, deemed more important than the extensive elementary phase teaching experience and PhD level study of curriculum and instruction, of the second, unsuccessful candidate. Whilst acknowledging more research is needed, **Zazkis and Zazkis (2011)** suggest that there is evidence that having deep understanding of mathematics enables MTERs to draw on this in their designing of tasks, developing values and appreciating problem-solving, for example. Which of these attributes is more appropriate for a beginning MTER is an interesting question.

Masingila, Olanoff and Kimani (2018) are also interested in the MKTT that MTERs use while helping PSTs to generate their own mathematics knowledge for teaching. MKTT was used by MTERs in their planning and teaching of problem solving through

their choice of: course and session goals; tasks, and their facilitation; questions to support reasoning, justifying, proving and disproving. This work contributes to the sector's growing understanding of MKTT and how adopting an inquiry stance enables critical thinking.

Bergsten and Grevholm (2008) identify a key concept, the "didactic divide" which they explain is the separation between the learning of teachers in their contexts based on university study from that in practically-based settings related to classrooms and pupils. They identify through the literature a progression from competency models related to teacher knowledge through to recognition of interactivity of teachers and teacher educators to consideration of the practices of teacher educators and their associated knowledge. Their chapter presents a range of approaches through which power differentials are reduced, and learning of pupils, prospective teachers, practising teachers and teacher educators take place within mutually sustaining environments that present opportunities to overcome the didactic divide.

This divide lies at the heart of research by **Li and Castro Superfine (2018)** which examined six MTERs' perspectives on the design of content courses including goals and challenges. All adopted learner-centred approaches to their teaching, and all six shared concerns about managing the varied mathematical backgrounds of PSTs. Other related concerns included re-shaping PST views about the value of content course and grading open-ended assessments which asked PSTs to give mathematical explanations, for example.

Jankvist, Clark and Mosvold (2019) offer a relatively new perspective on the merits of including history of mathematics as part of an MTER course. Through case-studies they provide some examples of how this might work in practice.

2.5.4 Task design, tools and the notion of disturbance

Zaslavsky (2008) signifies the importance of task design, its use and adaptation in promoting learning. Several papers focus on enhancement of mathematical knowledge via task design, the use of tools (specifically designed artefacts to foster learning), and allude, either directly or indirectly, to the notion of *disturbance*. Focusing on the *content* of one's own learning is a purely personal activity, linked with *becoming*, but when the *process* of learning is explored deeply it is likely to form part of a knowledge-base as a teacher educator and influence teaching. The paper by **Zazkis and Mamola (2018)** provides a prime example of this. In common with other authors in the *100-set*, they draw on key concepts such as Mason's layers of classification of *awareness-in-action*, *awareness-in-discipline* and *awareness in counsel,* and his notions of *'accounting-of'* and *'accounting-for'* (Mason, 2002), and *contingency*, a term also used by **Rowland et al. (2014)** in the knowledge quartet and referring to the teacher's 'in-the-moment responses' to unanticipated and novel events, such as for example, an unusual question from a learner. Responding to the issue of divergence of teacher intention and student activity raised by Mason, **Coles and Brown (2016)** draw on 20 years of experience and research to create a set of *task design principles*.

Tzur (2008) building on his earlier work (Tzur, 2001) expands on this theoretically to conceptualise and characterise a construct called PALP (Profound Awareness of the Learning Paradox). PALP leads MTs or MTEs to construct tasks that might seem counter-intuitive to those lacking such awareness, but which result in learning of desired concepts by the students or teachers who are the focus of the tasks. Tzur (2008) charts his own developing awareness of addressing the learning paradox and synthesises five 'capacities' that serve as goals for MTEs' development.

Perks and Prestage (2008) focus on tools (in the widest sense of Vygotsky's use of the word (Vygotsky, 1986)) for learning, including the learning of pupils, prospective

teachers and their own learning as MTEs at secondary level. A Vygotskian theoretical frame is used to reflect on their own use of tools, particularly the tool of academic writing, in which they encapsulate and synthesise concepts that are in process of formation.

Chen, Lin and Yang (2018) consider a similar theme. Highlighting the complexity of MTER knowledge, they record the processes as a novice MTER plans professional development tasks for teachers, designing, analysing and revising tools (resources) to be used with them. The MTER's objective is to facilitate teachers' designs and implementation of their own tools in their classrooms. The MTER supports teachers' professional learning by encouraging reflection on their students' learning. In undertaking these activities, the MTER also learns significantly.

2.5.5 Knowledge of Research

Goodchild (2008) speaks of achieving 'good research' equating this to the aim of achieving better mathematics teaching and learning. He explains his own progression as a researcher from 'data extraction' – extracting and analysing data from research settings with minimal involvement of the participants - through to developmental research in which all participants are engaged fundamentally in the research and informed by this involvement to improve practice. Goodchild exemplifies this through a large-scale project undertaken in Norway.

In her chapter, Chapman (2008) reviews and categorises MTER research into their practices (instruction) undertaken in the US in the national context of responding to reform in mathematics education. A key finding was that many of the studies did not explore how authors reflected, what knowledge they acquired and what impact the research would have on their future practices. In other words, personal professional development should be more routinely addressed in MTER research.

In examining the views of 42 MTERs and 9 teacher-consultants arising from activities set during a forum, **Lin, Yang, Hsu and Chen (2018)** used qualitative analysis to determine that three clear perspectives were apparent, focused on: research; practice; and, the connections between research and practice. The latter category was sub-divided into with and without consideration of context. This discovery clearly has implications for their practice in designing and delivering professional development for teachers.

2.5.6 MTER perspectives on effective teaching and the 'expert' mathematics teacher

In a seminal paper related to this area, Askew, Brown, Rhodes, Wiliam and Johnson (1997) categorised three types of orientation in relation to the teaching of mathematics: connectionist; transmission; and, discovery. The discussion is still very relevant today. **Hemmi and Ryve (2015)** consider effective mathematics teaching as perceived by MTERs in Sweden and Finland. A combination of qualitative data from interviews, focus group and feedback discussions (post PST teaching) was considered for analysis. The observing researcher was able to determine what aspects of teaching were considered effective by the MTER providing feedback to the PST. Recognising the limits of their study, the researchers reported some pertinent differences in views, for example, the apparent valuing of presenting mathematics interactively compared with stressing the importance of clear presentation and routines.

Yang and Leung (2013) interviewed 37 MERs in Hong Kong and Chongqing to better understand their views on the characteristics of an "expert mathematics teacher". Whilst there were some similarities in opinion a major difference from those in

Chongqing was that the expert teacher should mentor other teachers, be able to conduct research and have knowledge of theory.

2.5.7 Some Reflections on *Knowing*

The mere fact that in this section we are confronted by a blizzard of competing diagrams, acronyms and descriptions of the types of knowledge required of MTERs, should tell us one thing – that the knowledge required by MTERs is neither one-dimensional nor is it easily characterised. One look at the diagram in Appendix A5 from **Chick and Beswick (2018**) tells us that. It would take an entire research project to thoroughly analyse and reconcile all the diagrams within the first subsection here, and even then, it is unlikely that such a reconciled study will have captured everything an MTER needs to know, since as **Beswick and Goos (2018)** remind us, MTE knowledge is still under-researched. What I attempt below is to provide a synthesis of some of the key ideas reflected in this section of the literature.

Part of the reason why the literature within the *knowing* lens is varied and extensive, is that in addition to drawing on articles within the 100-set, I have referred to the work of those cited within that set, such as Jaworski (2008), since this work was referenced many times. Similarly papers by Tzur (2001) and Tzur (2008) are referenced on several occasions within the 100-set, and clearly the citing authors thought Tzur's work was clearly of relevance.

Therefore, much of the work in this first section comprises the work of "theorists" trying to categorise and classify knowledge in different ways, and putting emphasis on different elements. Jaworski (2008, p.336) claims an overlap between MTERs' and mathematics teachers' knowledge, but that each will have unique elements. This view respects the knowledge teachers have of their pupils and school contexts, and recognises the value of partnership working in the field of teacher education.

The diagram is decidedly non-hierarchical, rejecting any idea that MTERs somehow transfer knowledge to teachers.

In contrast, Tzur's framework does have elements of knowledge transfer, and in this model, development occurs through the interaction between different levels: learner, teacher, MTER and MTER-M (mentor of MTERs), with reflective processes at one level triggering "a conceptual reorganization of practices used at the lower level(s)" (Tzur, 2001, p. 272). Such processes allow MTERs to develop theories which in turn will underpin their practice (Tzur, 2001).

Underpinning many of the diagrams themselves is the influence of Shulman (1986 and 1987), whose characterisations of different types of knowledge required by teacher education is to be seen across many sectors. Chick and Beswick (2018) for example, build on Shulman's work by taking one of the categories, Pedagogical Content Knowledge, and providing examples of how these are manifested in what exactly an MTER might do. If these categorisations and diagrams are to be more than mere static descriptions, then such illustrations concerning their use are vital to explain how an MTER might think about applying their knowledge.

There is clearly a lot of overlap here between these models, but it is also clear that many of these authors are struggling to categorise something which is huge, diverse and highly interconnected. Some of the diagrams like those of Chick and Beswick, and Jaworski treat the knowledge in isolation – a "thing" to be known. Others see knowledge as a process, whether that is individual knowledge or the transfer of knowledge between individuals. The issue here is that both are required. A treatment of the knowledge of MTERs should tell us what MTERs need to know, where they get this knowledge from, how their knowledge develops and changes over time, and what do they do with this knowledge as part of their role in producing the next generation of teachers.

The subsection on pedagogy (2.5.2) addresses that point. Many aspects of *knowing* are more fluid and dynamic than suggested by some of the frameworks above, since they are specifically related to pedagogical processes, that is, the application of mathematical knowledge in the process of teaching. This is where empirical studies have value, for example those of **Jansen (2009),** in deriving motivational profiles, and **Rowland et al. (2014)** whose work on the *Knowledge Quartet (KQ*) has been extremely influential. The crucial difference here is that these structures are derived from knowledge as an activity, not as an entity. The application of such knowledge is immediately apparent, since it is derived from observed and observable practice.

In the same manner, Task Design is also an important application of knowledge, one that requires an MTER to draw on many different types of knowledge to construct a successful task. Again, many studies reference the theoretical underpinnings to this activity, with for example, **Zazkis and Mamola (2018)** drawing on the work of Mason's (2002) categories of *awareness*, *accounting* and *contingency*. In contrast, **Coles and Brown (2016)** create their *task design principles* directly from 20 years of experience of teaching at various levels. While these constructs might be extremely useful, as ways of thinking about task design, they do not tell us how they are actually used in practice, or whether the categorisations are helpful to those trying to develop or improve practice. Research such as that by **Chen et al. (2018)** helps to do just that, by documenting novice MTER plan tasks for teachers, and the processes of reflecting on their use, evaluating and improving them.

The link between research and practice is clearly an important tension for MTERs. The empirical study by **Yang and Leung (2013)** concluded that an "expert mathematics teacher", in addition to mentoring other teachers, should themselves be able to conduct research and have knowledge of theory. However, these are not to be seen as separate domains of knowledge. **Lin et al. (2018)** in their work on MTER's perspectives found that making connections between research and practice

was a knowledge domain in the same vein as knowledge about research, and knowledge about practice. In the study by Goodchild (2008), it is suggested that such connections might be enhanced by an MTER's involvement with research and their development as a researcher, for example by moving from a 'data extraction' model to a full engagement with participants. Goodchild (2008) notes that such a transition helped MTERs inform their practice.

The main issue arising from this section has been the sheer breadth of knowledge one might expect of an MTER and the complexities of trying to encapsulate that into a model. Many researchers recognize this reality, and instead have concentrated on how MTERs can develop new knowledge, rather than attempting to characterise precisely what it is. What might be useful, however, to novice MTERs, and perhaps even some of long standing, is for advice on sources of knowledge, and what types of knowledge are seen by MTERs as crucial to their role. Of particular interest here is the relationship between research and practice and how one informs the other. For example, at what point do MTERs create the links between the two that seem so vital, enabling knowledge acquired through research to be converted into tasks which help PSTs and teachers develop their own practice? In this regard, **Jaworski and Huang (2014)**, may offer some insights; they describe the potential significance of communities of inquiry into teaching and learning in providing a framework within which both teachers and MTERs can significantly enhancing their knowledge-bases. This study is considered more fully in the final lens *belonging* (Section 2.7).

2.6 *Being* a Mathematics Teacher Educator Researcher

Davey describes *being* as the lens through which we might view "*professional identity as the personal in the professional"*; in exploring the notion of *being*, she suggests investigating the following: "*adopted and ideal personae; roles; personal qualities, emotionality; likes and dislikes; sources of pleasure and anxiety; self-image and self-imagery; [and] values."* (Davey, 2013, p. 38).

This breadth of *being* is not reflected In the *100-set*, which might suggest that MTERs are less inclined to research these areas. The articles below fall most easily into the area of values; also included are papers relating to beliefs, a related concept. A value can be defined as, "*a person's principles or standards of behavio[u]r; one's judgment of what is important in life*" whereas a belief is defined as, "*Something one accepts as true or real; a firmly held opinion*" (Lexico, 2019). As the emotive vocabulary used above might suggest, the eight papers included in this sub-set are certainly thought-provoking. It occurs to me too that whilst not strictly part of Davey's being, the sense of "*being valued*" seems to be missing from the literature. The papers have been categorised into three groups for the purposes of consideration.

2.6.1 Belief Structures

Two USA-based studies explore beliefs and how these affect MTERs. In the first, a collaborative self-study, six MTER authors examined their personal beliefs about mathematics teacher education, identifying four shared beliefs:

- "Mathematics is problematic and generated through sense-making;
- A community of learners enhances learning;
- Mathematics Teacher Educators need to be explicitly aware of the learner in different contexts;
- Teaching is complex at all levels."

  (Lovin, Sanchez, Leatham, Chauvot, Kastberg and Norton, 2012, p. 58)

In undertaking this exploration of beliefs and practices, and determining their shared beliefs, the team realised that their beliefs were not necessarily evident within their practice so they set about to change this. Again, a strength of this study is its collaborative nature: a recurrent theme in this review. An important point they stress is

> "it does not immediately follow that an excellent mathematics teacher will become an excellent mathematics teacher educator. As a field of teacher education, we need to address the tendency for teacher educators to learn to teach about teaching in isolation"
>
> (**Lovin et al., 2012, p.65**)

Conner and Gomez (2019) use case study methodology to describe the beliefs and shifts in beliefs of a secondary PST, noting her resistance to change over the period of an initial teacher education programme. To better understand this change, and her resistance, they characterise her as an "*adaptive idealist*", drawing on earlier work into conceptualizing belief structures. When core beliefs are deeply embedded and strong, they are especially resistant to change, and while an adaptive idealist's peripheral beliefs may be modified, they continue to rationalise core beliefs through their experiences and when challenged to behave differently, for example to use a different approach when teaching mathematics, they deal with contradictions simply by "*embracing vocabulary with interpretations that fit [their] beliefs*" (**Conner and Gomez, 2019**, p.207). The authors' motivation as MTERs is to become better equipped to provide more effective interventions in mathematics teacher education to tackle this significant challenge, and this illustration of MTER research further serves to demonstrate the complexities of *being* an MTER.

2.6.2 Social Justice, Equity and Power Balance

Matters relating to social justice are clearly of concern in teacher education (Willemse, Lunenberg and Korthagen, 2005; Grudnoff, Haigh, Hill, Cochran-Smith,

Ell and Ludlow, 2017); three papers from the *100-set* directly address this issue – two from the US and one from Canada.

Esmonde and Caswell (2010) use the terms *Social Justice* and *Equity* interchangeably, acknowledging the lack of both consensus on definitions and effective practices to address equity in the classroom. The belief underpinning their work is that mathematics education "*should contribute to broader struggles for social justice*" (**Esmonde and Caswell, 2010, p. 245).**

Esmonde and Caswell (2010) caution about equity being viewed merely in terms of seeking to redress levels of achievement and participation in mathematics of groups according to race, gender and class, arguing instead for a questioning of both content and pedagogical approach in mathematics as a means of ensuring accessibility. The authors make use of Cochran-Smith's (2004) six principles of teaching for social justice as an analytical frame for their research. This is part of a body of work considering international evidence to inform teaching for equity in a teacher education curriculum (Grudnoff et al., 2017). The study by **Esmonde and Caswell (2010)** is smaller-scale, focusing on one Canadian elementary school. Nonetheless in working collaboratively with teachers in the school and the district, they gained a deeper understanding of social justice approaches through their developing inquiry stance.

A more extensive study of 23 MTERs, investigated the challenges in teaching for equity within mathematics methods courses, and the ways in which MTERs attempted to address them (**Vomvoridi-Ivanovic and McLeman, 2015**). The participants were targeted either from a conference list or through their equity-related publications or work. Using interviews and a constant comparative method (Glaser and Strauss, 1967), the researchers found that the challenges to MTERs centred on either themselves or the PSTs, and their beliefs that mathematics is neutral or culture-free. While the sample is clearly not representative of all MTERs, the MTERs targeted in the study are more likely to be attuned to the issues, and so

their insights might be considered valuable in a field which deserves further consideration.

In her paper, **Monroe (2013),** reflects on extensive personal experience as an MTER, focusing on three separate groups of teachers and PSTs within different contexts, reveal particular values related to balance and equity within the MTER-teacher relationship. Her realisation was that in order for there to be benefit to her teacher groups, she should not impose her views of mathematics or mathematics teacher education on them; rather, her role is seen as devising meaningful tasks, deciding discussion foci, and seeking to create learning environments that lead to the construction of meaning within the given cultural context.

A novel insight on this is given by Mohammad (2008), and serves to remind us of the importance of the wider cultural context when working with teachers or PSTs. She provides a unique personal perspective to *becoming* an MTE in the context of Pakistan. This paper, like those of **Helliwell (2017a and 2017b)**, highlight how the lenses of Davey (2013) are not mutually exclusive; in addition to relating to professional development, a key aspect of *becoming*, Mohammad's narrative concerns also notions of *being*, in particular upholding particular values, and *belonging*, in the context of working with teachers.

Mohammad (2008) describes how her loving and caring family upbringing and early exposure to tales of morality led her into the profession of teaching and later, following study at master's level, into teacher education. Using a self-study methodology, (LaBoskey, 2004; Loughran, 2005), Mohammed references key episodes of work with teachers to reflect on her professional learning as an MTE and in particular, the dilemmas faced within her particular context when attempting to enact her values in support of teacher development. Mohammed acknowledges the hierarchical culture within which she is working together with the constraints the teachers are working under, which inevitably lead her to make compromises.

Initially her values led her to a desire to work collaboratively on equal terms with the teachers, in line with substantial research already cited (**Potari et al. (2010)**, **Goos (2014), Benken and Brown, 2008)**. Mohammed's realisation was that she needed to view equality not in terms of status, but in terms of mutual respect, so that collaborative learning could be undertaken not via equality of status or knowledge or even understanding but through support and encouragement of a teacher's thinking and autonomy, in essence reinforcing the conclusions of **Monroe (2013)** and **Vomvoridi-Ivanovic and McLeman (2015)** above. In this realisation, she also stresses the importance of teacher educators enabling teachers in turn to become more analytical in regard to the moral and ethical influences that their practices have on students.

2.6.3 Nurturing and ethical aspects of the role

The papers grouped below all indicate the depth of responsibility felt by the authoring MTERs in regard to the PSTs with whom they work. All are based on self-study (La Boskey, 2004; LaBoskey and Richert, 2015; Loughran, 2005) or personal reflection on practice (e.g. Schön, 1983); the methodology of the former was examined in the *doing* Section 2.4.1.

Nicol et al. (2010) in a collaborative, participatory self-study in Canada, used Mason's (2002) idea of 'noticing' when examining the practice of one MTER and her PSTs, including following one into her first year of teaching. A strength of this study is its purpose of combining two fields of research to better understand MTERs' pedagogical practices. The first field concerns the development of the PSTs' mathematics for teaching, together with their understanding and beliefs about it, and how these develop and change through practicum. The second field concerns the pedagogical relationships between MTERs and their PSTs. Recognising that many PSTs have a fear of mathematics and mathematics teaching, their concern is to develop an appropriate mathematics methods course which both challenges the

PSTs in their mathematics learning and teaching through an inquiry-based approach whilst at the same time ensuring s due care is given to the very real anxieties felt by many elementary PSTs. In many ways this is similar to the approaches suggested by **Monroe (2013)** above**.**

One specific strength of **Nicol et al. (2010**) paper is the methodology in which two MTERs act as critical dialogue partners to a third MTER (Janice) whose practice is explored over a period of 8 weeks. Schuck and Russell (2005) recommend critical friends "take risks to challenge […] fundamental assumptions". Many other self-study papers, e.g. **Nolan (2015a)** are the result of solitary activity. While solo activity does not de-value an activity, it perhaps makes possible generalizability more challenging; however, that is seldom the point of such an activity. In their conclusions, **Nicol et al. (2010)** recognise the challenges and benefits of undertaking a collaborative study; they also note that caring relationships should be nurtured in order to build sufficient trust to truly foster an attitude of openness to challenge. Again, this echoes the concerns of **Monroe (2013).** Trust appears as a theme in a number of papers (**Reid and Zack, 2010a**; **2010b**; Dawson, 2008) and is linked with the role of emotion in teachers and teacher educators' lives (Day and Leitch, 2001). Sztajn (2008) also raises the valuing of relations between MTERs (caring) and mathematics teachers (as cared-for) claiming this to be of equal import to format and content, and necessary for high quality professional development of teachers.

In another reflective study, **McGlynn-Stewart (2010)**, discusses the importance of listening carefully to her PSTs, adjusting her practice in an attempt to address their anxieties concerning mathematics and mathematics teaching. This included providing opportunities, in a safe and supportive environment, to engage in activities to develop understanding of primary mathematical concepts. Through engaging in the study and improving her own practices, McGlynn-Stewart likens their fears those she experiences herself in regard to pioneering a new course.

Although a solitary study, McGlynn-Stewart had the valuable support of a critical friend during the experience.

Drawing on data from large-scale studies, **Stoehr (2017)** uses a research methodology based on narrative interpretation to investigate the case of a single elementary PST, providing a detailed analysis of the anxiety experienced by her. Stoehr suggests opportunities for PSTs to explore what triggers their anxieties, combined with options and awareness raising may be helpful to what she says is a potentially long-term difficulty. Anxiety about mathematics within the elementary/primary PST community is also a concern here in the UK, with a standard text for Primary PSTs devoting the first chapter to it. (Haylock, 1995; Haylock, 2018).

Others have also identified negativity to mathematics as a serious issue, Krainer (2008) provides a personal account of his development as an MTE. He makes the point about addressing public awareness of the power and beauty of mathematics, noting that if mathematics is unknown or viewed as elitist or separatist and feared by members of society and education it cannot be accessible to all.

2.6.4 Some Reflections on *Being*

Comparing the content of this section to Davey's description at the head of Section 2.6, that of *being* as the lens through which we might view "*professional identity as the personal in the professional",* it can be seen that hardly any of what Davey envisages as *being* is present here. This breadth of *being* is certainly not reflected within the *100-set*, which might suggest that MTERs are less inclined to research these areas.

However, although the papers here have been limited in scope in regard to Davey's conception of the *being* lens, nonetheless they have contributed significantly to knowledge and understandings about the more emotive side of *being* an MTER. As might be expected for such a topic, studies here have been relatively small scale though some have been slightly larger – for example the study of **Lovin et al. (2012)** involved 6 MTERs, whereas 23 MTERs contributed to the study by **Vomvoridi-Ivanovic and McLeman, (2015)**. Nonetheless, these have provided good insights into a range of MTER beliefs and values, and the potential conflicts that MTERs encounter as they consider their practice in the light of their own beliefs and values and those of their target audience. This has included some interesting and thoughtful contributions to the discussion on MTER values and beliefs, social justice, equity and power balance and the nurturing and ethical aspects of the role.

In concluding this section, I want to return to messages found within the study by **Lovin et al. (2012**) of a group of six MTERs. These MTERs are highly self-critical and find mismatches between their beliefs and their actions. Considering the implications of their work they are keen to stress that teacher educators do not and should not work in isolation. As both Zeichner (2005) and **Lovin et al. (2012)** point out: being a good teacher does not automatically translate into being a good teacher educator or a good mentor of teachers. Of all the sections, this was the one which I personally found particularly rewarding to investigate. The writers make clear that our values and beliefs are important and how we carry these into our practices must be significant. These values are exemplified in practice in the work of others considered in this section (**Monroe, 2013; Nicol et al., 2010; McGlynn-Stewart, 2010 and Stoehr, 2017**). Values are an important part of who we are as MTERs, and any study which purports to examine the identity of MTERs, but omits to consider values will be significantly diminished as a result.

2.7 *Belonging* as a Mathematics Teacher Educator-Researcher (MTER)

Through the final lens, *belonging*, Davey refers to professional identity as collective affinities, i.e. "*the aspects of professional identity that are about collectivity and a consciousness of belonging to, or not belonging to, particular professional groups and communities*" (Davey, 2013, p. 142). The papers forming the sub-set of the 100-*set* referenced here refer extensively to the work of theorists and researchers such as Wenger, 1998; 2001; Lave and Wenger, 1991; Wenger-Trayner and Wenger-Trayner, 2015; Jaworski, 2003; Gee, 2000). MTERs writing in the area of *belonging* clearly value these key works to inform their positions.

2.7.1 Communities of Practice

A *community of practice* (CoP) can be defined as "*a group of people who share an interest in a domain of human endeavor and engage in a process of collective learning that creates bonds between them*" (Wenger, 2001, p. 2339). Through our lifetimes, Wenger suggests, we might belong to several different CoPs, and the nature of these communities is likely to change over time. Membership of a CoP implies that participants hold a certain level of knowledge and competence within the shared-interest domain, where participants may engage in joint activities and dialogue, and provide support for one another as well as for those who may be novices (apprentices) within the group. A CoP goes beyond simply having the same job; it necessitates interaction between, and mutual learning of, all participants. Members of a CoP share practices, Wenger suggests, which require them to "*develop a shared repertoire of resources: experiences; stories; tools, ways of addressing recurring problems*" (Wenger, 2001, p.2340).

A key point arising in this section is that MTERs not only form communities with other MTERs - there was some evidence of this within the *doing* section – but they

also form communities with teachers, as discussed in *becoming*, and, in further examples below, with mathematicians and other MTERs.

2.7.2 Communities of Inquiry

In subsection 2.3.3 of the *becoming* lens, papers were considered together because they concerned communities of MTERs and teachers collaborating in a variety of ways which promoted mutually-beneficial learning and development **(e.g. Benken and Brown, 2008; Brown and Coles 2010; Goos 2014**). Some key points arising from these papers in relation to the building of communities of MTERs and teachers are considered below. It is worth noting that Jaworski (2003) suggested the language of *community of inquiry* better describes the sought-after ethos, and this language of *inquiry* rather than *practice* is used in several papers (**Potari et al., 2010; Hunter, 2010; Sakonidis and Potari, 2014; Goodchild, 2014a; Goodchild, 2014b; Biza, Jaworski and Hemmi, 2014**).

From these papers we can note that the setting up communities of inquiry (COI) in the first place required consideration and planning even where groups already existed in some form. To become fully established COIs the process took several years in some instances before realising the ambition of becoming truly inquiry-focused. MTER roles within these communities varied according to the exact nature and purposes of the COI and changed over time, and the extent to which all members of a COI 'bought-in' to the community varied affecting the dynamics and successes or otherwise of the projects. These points are exemplified with reference to some of the studies below.

In the study by **Sakonidis and Potari (2014)**, one COI arose because teachers had specifically asked for a community to be set up; the other arose in circumstances where there was an element of convenience, i.e. a group of teachers undertaking master's level study were introduced to the practice of inquiry. The authors

acknowledged there were differences in teachers' awarenesses, experiences and commitments to the practice of inquiry. The MTERs analysed their different roles in the two communities. The nature of the first COI meant them taking on a more practical role, supporting the teachers significantly in the first instance, eventually morphing into the roles of 'co-researcher' with the teachers' activity central to the group. In the second, the focus was more on sharing research papers and providing tools for the teachers to analyse their practice, with the role of MTER being more prominent. Tensions occurred, given the need both to critique and support teachers. Their analysis led them to revise their Master's programme, making the process of teachers becoming researchers more focused and accessible. Overall, their analysis of undertaking two roles simultaneously with the two COIs led to a clearer understanding of MTER roles, tensions and ways in which these might be alleviated.

Whilst taking a slightly different approach to their analysis, **Sztajn, Holt Wilson, Edgington and Myers (2014, p. 201)** provide a detailed account of their COI discussing it in terms of "*a premier space for teachers and researchers to exchange knowledge from their communities*". They discuss *boundary encounters* as a means by which the communities can exchange knowledge, and explain that both researchers and teachers act as *boundary brokers* when they introduce knowledge from one community to the other. In discussing identities, participants saw themselves as having *dual rol*es as both *learners and guides*. A key point is that of valuing each other's contributions and acknowledging that both groups gain from the process. Key *boundary objects* (artefacts) were identified, for example the videos of colleagues' classrooms and related interviews; their value was realised most significantly through the dialogue that they generated within the community. The teachers reported their most significant learning occurred when their views of mathematical learning were challenged. This wish to be challenged appears in stark contrast to the PST preferences to favour a pedagogy of care over inquiry (**Nicol et al., 2010**). The MTERs in the **Sztajn et al.** (2014) study had started their engagement in the process with the intention that their research-based goals would

be presented in such a way that *cared for teachers*, however this position shifted to one of recognising that in designing research-based goals, it was for the teachers to set the goals and to be interested in the related research results.

This point links closely with the results of the study by **Goodchild (2014a)** who experienced negative reactions from one group of upper secondary teachers. Although it was disappointing to have particular tasks rejected in this venture (setting up a COI of teachers and MTERs in relation to the teaching and learning of algebra), Goodchild recognised some important lessons learnt both for himself and the wider MTER community. His perception of the issue, which he presents cautiously, relates to the critical alignment of project goals to the participants. If this is present then it provides the most opportunities for learning. In this case, the teachers perceived the tasks "*as belonging to grades below those at which they teach, even if engagement is about adapting the tasks to make them more challenging and appropriate for their level*" **(Goodchild, 2014a, p. 314)**. The key point is the importance of activity being based on experiences to which the teachers can relate. The notion of power dynamics appears to be relevant here too, if teachers perceived their voices were not being heard, they may choose not to use their voices and consequently not fully engage (Wenger-Trayner and Wenger-Trayner, 2015).

A study of relevance here is one conducted in Norway by **Bjuland, Cestari and Borgersen (2012)** which although predominantly looking at Mathematics Teacher Professional Identity, identified four identity indicators related to Teachers' engagement and critical alignment in a community of participants, a key one *being the challenging positioning in relation to didacticians* alluded to above. An interesting insight on this matter is offered by **Castro Superfine (2019)** who discusses emerging models of working *with* teachers rather than conducting researching *on* them. The focus of the articles concerns teacher learning and professional development rather than focusing on MTER learning or assessing the

mutual benefits of collaboration, nonetheless it is interesting to see where the most current research is moving. I would argue based on the work discussed that much more could be developed in terms of communities comprising teachers and MTERs.

2.7.3 Communities of Mathematicians

Another perspective which arises from the *100-set* having been explored both in the US and Australia is that of communities of practice comprising mathematicians and MTERs (**Bleiler, 2015; Goos and Bennison, 2018**). **Bleiler (2015)** examines the experiences of a mathematician and an MTER as they team-taught both a mathematics content and a mathematics methods course for PSTs. The pair under examination was one of four pairs involved in a funded project, Knowledge for Teaching Secondary School (KnoTSS) and was selected because the researcher was interested in their *polarized views of mathematics*. Bleiler focuses very much on the processes and dynamics involved in their collaboration rather than suggesting there is a particular finished product to analyse. Generally, however, the activity led to increased awareness of their own practices and practices characterizing their respective communities. The MTER found it useful, though challenging, to be in a position in which she had to articulate practices which were part of an almost unconscious repertoire, whilst the mathematician found he developed an increased understanding of student need and realised the need to reconsider his vision for mathematics teaching in his own classes. A key success in this pairing was a result of a positive working relationship between the two. When the researcher was present in the second two thirds of the initiative this presented some challenges and the researcher perceived that her presence may well have made the participants less open than they had previously been.

The notions of *boundary crossing* and *brokering* are also studied by **Goos and Bennison (2018)** in their study of mathematicians and MTERs. Similar to the **Bleiler (2015)** study, this was connected to a larger initiative in which collaboration

between mathematicians and MTERs in six Australian universities were fostered "to *investigate the potential for learning at the boundaries between the two communities*" (**Goos and Bennison, 2018**, p. 255). Advantages of the collaboration included increased integration of content and pedagogy through collaborative planning and teaching of courses, and new ways in which to create communities of PSTs. An inventory of enabling and hindering conditions for this type of collaboration was produced based on the findings of the study.

2.7.4 Communities of MTERs

It is worth noting that the most obvious community of practice, that of MTERs collaborating with one other, seems to have been overlooked in the literature. However, any idea that such collaborations are absent is far from the case. In fact, evidence of these communities of practice can be found throughout this review in every single section, and there are many instances in the literature of MTERs collaborating and forming their own communities, with many of these captured through the other Davey lenses. A typical example of this is provided by McDuffie, Drake and Herbel-Eisenmann (2008), in which three MTERs engage in collaborative activity to reflect on their planning and teaching of mathematics methods courses for PSTs and acknowledge their own learning through collaborative preparation and writing of the paper. They characterise the developmental process in learning to teach as "teaching as learning in practice" and speak of inquiry approaches throughout their practice with PSTs. As they encourage their PSTs to learn through inquiry they inquire into their own practice and become more knowledgeable about their activity and its development.

In fact, while this entire section has provided an overview of some key findings relating to MTERs' sense of belonging in the context of communities with peers, with teachers, and with mathematicians, there is overwhelming evidence from this and the previous sections of MTERs working together and in some cases forming

communities. However, for the most part, the emphasis in those papers has been more on the study itself rather than a detailed analysis of the collaboration.

2.7.5 Some Reflections on *Belonging*

In this section focusing on MTER *belonging*, evidence has been presented of MTERs engaging in collaborative activity and having a sense of *belonging* and appreciation of the benefits this brings. The practices are clearly of significance to MTERs. However, with benefits also come challenges, and tensions around *belonging* also occur and these have been considered too.

It is worth bearing in mind that in a significant number of studies referenced in earlier sections, MTERs write of their collaboration with at least one other professional, often another MTER but certainly not exclusively so. These include **Huang et al., 2014**; **Zhou and Kim, 2010**; **Coles and Brown, 2015**; **Fernandez and Erbilgin, 2009; Chen et al., 2018;** Askew et al, 1997**; Hemmi and Ryve, 2015; Yang and Leung, 2013; Lovin et al., 2012; Conner and Gomez, 2019.** While avoiding repetition of detail here, it is important to note that the articles in this selection concern some of the other communities with which MTERs engage or create, largely with teachers but also with mathematicians and others.

A further point to note too, is that these communities are not necessarily longstanding. Such communities may have pre-defined life-times, as in the cases of some of the Communities of Practice and Communities of Inquiry referenced in the previous paragraph, which were set up for a specific purpose over a fixed period of time. Wenger (2001) had suggested we might belong to several different CoPs over time. This has been alluded to at various points.

As is noted in Section 2.7.2, many MTERs refer to Communities of Inquiry as an alternative way of describing their communities (**Potari et al., 2010**; **Hunter, 2010**; **Sakonidis and Potari, 2014; Goodchild, 2014a; Goodchild, 2014b**). Establishing such communities is not straightforward, takes time, and may face many challenges, such as the power dynamics described by Wenger-Trayner and Wenger-Trayner (2015), which may play a role in preventing the "inquiry" aspect from being fully established.

Sakonidis and Potari (2014), for example, cite two communities of inquiry with which they are engaged, but note that for the reasons detailed above, only one was truly successful as a community. **Goodchild (2014a**) experienced more significant failings with one of his ventures. He usefully documents the reasons for this. There are clear parallels in both instances where these communities of inquiry were less than successful. What seems to be fundamental is the critical alignment of project goals and the need for voices to be heard, and more importantly perceived to be heard. **Bjuland et al. (2012)** consider this issue and identify four identity indicators related to teachers' engagement and critical alignment in the community of participants, a key one *being the challenging positioning in relation to didacticians*. Part of the issue here, seems to be that where two or more communities come together to form one (for example MTERs and teachers), there are the notions of (interdisciplinary) *boundary crossing* and *brokering*. This is exemplified explicitly in the case of the Australian project where a group of MTERs were paired with mathematicians (**Bleiler, 2015; Goos and Bennison, 2018**).

As noted earlier, MTERs collaborating within their peers either within the same institution or with a wider group nationally or internationally can create a sense of *belonging* (**Huang et al., 2014**; **Zhou and Kim, 2010**; **Coles and Brown, 2015**; **Fernandez and Erbilgin, 2009; Chen et al., 2018;** Askew et al, 1997**; Hemmi and Ryve, 2015; Yang and Leung, 2013; Lovin et al., 2012; Conner and Gomez, 2019**). Examples of this are plentiful across the literature and across the lenses

demonstrating that *belonging* contributes to, and in some sense is a feature of each of the four other Davey lenses: *becoming*; *doing*; *knowing*; and, *doing*. There is overwhelming evidence in the previous sections of MTERs working together and in some cases forming communities; however, for the most part, the emphasis in those papers has been more on the study itself rather than a detailed analysis of the collaboration, or indeed who exactly the individuals are who form the communities.

2.8 Summary

Sections 2.0 to 2.2 set out an overview to the field of identity culminating in a rationale for the use of the Davey framework, with its five lenses for exploring professional identity, to support the structure of my study (Davey, 2013). In addition, I set out a clear rationale as to why a systematic review to the literature was necessary and how exactly this would be conducted. In Sections 2.3 to 2.7, I have considered each lens in turn enabling me to investigate *becoming, doing, knowing, being and belonging* in the context of an MTER.

Davey sets out clearly what each lens might comprise, but the quality of the images obtained within each lens by focusing on the available literature varies considerably. The one thing we notice is that some of the lenses are well-researched, others barely examined. For example, within the lens of knowing, the material falls into two parts: the theorists who are trying to categorise and document what an MTER needs to know, by producing ever more complex diagrams of the interrelationships of that knowledge, and individual researchers, looking at elements of MTER knowledge which are of concern to them, such as aspects of pedagogy, or how best research can be applied in their teacher education practices with PSTs.

The implications of this are that despite the literature appearing to be voluminous, and the systematic searches unearthed 100 academic papers which potentially provided an overview of MTER identity, the entire picture obtained from the literature is one of a few meticulously documented areas of clarity, with huge blanks to be filled in later. In many respects however, these studies, in the main, are studies done by MTERs for MTERs, and reflect the concerns of MTERs. If there are highly personalised studies, then it needs to be asked whether such studies have been sufficiently important to MTERs to warrant their time and effort in documenting it. On the other hand, it may be that MTERs are so overwhelmed by their role or not attuned to research that while some studies might be important, the opportunity or the motivation for them does not present itself. The role of self-study is given some consideration in Section 2.4 since it is so widely used. Its advocates (LaBoskey, 2004; LaBoskey and Richert, 2015) are clear that self-studies should be shared; the learning achieved might thus be deemed meaningful to others in the field (Loughran, 2005 p.6).

What has become clear from this Literature Review is that there is no single holistic picture of the professional identity of an MTER and this represents a substantial gap within the literature. Whilst it has been possible to some degree to consider in isolation the different aspects of professional identity that Davey suggests, namely: *becoming; doing; knowing; being; and, belonging*, this has been achieved through personally classifying the research papers in the set as relating to one or more of Davey's areas, and undertaking a discussion of the content and conclusions to build up a picture of what each of the five aspects might mean in the context of an MTER's professional life. Given the volume of papers, most were allocated to one area only, however, this results in a more fragmented picture than is the reality, potentially creating over-simplifications which may counter our goal of seeking to enhance our knowledge of professional identity within this specific group. I have, of course, tried to mitigate this with some cross-referencing demonstrating that the lenses are indeed, as Davey (2013, p.163) confirmed, "both differentiated and overlapping".

The overlaps are clear to see across the Davey lenses in respect to specific elements however I was grateful to have the structure of the framework to help me to make some sense of the available literature. As Wenger-Trayner and Wenger-Trayner (2015, p.13) argue "*the body of knowledge of a profession is best understood as a 'landscape of practice' consisting of a complex system of communities of practice and the boundaries between them*." There were many instances when exploring the notion of communities through the *belonging* lens, that the same study had appeared as important in every one of the other four lenses. In *becoming*, the overlap concerns professional development and here too, much of this takes place in the context of communities (**Benken and Brown, 2008**; **Brown and Coles, 2010**; **Goos, 2014**). Many references to Communities of Inquiry, an alternative to Practice and advocated by some MTERs (Jaworski, 2008, link closely with knowledge (**Sztajn et al., 2014**; **Goodchild, 2014b**). And in *doing*, six MTERs collaborate to examine shared beliefs and the extent to which these present themselves in their practices (**Lovin et al., 2012**).

Florio-Ruane (2002) reminds us of the complexity of our social situations and urges caution against limiting our inquiry and understanding. She also suggests exploratory studies may be overlooked but that useful information can often be gleaned from them for other practitioners in the field and policy makers.

Furthermore, and significantly, there is no systematic study which accounts for each of Davey's five aspects as they might apply to a single sample of MTERs. In addition, much of the research within this review can be seen to be based on individuals or small groups of MTERS, with the predominant methodology being ethnographic in style, and with many studies taking an autoethnographic approach. From Chart A2.2 (Appendix A2), it can be seen that only five studies out of the 100-set used a survey approach yielding predominantly quantitative data, and these were quite limited in focus.

It is therefore possible to question the reliability of some of the data compiled within the Literature Review; for while it might be argued that the approaches used yield rich, "thick" descriptive data (Wang, 2016, after Geertz, 1973), which validly represents the lived experiences of individual MTERs, such studies cannot tell us whether these experiences are common to all MTERs, nor to which subgroup(s) of MTERs the results might be generalizable. It is also apparent from the Literature Review that there is no study which has sought to investigate the MTER community as a whole, or whether in fact any such community can actually be claimed to exist.

My research seeks to address many of these issues: firstly, by exploring each of the five aspects of Davey's framework with a large group of MTERs, and secondly, by using an approach which yields both statistical information, and personal testimony. This will address the issues of reliability highlighted above, while at the same time rooting the research in the valid testimony of the respondents. While the results may not be generalizable to all MTERs everywhere, the approach will certainly yield specific groups for whom the results might be valid.

One final point: in reviewing the 100-set MTER literature for this chapter, it has also become clear that not all writers align themselves explicitly with a particular theoretical position, although in some cases, theoretical positions may be readily inferred. Where authors did identify philosophical positions, these were largely related to social constructivist beliefs. Bryman (2008) explains that research methods in the social sciences are not independent of the ways in which we view social reality, and perceptions of how we should investigate the social world around us. In the next chapter, I therefore begin by clarifying my own philosophical position before introducing the research questions and discussing the research methodology in detail.

Chapter 3: Methodology

3.1 Chapter Overview

In this chapter, an explanation and justification of the methodology of the study is provided, and I begin by clarifying my personal philosophical position in regard to the research undertaken. I briefly explore this position and provide an explanation of how this perspective has influenced my research approach and strategy. The research questions are then considered, together with the methods chosen to investigate these lines of enquiry and justifications. Design decisions are considered and how the piloting of the research tools led to their revision is reported. The chapter concludes with a consideration of the methods used for analysis.

3.2 Research Approaches

This section addresses the philosophical considerations of the research, the assumptions and aims of the research together with the approach adopted and the research questions to be addressed

3.2.1 Philosophical Position

Since my student days, I have identified with a social constructivist view of the world. However, having a strong mathematics and natural science interest, I have also identified with the more scientific approaches to research, and in terms of mathematics education became very influenced in the 1990s, by the work of Paul Ernest (for example, Ernest, 1991). As Ernest (1994) explains: *"Constructivism accounts for the individual idiosyncratic constructions of meaning"* (ibid. p. 2)

Careful consideration of one's philosophical position is necessary prior to embarking on doctoral level study and especially when selecting a particular research approach and strategy. This has caused me personally a number of challenges to my thinking.

I tend to view theoretical stances not in terms of polarised outcomes, but in terms of continua of perspectives with extremes at opposing ends. These include, a specifically absolutist versus relativist position, or a positivist versus interpretivist approach, objectivist versus subjectivist or a realist versus constructionist philosophy. In my experience, the first item in each pair tends to be associated with the natural sciences whilst the latter leads to methodologies more aligned with the social sciences

The background to my own position stems from a section in Ernest(1991), citing the work of Perry(1970) in which he outlines a possible sequence of stages of intellectual development, in terms of dualism, multiplicity, and relativism, the latter requiring context-dependent evaluation and justification. While Ernest admits that this 'theory' may well be falsified, I have always seen it as a useful way of framing debates about philosophical stances, since nothing in educational research is ever black and white, and for every theory they can be many counter-theories, the only way to know anything for sure is to look at how the research was carried out, in context.

Whilst this is perhaps an over-simplification it provides a starting point for me in regard to clarifying my position in so far as it can ever truly be determined or fixed. My personal position therefore, is one of contextualised pragmatism, which never sits comfortably at either end of any one continuum but rather shifts, dependent on the situation, sensitive to its features and constraints.

After looking for possible approaches in which to frame this study, and one which aligns with this thinking, I eventually alighted upon critical realism. One reason for this is that critical realism is not actually a theory or a methodology, but

> "a metatheoretical position: a reflexive philosophical stance concerned with providing a philosophically informed account of science and social science which can in turn inform our theoretical positions"
>
> (Archer, Decoteau, Gorski, Little, and Porpora, 2016, no page no.)

Critical Realism (CR) stems from the earlier work of philosophers such as Bhaskar (1978, 1979) and Archer (1982) and has seen increased popularity within both Science and the Social Sciences (Price and Martin, 2018). My research clearly falls within the Social Sciences as an exploration of a societal conceptual idea, namely *professional identity*, rather than a naturally occurring scientific phenomenon.

CR evolved as a response by social theorists and researchers to significant criticism in the 1970s and 1980s of the positivist era (O'Mahoney and Vincent, 2014). Archer, Decoteau, Gorski, Little, and Porpora (2016) acknowledge the difficulties of defining CR, clarifying that it cannot be encapsulated as a single philosophical position with a unique framework or methodology. The approach however is unified by:

> "… a commitment to formulating a properly post-positivist philosophy. This commitment is often cast in the terms of a normative agenda for science and social science*: ontological realism, epistemic relativism, judgemental rationality, and a cautious ethical naturalism."*
>
> (Archer et al., 2016, no page no.)

These four considerations are explored through reference to the work of CR advocates and considered in the context of my study.

Ontological Realism assumes a reality which - *"exists and operates independently of our knowledge of it";* **Epistemic Relativism** asserts that - *"knowledge is articulated from various standpoints";* **Judgmental Rationality** provides us with - *"criteria for judging which accounts of the world are better or worse"*, and **Cautious Ethical Naturalism** is an *"attempt to connect facts and values",* which are *"… not seen as isolated from one another"* (Archer et al., 2016, no page no.).

O'Mahoney and Vincent (2014) assert the importance of ontology and epistemology to CR researchers because, as they explain, researchers' beliefs have implications for their research practices, and that it is necessary to detach the descriptions of "truth", from beliefs about it. They further suggest that it is possible to arrive at such descriptions through, for example, their reconstruction via retroductive or abductive inferences

Two papers (Marks and O 'Mahoney, 2014; Sims-Schouten and Riley, 2014) discuss the use of critical realism to research identity, with the first of these papers providing ten principles, including addressing issues of causality, emergence and temporality. Causality is also addressed by Sims-Schouten and Riley (2014) pointing out that while critical realism cannot make claims of direct causal relationships, it provides analysis which provides the possibility of "sense-making" (ibid., p. 52)

While the work of Critical Realists, would normally concern eliciting grand themes and overarching theories of society, such as those described by Edwards, Vincent and O'Mahoney (2014), there is no reason in principle why these approaches cannot be adopted to small-scale studies, even down to the level of investigating the existence and nature of relationships at the level of individuals.

3.2.2 Assumptions underpinning the Research Methodology

The research is based on the following assumptions.

1. That there is an identifiable group of individuals called MTERs, and that "MTER identity" actually exists and can be described and studied.
2. That the Davey framework can provide a series of lenses through which it is possible to study MTER identity.

The fact that many authors of the papers have self-identified as MTERs, that MTER organisations exit, and personal experience asserts that Assumption (1) is valid. Assumption (2) is adopted tentatively and somewhat pragmatically purely as a means of studying (1).

In making these assumptions, I assume the ontological realism of MTER identity, and to take such a critical realist stance, I need to understand how this might manifest itself. If MTER identity exists at all, it exists as a conflation of different aspects of the mental states of individuals each of whom we would identify as MTERs, and probably more importantly, who would identify themselves as MTERs. Furthermore, as has become clear from the literature review, specifically the papers in the *100-set* which address *belonging*, there is a community of other MTERs with whom an individual can identify, and from which they derive aspects of identity and possibly to which they contribute in terms of views and collective understandings. This community is probably best regarded for now as a loose collection of individuals all of whom share a common professional interest in the mathematical education of teachers.

Within such a community, individuals will all be different, with different backgrounds and with different perspectives; therefore in order to study the phenomenon of MTER identity and gain knowledge about it, the methodology used must respect this fact. Most previous studies have taken the view that because of these differences, studying aspects of MTER professional identity are best studied using an interpretative methodology, seeking to understand specific aspects of identity through the eyes of the individual already in possession of that professional identity. 20 of the papers in the *100-set*, for example were self-studies.

However, it should also be recognised that the MTER professional identity comprises an entire set of behaviours, philosophies, methodologies, literature and

the set of human interactions of a group of people who either identify themselves as MTERs or as being someone who is part of a community of MTERs.

Studying MTER "identity" on a larger scale means that we must distil all those aspects of the MTER condition into a study of how different individuals might view themselves and others as MTERs. Such a study can only seek to examine the different mental states of different MTER individuals. However, if there is something more here than just a collection of disparate mental states in different individuals, then it is necessary to determine commonalities between those states, to find common perspectives, and to determine levels of agreements between individuals on such things as meanings, motivations and priorities – and while it may be that not all individuals completely agree, it may be possible to form consensus positions on some of the more important issues, especially those which seem to form the core of identity.

Assumption (2) adopts an epistemic realism stance, and seeks to provide a range of different perspectives to look at the MTER condition. There is no claim that the categories of *becoming*, *doing, knowing, being* and *belonging* are either mutually exclusive or exhaustive; indeed, it seems from the start that they are not. Rather than Davey's framework as a method of categorisation, it should be seen as a series of different perspectives on the entire notion of MTER professional identity, much as in architecture a series of plan and elevation views are used to describe a building. So, while it would be reasonable to expect, for example, that professional development would appear within multiple lenses, we might also expect to view it somewhat differently through the different lenses.

3.2.3 Research Questions

The following Research Questions (RQ) will therefore be addressed:

1. *What can we learn about the different aspects of MTER professional identity and the community of MTERs through each of Davey's five lenses?*
   - 1.1. *What types of individuals comprise the MTERs community? What are their backgrounds, and their qualifications?*
   - 1.2. *Examining MTER identity through each of Davey's five lenses: what are the commonalities, what are the stated positions, and what rationales do individuals provide for their views and behaviours?*
   - 1.3. *What associations are discernible between the different aspects of MTER identity? Do particular views or behaviours vary with time in role, qualifications held or by age-phase focus?*

2. *How useful is Davey's framework in trying to capture the notion of MTER identity?*
   - 2.1. *Does the framework encompass all aspects of MTER identity? If not what aspects have been omitted, and how can these be characterised?*
   - 2.2. *Does the framework actually achieve a resolution of identity into five distinct viewpoints? If not, could this be achieved by modifying the categories: augmenting them or conflating them?*

3. *In what ways can a study of MTER identity contribute to improving the education of teachers?*
   - 3.1. *Are MTERs recruited to the workforce as well-qualified individuals, with access to support and training opportunities?*
   - 3.2. *In what ways is the individual and collective professional development of MTERs helped or hindered by organisational constraints or National Policies?*

These questions are intended to be exploratory and not prescriptive. RQ1 is the main focus here: RQ2 and RQ3 are seen as subsidiary questions which will be answered through an examination of RQ1. The ontology of identity in RQ1, and the multiple lenses to study it are in line with the first two principles of Archer's (2016) principles of CR. Inclusion of RQ2 and RQ3 extends this to include Judgmental Rationality, being critical in the way that the framework is applied, not simply accepting that there are different perspectives, but questioning whether the views so yielded are appropriate, and whether the perspectives themselves are valid ways of examining the different aspects of identity. Finally, we will seek to determine whether or not particular aspects of MTER identity revealed are value-laden, or whether situations might be ameliorated or improved. This is in line with the fourth principle of Cautious Ethical Naturalism.

3.3 Research Design

3.3.1 Overview

As the Research Questions do not contain specific hypotheses, but each is intended to be exploratory, the basic overall design of the research comprised two complementary elements:

A. An **extensive questionnaire**, comprised mainly of Likert-scaled items eliciting agreement or otherwise with a series of statements, to be completed by as many MTERs as could be reached within the limited resources and timescale of the study.
B. A **series of semi-structured interviews**, designed to explore some of the issues highlighted from the literature and from the initial analysis of the questionnaire results, with the subjects of the interviews being drawn from a more focused sample pool, primary phase MTERs, than the questionnaire respondents. Again, the intention was to interview as many respondents as could be reached within available timescale and resource constraints.

Both the questionnaire and the semi-structured interviews are based on Davey's (2013) Framework. In essence, the questionnaire mainly addresses the multiple perspectives on professional identity within the MTER Community as a whole, while the interviews focus on the multiple perspectives of Individual MTERs. However, within the questionnaire were opportunities for individual MTERs to express views and elaborate on viewpoints, and many respondents used this extensively. The interviews also serve as a way of testing and possibly explaining any associations or hypotheses which emerge from the questionnaire results.

There were some tensions in designing the questionnaire and the interviews around Davey's framework given its quite extensive scope, and given the nature of my study as an exploratory. For example, it was unclear whether or not some areas should be given different significance or weighting.

I also found some conflict in my approach as although I perceive that quantitative data can yield results which are illuminating in an area which is strictly natural-science based, in terms of the social sciences my perception is that quantitative data is useful but limited in scope, and the very nature of questionnaires can create research artefacts. Nonetheless, as has been made clear in the Literature Review: there is very little quantitative data available relating to MTERs, and I thought it was a necessity to address this within my research.

I personally also see value in collating and analysing quantitative data, as this can provide not only clear numerical evidence, but also indicate where results are statistically significant; i.e. may be more than simply features of this particular data set. However, in a context such as MTER identity, my belief is that such data needs to be validated and possibly explained, through the analysis of qualitative data, which is more likely to enable understanding, rather than producing facts which without commentary may not in themselves be meaningful.

Whilst a Critical Realist approach often results in researchers adopting qualitative research methods, non-hermeneutic, quantitative data approaches are certainly not ruled out (Price and Martin, 2018; Archer et. al., 2016). In fact, Brown and Roberts (2014) discuss at length the arguments for or against the use of quantitative data methods such as those employed within his study under a critical realist approach. Quantitative data can provide correlations, and even at times, indicate causality, however such methods have been criticised, for example by Lawson (1997; 2003), claiming that the regularities elicited via statistical methods are only appropriate to "closed systems", rather than the "open systems" of social science. Brown and Roberts (2014) resolve this issue by framing these methods within a "dialectical approach" (p. 318). Following this argument, in this study, that dialectic will be created by statistical results from the survey being treated as "potential hypotheses" rather than firm conclusions, first to be understood within the context of a pre-existing model or framework, and then being challenged using data from the interviews. This utilises the critical realist methods of "abduction" and "retroduction" (O'Mahoney and Vincent, 2014, pp. 19-20).

The research design might best therefore be described as "mixed methods", comprising both quantitative and qualitative approaches. While the questionnaire is detailed and extensive, and forms a substantial part of the thesis having been circulated to almost 300 MTERs, the semi-structured interviews nonetheless play a crucial role, not only in providing checks and balances, but also in terms of explanatory function and enrichment. The research tools are each considered in turn below.

3.3.2 Reliability, Validity and Generalisability considerations

In any study, it is important to consider the reliability and validity, not just of the findings, but the methods which elicited the findings. Reliability and validity are the two main opposing tensions of research, and while related, they often create

conflicting demands. Taken in very broad terms, validity refers to *"… the integrity and application of the methods undertaken and the precision in which the findings accurately reflect the data*", while in contrast reliability ensures: "*…consistency within the employed analytical procedures*" (Noble and Smith, 2015, p.1).

There are many such definitions of reliability and validity, and most authors seem to suggest that notions of reliability and validity are primarily derived from quantitative studies, where they seem most applicable (Bryman, 2008). Indeed, some authors have questioned whether these terms apply equally to quantitative and qualitative research in the same manner, with some even questioning whether the concept of reliability is even applicable to qualitative research at all. For example, one author writes:

> "… the concepts of reliability and validity are viewed differently by qualitative researchers who strongly consider these concepts defined in quantitative terms as inadequate. In other words, these terms as defined in quantitative terms may not apply to the qualitative research paradigm."
>
> (Golafshani, 2003, p. 599).

As was indicated in the previous section, the rationale for using a "mixed methods" approach to this study arose from the concern to provide both checks and balances. It will be useful at this point to consider in some detail why such an approach is necessary, and why it might fulfil its purpose.

Campbell (1969), in a seminal paper, discusses these issues in terms of research validity, firstly by identifying nine threats to internal validity, where the design of the research is such that it yields results which may simply be artefacts of the research process, and therefore not valid representations of an underlying reality. In addition, he identifies six possible threats to external validity, where the results while being valid for the group or situation under study, may not be immediately generalizable to other contexts where we might think they should apply. Campbell was primarily discussing experimental or quasi-experimental design, so many of his

categories are not relevant here. However, several of the issues he raises also pose threats to both questionnaire and interview-type research, and so are worthy of consideration.

Of Campbell's categories, History, Maturation, Instability and Selection could all potentially affect the validity of conclusions: a respondent's personal history could be such that external factors, not taken into consideration by the questionnaire, could have affected their views making attribution and causality challenging. In a similar manner, natural changes to outlook might develop as respondents grow older, and with maturation bringing more life experiences, this could change opinions; these changes could be unrelated to identity or their professional development; again, attributing causality in such situations becomes more precarious. Additionally, the questions used or the topics raised, could lead to and instability in the responses, with questions meaning different things to different respondents. Finally, the sampling itself might introduce selection biases, so a view that is held by the majority will simply be a result of a selection process which results in an over-representativeness of respondents of a particular type.

Of Campbell's threats to generalisability, there are three that represent relevant potential challenges: Interaction effects, where simply being selected for the research itself, might cause respondents to respond (or think they need to respond) in specific ways which run counter to their usual attitudes; reactive effects, the act of participating in interviews and questionnaires might cause respondents to give responses that they would not normally give in other situations, and which would not necessarily be part of their usual mind-set – a kind of "Hawthorne effect", where specific opinions are "invented in the moment" simply as a response to being interrogated, and where the act of being studied produces results which would not exist, had the study not occurred. Finally, there is the irrelevant responsiveness of measures, which applied in this context would mean that the questions themselves, and the topics chosen are actually not at all relevant to the subject, and their

responses to them are simply created by the respondent for the purpose of answering the question.

While many of these points are relatively minor, and certainly none of these threats is fatal to the current study by itself, these nonetheless represent challenges which need to be borne in mind at different stages in the process: not just in laying out the methodology, but in undertaking the research itself, and in drawing conclusions from the data collected.

Many of the above issues primarily concern themselves with the quantitative aspects of this study. This is appropriate given that a substantial focus of the research is quantitative in nature. However, there are significant elements of qualitative material both within the questionnaire as well as the interview data, whose reliability and validity also needs to be considered.

In relation to these qualitative aspects, there has been a spectrum of advice given in the literature, ranging from the suggestion that in order to achieve rigour in qualitative research, "being thorough, careful and honest in carrying out the research" is sufficient. (Robson 2002, p. 176), to quite detailed schemes such as that proposed by Lincoln and Guba (1985), who lay out criteria such as credibility, neutrality, confirmability, consistency and transferability as the benchmarks for rigour and quality.

The entire structure of this current study is in fact, an attempt to address these concerns. In making the decision to use a questionnaire to elicit information on a large enough scale to attempt to understand something about how the community of MTERs view themselves and their identity, I was all too aware of the strengths and weaknesses of such an approach. Obtaining information via questionnaires can, in principle, provide strong statistical reliability, in that any repetition of the same

exercise will yield roughly similar results; however, this reliability may be bought at a validity cost, since because of the way that items are framed, the way a survey is carried out and the sample selected, the answers obtained may not be an accurate reflection of what respondents actually think. Furthermore, inherent sampling biases may skew findings, so that results are not generalizable in the way that such a method would suggest.

In combining this quantitative approach with more qualitative elements, that is the open-ended items in the questionnaire, and the semi-structured interviews, many of these issues can be directly addressed. For example, re-presenting participants with their responses to questionnaire items, together with an interpretation of this data, and allowing them to elaborate, is one aspect of the "credibility" criterion proposed by Lincoln and Guba (1985) above, normally referred to as "respondent validation" (Bryman, 2008). Correspondingly, the weaknesses inherent in taking a qualitative approach – that of external reliability, and generalisability from a relatively small number of cases (Bryman, 2008), and especially that of replicability are offset by the corresponding strengths of the questionnaire approach which seeks to determine consonances across a large sample. "Thick descriptions" (Geertz, 1973) elicited in the interviews can at this point also provide deeper levels of interpretation to illuminate such findings. This material would also satisfy Lincoln and Guba's (1985) criterion of *transferability*, i.e. the ability to judge whether any conclusions drawn from such data are generalizable to other contexts. LeCompte and Goetz (1982) suggest the criterion of *comparability* is also helpful in this regard, that is, providing sufficient detail about the sample or context so that a reader can judge for themselves whether conclusions apply to similar, comparable contexts. By adopting these approaches, this study therefore seeks to triangulate its data via contrasting and complementary methods, in an attempt to ensure that both reliability and validity are as high as possible.

The “mixed method” approach described in Section 3.3.1 above therefore consists of both quantitative and qualitative elements. In the questionnaire, the open-ended data is used to interrogate the validity of the item responses, and where applicable this qualitative data is categorised, collated and presented as statistical summaries, and directly compared with the data arising from the core items, in order to address reliability concerns. This, as noted in 3.3.1, using a critical realist stance, results in a series of hypotheses to be tested. In the Interview data, these hypotheses, and other issues arising from the questionnaire are explored more deeply, and responses coded and summarised where applicable, and cross-referenced against, and challenging the findings from the questionnaire. In this manner, results from both questionnaire and interview are systematically cross-referenced against one another for each of the five lenses in the Davey framework. In fact, the use of the Davey framework itself, can be seen as a central over-arching triangulation exercise – an attempt to view the same data through five separate lenses.

Triangulation is seen as one way in which validity can be enhanced via the use of multiple methods, in an attempt to cancel out any inherent bias in data sources, investigators and methods, by conjoining them with other data sources, investigators, and methods, with the goal of converging on a “truth” about some social phenomenon (Mathison, 1988). However, triangulation is not a panacea; as Mathison (1988) goes on to point out: triangulation can result in three different outcomes: convergence, inconsistency or even contradiction. Thus, the purpose of triangulation is not simply to validate, it is to provide another layer of data to aid understanding and possible clarification. As Mathison puts it:

> “The value of triangulation is not as a technological solution to a data collection and analysis problem, it is as a technique which provides more and better evidence from which researchers can construct meaningful propositions about the social world. The value of triangulation lies in providing evidence such that the researcher can construct explanations of the social phenomena from which they arise.”
>
> (Mathison, 1988, p. 13)

In a very real sense, triangulation is core to the critical realist stance that I have adopted. The critical realist methods of "abduction" and "retroduction" (O'Mahoney and Vincent, 2014, pp. 19-20) referred to in 3.3.1 above, very often require two different methods of examining the data, with each method having different validity and reliability concerns.

The qualitative and quantitative approaches to this study have been chosen specifically because they make different demands in terms of reliability and validity. However, in order for any study to have rigour, the reliability and validity concerns need to be examined against criteria, and any actual threats highlighted or addressed. The criteria used in this study to determine the threats posed in each context predominantly follows the schemes laid out in Bryman (2008, pp. 149-153 and pp.376-379). However wider sources have also been consulted, especially for statistical validity and reliability issues, and these become apparent in context.

For quantitative approaches, criteria such as *stability, internal reliability* and *inter-observer consistency* are used to address reliability, while validity concerns focus on face validity, *construct validity* and concurrent and convergent validity. For qualitative approaches, the criteria of *credibility, comparability* and *transferability* are used to address the external and internal validity, while criteria of *dependability* and *confirmability* are used to address issues of reliability. It can be readily seen that these latter criteria are mainly based on those proposed by Lincoln & Guba (1985) and LeCompte and Goetz (1982) above. A full list of the criteria, with descriptions and examples of how they are used, can be found in tables G1.1 (Quantitative Data) and G1.2 (Qualitative Data) in Appendix G1, where can also be found examples of how triangulation has been used in this study at different scales.

While the structure of the study, and many of its elements have been designed specifically in order to address potential issues of reliability and validity,

nonetheless, there are inevitably places in the study where such issues raise specific concerns. Where these occur they are flagged, and the possible consequences considered. Concerns about generalisability in this study will be primarily, though not entirely, dependent on the sample, and such concerns are explored in later sections which discuss the nature of the sample and its demographics, as well as the manner in which the data is elicited.

3.3.3 Developing the Questionnaire

A significant aim of the research was to secure the views of as large a number of participants as possible from a large group of Mathematics Teacher Educators and Researchers (MTERs) situated within the UK and further afield, in order to provide sufficient data which might act as a benchmark for future research, and provide a contextualised view of professional identity. In order to achieve this aim, the most obvious choice was to produce a questionnaire, focusing a substantial initial investment in developing an appropriate questionnaire instrument which MTERs could be invited to complete online.

The survey tool at Online Surveys, formerly known as Bristol Online Surveys (Jisc, 2019) is well-used by the university sector and trusted as an appropriate research tool (The University of Edinburgh, 2019; University of St. Andrews, 2019; University of Reading, 2019). It was therefore a straight-forward decision to use this tool for the purposes of constructing and managing an online questionnaire. The tools available enabled me as researcher to manage the interactions with a significant number of respondents; it also supported my questionnaire structure and provided some analytical tools. More importantly, it allowed the data to be exported for further, more intricate analysis.

In the early stages of development, I took the pragmatic decision to create my question bank in a word document and to conduct a preliminary trial with a paper-

based version of the questionnaire in the first instance. This worked well in practice and proved to be an effective strategy, as respondents were able to highlight, and annotate question wording. In preparing the paper versions, however, I needed to ensure that I was familiar with what the online tools permitted in terms of question and response structures, so that the finalised questions were suitable to use within the online system. This was clearly a crucial element of the process, which fortunately did not lead to any restrictions in regard to question design, as the options offered by the online tooled are quite varied, and I was able to use a range of different item types: Likert-scaled items, selections from lists, multiple choice items and open-ended text response items, as seemed appropriate.

For the core set of "attitudinal"-type response, I used a 5-point Likert scale, supported by a range of open-response categories, where respondents are provided with statement to which they signal agreement or disagreement. The rationale for this choice is set out in Section 3.6.1, where I discuss issues related to the validity and reliability of the questionnaire.

The second stage of trialling involved using the online tool to test out its manageability from a user perspective, and to pilot the finalised question wording. Below, I outline the process of developing the questionnaire in more detail.

3.3.3.1 Constructing the Questionnaire

In keeping with the nature of this research as an exploratory study, the questionnaire was designed to closely follow Davey's (2013) Framework for Investigating Professional Identity and divided accordingly into sections to reflect the five analytical lenses that she identifies. The questions were designed specifically to address the themes indicated within each of the lenses in her diagram illustrated in Appendix A1.

The Framework did not extend to a list of pre-prepared questions, or even a detailed agenda on which I could base my questions and statements; however, there was further rationale provided within each of the chapters of Davey's work, corresponding to each of the five lenses, and this combined with knowledge gained from my review of literature within the MTER field, enabled me to select material from which I could frame my questions and statements.

As noted in the literature review Section 2.1.5, Davey used the framework to support a dialogue with colleagues, exploring the various aspects of their professional identity. Davey's original participant group comprised eight secondary English and Drama teacher educators, two of whom had some primary experience in their backgrounds. Clearly, while the structure of the framework would be relevant to all Teacher-Educators, I needed to develop well-focused survey items that would be meaningful and relevant specifically to MTERs. I achieved this through an iterative process of searching the literature for relevant topics and phrases which seemed to match the intentions of the Framework, followed by reviewing the material several days later.

In describing and justifying her framework, Davey had provided extensive references to the general teacher-educator literature and this provided a good starting point. However, in addition to this, I drew on mathematics-specific studies from the 100-set, as well as other sources cited in the literature review, in order to focus and frame my mathematics-specific survey items.

What follows is a brief explanation of how some of the statements and questions, were derived from these sources.

3.3.3.2 The Becoming Section

As noted in Section 2.3, Davey (2013) breaks down the lens of *becoming* into areas such as professional biography, motivations, hopes, induction experiences, professional development and career plans. Within my systematic MTER literature review, I did not encounter specific references to motivations or aspirations relating to *becoming* an MTER, which might support the construction of statements. However, the literature that Davey consulted in regard to motives for becoming teacher educators appeared, because of generic references to discipline or subject, to be as equally applicable to an MTER group as it was to her participants (Reynolds, McCullough, Bendixen-Noe and Morrow, 1994; Acker, 1997). Despite this, it was important to me to ensure I included specific reference to mathematics given my focus. In practice, this meant creating statements to check, for example, whether motivation was related to: specialising in mathematics; combining mathematics with pedagogy; conducting research in the field; or, combining mathematics with an interest in pedagogy. I did however retain some reference to more generic motives such as: greater level of challenge; greater opportunity to influence the teaching profession; deliberate career planning; and, natural extension of role within school. Whilst I did not use the exact phraseology of Reynolds et al. (1994), there was sufficient similarity to maintain coherence with the Davey framework (Davey, 2013).

Items in the *becoming* section were also designed to investigate what activity had supported MTERs during their induction period. With no mathematics specific references to draw upon from the 100-set, I drew on the work of those key teacher educator authors who had influenced Davey (in particular, Murray and Male, 2005; Cochran-Smith, 2003; Zeichner, 2005). As indicated in Section 2.3 of the literature review, research into induction practices of TERs (not MTERs specifically) paints a rather negative picture of induction periods. I was keen to see at a basic level whether, as new MTERs, they had: been formally inducted; been able to observe, plan and work alongside other MTERs; and, whether they had had a particular role model. In discussion with colleagues prior to the trialling stage, it was clear that

differences were evident in regard to early support that had been available to them, so this appeared to be a useful starting point. As with most sections, I offered an open commentary box to elicit additional information from participants.

Also within the *becoming* section, there were items related to Davey's reference to hopes (aspirations), career plans and professional development. My intention here was to gain a picture of participants' plans specifically in relation to their MTER role, for example, whether or not they thought they could develop further in that role and also whether or not they perceived the role as being the major focus of their career, and how important professional development was to them. The statements were perceived to be useful in supporting the contextualisation of participants' responses. I decided to leave as open-ended two questions relating to what had been significant in their development as an MTER and whether or not there had been any factors impeding their development. This decision was taken in recognition that both are personal and could be quite varied in nature.

3.3.3.3 The Doing Section

The *doing* section of the questionnaire was aimed at identifying the key aspects of the MTERs' daily roles and was designed to address the areas identified by Davey including: job description; roles and responsibilities; professional activities; task scope; priorities and commitments. To begin with, I was keen to see the relevant significance of the MTER aspects of the role in relation to their wider role within the organisation. This was, in part, an acknowledgement of my awareness that roles appear to have become more varied in nature though, of course, the point of this data collection activity is to see whether the responses reflect this perception. The response to this question, "*Which of the following best describes your current role …?"* was intended to provide a picture of MTERs as a whole group but it also served to contextualised the responses of individuals. Of the four Likert scale statements in this section, the first two were constructed simply to capture the extent to which MTERs perceive that their job descriptions set out key responsibilities and

encapsulate the full extent of MTERs' activities. Davey (2013, pp. 79-81) specifically refers to the variety and complexity of roles and the picture she paints of the 'job accrual' of her participants, that is, the expanding nature of the role over time. This posed an interesting question prompting the third Likert item concerning the extent to which teacher educators feel in charge of setting their own agenda of priorities and commitments. The final Likert item in this set was intended to elicit the balance between a teaching and a research focus. It was not intended to suggest that these are the only two elements however.

From the MTER literature review, and from years of experience in role, it is clear that MTERs engage in a variety of activities. A simple checklist was included in this section. During the inputting into the system stage, I noticed that I had omitted "assessing academic work" from the list and, unfortunately, did not realise this error until the questionnaire had gone live. Amending the questionnaire at that stage would not have been appropriate. In her narrative concerning *doing,* Davey (2013) also refers to the 'service' aspect of the role; whilst this was certainly an area which was identified by MTERs (for example, pastoral activity), it was another item which I did not explicitly include in the checklist. The list could have become too huge so the option to add in any missing activity via an open response box was sensible.

3.3.3.4 The Knowing Section

The third section on *knowing* had the potential to become overly extensive given the MTER 100-set revealed there was much that could be explored here. I made a pragmatic decision to pull out detailed information regarding qualifications and experience to a different section, because I envisaged this being part of a separate demographics section. The statements focused instead on broad strokes to ascertain agreement to the necessity of specific knowledge areas (extensive knowledge of mathematics teaching and learning (**Chick and Beswick, 2018**); deeper understanding of mathematics subject knowledge than most teachers

(**Chauvot, 2008**); thorough understanding of pedagogical approaches (**Jansen, 2009; Chauvot, 2009)**); good understanding of how student teachers learn to teach (Tzur, 2001); detailed knowledge of school curriculum expectations (DfE, 2019)) rather than the detail of what each of these might mean in practice. This latter would not be practical within the constraints of a questionnaire covering all five lenses of Davey's framework (Davey, 2013) nor would covering even all the broad areas; I had to constantly remind myself that I had set out to undertake an exploratory study. I included an open response box and was not entirely surprised by one comment from an MTER indicating that it was not really possible to provide, as requested, 'in brief' what they might consider to be the essential knowledge, skills and expertise required. One particular statement which referred to there being "a single consistent view of how best to teach particular aspects of the subject" turned out in some instances to be construed differently to how I had intended it. This was something that I was followed up on with those participants who were interviewed and is explored in detail in Appendix E1.3.

3.3.3.5 The Being Section

The next section sought to explore Professional Identity through Davey's *being* lens. Davey refers to the professional personae and the perceived difficulties of separating personal and professional lives. The statements were derived through unpicking Davey's overview of *being* as "the personal in the professional" (ibid., p. 38) with her key prompts including personal qualities, emotional likes and dislikes, sources of pleasure and anxiety; self-image and self-imagery; values. I considered these in the light of the MTER 100-set, however, what I was determined not to do was to do was to prompt participants by referring to specific values or particular sources of anxiety. I was keen to hear their examples rather than provide any which might potentially elicit responses that may not have been wholly reflective of individuals' thinking. Instead, the statements seek agreement on whether the MTERs perceive some commonality in their professional personae, for example, being a particular kind of personality; possessing specific attributes and qualities;

having a clear philosophy; contributing to research; holding specific values. Statements were also designed to determine agreement levels in terms of satisfaction gained from and anxiety about the role.

3.3.3.6 The Belonging Section

The section relating to Davey's *belonging* aspect specifically concerned professional relationships; group affiliations and communities and engagement in dialogue, research or other activities with MTERs or other professionals. Statements were derived to provide an overview of MTERs' engagement with others in terms of the form and extent of engagement, and the perceived value.

3.3.3.7 Other items

As noted within the Literature Review, one aspect of identity appeared to be missing – the notion of *being valued*, the sense of self-worth that individuals might possess about themselves and about how they feel others might see them. This possibly related to *being*, but as this was not part of the framework, these items were put into the final section, and only asked to those who were University MTERs.

3.3.3.8 Piloting the Questionnaire

Pilot studies are discussed by Bryman (2008, pp. 247-8). In particular, he highlights the desirability of conducting pilot studies, suggesting that they not only enable checks on whether individual questions work as intended but are useful in examining the functionality of the questionnaire as a research tool overall. Initial Pilot Studies were carried out in two phases: a paper-based version; and, an online version.

The First Pilot Study

A paper version was first created with questions addressing each of the five lenses as outlined above, with approximately equal numbers of questions within each. Via informal interviews, two colleagues (one a current MTER and one a former MTER) agreed to work through the questionnaire independently and then to provide me with feedback on their interpretation of the questions, their composition, length, and their overall impressions. The main issues I was looking for were to do with readability, and clarity. However, a crucial methodological issue here was to address the individual content validity of each item, and the collective content validity of the lens as a whole. Two questions were therefore important: whether the question made sense to respondents who had neither read the framework nor the literature on identity, and whether, having understood the requirements of the Framework, whether they thought the question adequately addressed the requirements of that specific lens.

As a result of the feedback from this trialling, it became necessary to review the content and labelling of each category, so as to ensure that the headings more clearly encapsulated the range of items within it, and that the question wordings, and the questions themselves were more clearly aligned with the category labels, and therefore matched the expectations of those trialling the materials. The feedback obtained from my colleagues at this pilot stage, suggested revisions to the ordering and structuring of some of the questions. This included moving items from one part of the framework to another.

Other feedback at this point was to ensure that no statement contained two parts. One early version of a statement in the *becoming* (motivations) section, suffered from this issue. It read, "I wanted to develop my understanding of mathematics teaching and saw this as an opportunity to specialise." Aside from the second aspect of this statement not being particularly clear – specialise in what exactly? – it

could be the case that participants might agree with one part but not the other. This had been a poorly constructed statement in any case and was rectified. There was constructive feedback on another statement, "I felt constrained within the context of a single school." The suggestion was that this might potentially read as 'leading' and be perceived as a possible researcher belief or bias that schools are places where one might feel constrained. The statement had been derived having considered survey findings referred to by Reynolds et al. (1994, p.17), namely, "lack of opportunities for advancement within classroom teaching, frustration with the static nature of the profession and the practice of teaching, and dissatisfaction with one's public school colleagues", which as noted above, had influenced Davey's framework. However, given that it was absolutely not my intention to make such a suggestion, I amended it. The point made however highlighted more generally the potential tensions in creating questionnaire statements; whatever is ultimately constructed could be perceived as reflecting the researcher's preconceptions. Overall, the engagement with the questionnaire as a research tool was perceived very positively by my colleagues and further, the indications were very much that once revised the responses from participants would yield interesting and useful data which one could begin to consider and analyse MTER identity.

The revisions from trialling resulted in an imbalance in the number of questions in sections, and the number of sections within each of Davey's "lenses", for example, the *doing* section was shortened. The sections were also divided into subsections, so as to group together questions on different themes – for example *becoming* was split into "motivations" and "induction and aspirations". This was both an organisational solution and a focusing mechanism to orient the respondents.

The Second Pilot Study

The resultant set of questions were input into the online survey tool, and this online version was subjected to a second stage Pilot Study. This was done at a distance by

two other MTER colleagues, before the questionnaire was finalised and went live to participants.

This second stage of trialling was practical in nature and mainly undertaken to ensure no issues arose in the use of the online tool. This was an essential stage as it proved important to check that the flow through of the questionnaire worked for participants as they would be new to the system. The other very useful detail that my colleagues were able to help with was to confirm receipt of the planned automated emails from the system at the times anticipated. What I also did was to set myself up as a participant similarly to ensure I could see the correspondence from the system. It should be noted that the emails that are generated are ones that I had written but I was keen to confirm that they had been received as planned.

Only minor changes were made to the body of the questionnaire at this stage, and changes to wording were merely cosmetic or to ensure clarity on the page, or because of formatting issues.

3.3.4 Description of the Questionnaire

The final questionnaire consists of 23 sections, with a total of 85 possible responses. 12 of these were demographic-type items, designed to yield information about the respondents themselves; 60 were closed multi-choice Likert-scaled response options, together with 13 open-response items. There were 7 administrative items, mainly pre-completed and hidden from respondents.

In designing the questionnaire, there were a number of considerations. In almost all cases, a 5-point Likert scale was used to seek agreement or disagreement with a statement (Bryman, 2008, p.146). Allowed responses ranged from 'Strongly Disagree' to 'Strongly Agree' with an 'Unsure' option in the middle and was applied to questions for which the response required judgment, opinion or was attitudinal in nature. In other cases, closed questions were used which merely allowed exact

responses, e.g. yes/no or ticking the box to effectively confirm that a statement is true in their circumstances.

The final structure of the questionnaire is noted in the table overleaf, and the full set of questions are viewable in Appendix B1.

3.3.5 Structure of the Questionnaire

The questionnaire construction is given in Table 3.1. Also included were an introductory statement, a link to the Participant Information form with a consent box, which required to be checked before the participant could submit any responses. An opt-out of the survey button was also provided with an option to provide a reason offered.

Table 3.1: Overview of the Questionnaire Structure

Type of Question Questionnaire Section and Focus	**Single choice response from selection**	**Multiple choice response from selection**	**Likert-style (5 point scale)**	**Open-response items**
Introduction				
Questionnaire Section 1 Introduction, Participant Information and Consent	QS1			
BECOMING				
Questionnaire Section 2: Motivations for becoming an MTER			QS2.1, QS2.2, QS2.3, QS2.4, QS2.5, QS2.6, QS2.7, QS2.8	QS2a
Questionnaire Section 3: Induction, early experiences (support and challenges) of MTERs			QS3.1, QS3.2, QS3.3, QS3.4	Q3a
Questionnaire Section 4: Ongoing development as an MTER			QS4.1, QS4.2, QS4.3, QS4.4, QS4.5, QS4.6,	QS4a, QS4b
DOING				
Questionnaire Section 5: Description of current role	QS5			QS5a (Other)
Questionnaire Section 6: Roles and Responsibilities as an MTER			QS6.1, QS6.2, QS6.3, QS6.4	
Questionnaire Section 7: Activities included in MTER role		QS7		QS7a (Other)

KNOWING				
Questionnaire Section 8: Knowledge requirements of an MTER			QS8.1, QS8.2, QS8.3, QS8.4, QS8.5, QS8.6, QS8.7, QS8.8	QS8a
Questionnaire Section 9: Knowledge sources accessed by MTERs			QS9.1, QS9.2, QS9.3, QS9.4, QS9.5	QS9a
BEING				
Questionnaire Section 10 Attributes, qualities and values of an MTER			QS10.1, QS10.2, QS10.3, QS10.4	QS10a
Questionnaire Section 11: Personal Views on being an MTER			QS11.1, QS11.2, QS11.3, QS11.4, QS11.5, QS11.6	QS11a
BELONGING				
Questionnaire Section 12 Interaction with other MTERs, perceived status in community			QS12.1, QS12.2, QS12.3, QS12.4, QS12.5	QS12a
Questionnaire Section 13 Conference engagement & other collaborations			QS13.1, QS13.2, QS13.3, QS13.4, QS13.5, QS13.6	QS13a
BEING VALUED				
Questionnaire Section 15 (For those responding YES to QS14) Sense of being valued by others beyond MTER community **[Possibly links with BEING]**			QS15.1, QS15.2, QS15.3, QS15.4	QS15a
DEMOGRAPHICS				
Questionnaire Sections 14, 16-23 Demographics Part 2 (ALL) Includes: Name; Email address; place and country of work; Age-phase concerned with; years in MTER post; qualifications; Professional Associations and University-based or not	QS20	QS19 QS21, QS22.1, QS22.2, QS22.3, QS22.4 (qualifications-related)		QS16, QS17, QS18, QS18a QS21a (Other qualification) QS23

3.3.6 The Questionnaire Sample: Intended Participants

The intended participants in the questionnaire stage of the research were those working in universities in the field of mathematics education. This involves a potentially diverse group including those:

- MTERs teaching student teachers (PSTs) who are studying how to teach the subject of mathematics in early years, primary or secondary schools or FE colleges;
- MTERs engaging almost entirely in research into mathematics education at various levels (i.e., school level and/or university level).

The online survey tool allows for emails and reminders to be sent, in block mailings. A list of possible participant names and email addresses were taken from a BSRLM conference attendance list and supplemented significantly by undertaking a trawl of UK university websites in an attempt to identify MTERs, by examining tutor profiles and CVs in order to identify those with some responsibility for mathematics education.

In order to maximise the response rate, along with the BOS survey invites, I timed a personal email to arrive simultaneously. Following the ethical procedures, my student university email address was used for this correspondence rather than my normal university email address which relates to my place of work. This procedure was repeated for all follow-up emails, generating 6 in all. Other researchers have recommended 2 or 3 reminders at particular intervals as being the optimum number of times to make contact (Bryman, 2008).

Participants invited were mainly from the UK, but a number of people who had been visiting the UK at the time of the conferences, or who were associate or visiting professors, resulted in the sample list including a number of overseas MTERs as well as those working predominantly in the UK. There were no attempts to

restrict possible participants. The email invitation and the opening part of the survey made it clear that the survey was aimed specifically at Mathematics Teacher Educator-Researchers. Given the amount of time needed to invest in completing the questionnaire the presumption is that only those who are interested and committed, and who have something to contribute would bother completing it. From the responses, this turned out to be a valid assumption, since eventually 144 completed questionnaires resulted, all of whom seemed to have at least some connection to Mathematics Education or to Research in the field.

Given that the sample is not random, but in some sense is merely opportunistic with elements of self-selection, an important question to ask is how representative the sample is of MTERs, and of what population might the sample be representative, if at all. This question will be addressed in the demographics section in Chapter 4, Section 4.1, with the implication for this considered in Section 4.2.

3.3.7 Data arising from the Questionnaire

There are three types of data resulting from the questionnaire: Demographic data, Likert-Scaled data, and open-response items. Each of these needed to be treated differently.

The responses entered by participants into the BOS website questionnaire can be downloaded from the system in several ways. Both individual and the whole set of responses can be viewed in a pdf format. However, the analysis tools on the website are limited, and some of the ways that data is treated are not always easy to understand nor appropriate. In this study, the spreadsheet of raw data was downloaded for manipulation in Excel, and later in SPSS, and it is these formats which have been used most extensively in the analysis. Detailed checks were undertaken to ensure that the summary data produced in Excel and that produced by BOS agreed.

3.3.8 Semi-structured Interviews

The second phase of the research was to conduct a series of semi-structured interviews. The rationale for this next phase and for selecting a different method with a much more qualitative approach was several-fold:

- to seek to validate or challenge the questionnaire responses and hypotheses arising from the survey, i.e. would verbal responses marry with or contradict information obtained via the questionnaire;
- to obtain greater levels of explanation from participants in relation to key areas, and to provide richer, more extensive testimony than that allowed in a survey format;
- to generate other material related to MTER identity, not covered in the survey, and not necessarily part of the Davey Framework;
- to elicit testimony from a group of MTERs who had a specific age-phase focus, in order to provide a potential future basis for comparison with other groups, and as a possible benchmark against which to judge hypotheses from the survey relating to age-phase;
- to provide more evidence as to the usefulness or otherwise of the adoption of the Davey Framework to analyse Professional Identity.

3.3.9 Identification of Participants for the Interview Stage

For this phase, a specific sub-section of the original target group was identified. For this, I chose to target primary mathematics teacher educators and researchers (PMTERs). Here the rationale was partly through a specific interest arising from my professional background experience in primary mathematics, and for the pragmatic reasons of needing to target a well-defined subgroup who might be interesting and be able to illuminate issues arising from the initial quantitative analyses. The choice was also conditioned by a methodological issue which emerged after the initial analysis of the Demographic data in the survey, that of the validity of the "age-phase" construct.

I invited those PMTERs who had completed the questionnaire to participate in the next stage: to be interviewed either face-to-face where feasible, or, as it transpired in most cases, by skype video-link. In the event, 27 interviews were conducted.

As a basis for the interviews, a series of questions were devised, again within each of the five areas of Davey's framework but so designed as to enable interviewees to elaborate on questionnaire responses with the intention of ensuring they did not feel restricted in their responses. These questions were augmented with a series of prompts gained from analysis of the online questionnaires.

Three pilot interviews were conducted with colleagues with whom I work enabling me to make some relatively minor changes to the 'schedule' although what was important to note was that an iterative approach similar to Grounded Theory (Glaser and Strauss, 1967) was adopted during the subsequent interviews because I felt it valuable where new or particularly interesting ideas were raised that there would be an opportunity to explore more fully whether or not these ideas were novel or unique to individuals or in any way represented shared ideas and thoughts. In practice this meant that, where appropriate, a small number of common supplementary sub-questions were asked of the participants.

The greater than anticipated response rate for both the questionnaire and the interviews meant that the data sets actually obtained warranted significant attention and have provided considerably more than could reasonably be given due consideration within the constraints of an EdD thesis.

In consultation with my supervisor, and for the pragmatic reasons acknowledged here, the decision was taken to reduce the amount of analysis of the interview responses to address very specific points. Having fully appreciated the participants' valuable time given to be interviewed and having myself completed the interviews

and the transcripts, and through gaining a greater understanding from the analysis undertaken to date there is clearly more that can be reported through follow-up research papers which can be more directly shared with the MTER community.

3.3.10 Ethical Considerations

All members of the University community are required to abide by the University's Code of Research Conduct and Research Ethics (University of Nottingham, 2020); hence, compliance with the Code, and familiarity with related literature (British Educational Research Association [BERA], 2018), were essential aspects of the preparation for this piece of research. Prior to embarking on the empirical research for this study, thorough consideration of ethical matters was given. This was largely evidenced at the planning stage through engagement with the processes outlined and overseen by the University's Postgraduate Research Ethics Committee, resulting in approval being granted to undertake the proposed research.

At all times throughout the planning, conducting and reporting of the research, the core values of honesty, rigour, transparency and open communication, care and respect, and, accountability as outlined in the Code (University of Nottingham, 2020, p.6) were upheld and researcher responsibilities taken very seriously. As noted by the British Educational Research Association "ethical decision-making becomes an actively deliberative, ongoing and iterative process of assessing and reassessing the situation and issues as they arise" (British Educational Research Association [BERA], 2018, p.2).

A prominent undertaking for any researcher is that of data protection of the participant and their respective institutions, the latter being necessary in this study given that potentially sensitive information might be shared should participants contextualise their responses. Familiarity and compliance with the General Data Protection Regulation (GDPR) is a necessity (Information Commissioner's Office,

2020). In the case of this research project, several considerations and actions, as noted below, were taken in order to ensure GDPR compliance.

The principle of informed consent requires that participants *"... understand and agree to their participation, and the terms and practicalities of it, without any duress, prior to the research getting underway*" (British Educational Research Association [BERA], 2018, p. 9). It is clearly essential that in providing consent the participant must be clear about what it is they are agreeing to so matters of consent and transparency go hand in hand. The nature of the research, its aims and goals, the security and preservation of data, and issues in regard to the identification of respondents in final reporting were all communicated to respondents prior to their engagement with the research. Questionnaire and Interview Participant and Consent forms are provided for information in Appendices B2 and D2. In addition, I ensured that my identity and status both as a doctoral student of one University and as an employee of another, my background in mathematics teacher education, and my interest in the topic and the rationale for the research were also made explicit to participants. Participants were only able to progress to the online questionnaire completion once they had agreed they had provided their consent to participate.

As required by the examining University, my student email address was provided for communication. The intended purpose of the research was clarified via information sheets for participants both at the questionnaire and interview stages. Similarly, at both stages, participants were asked for their consent. In the case of the online questionnaire this was via a check box with the information sheet and participant consent form downloadable for future reference, if required. At the interview stage, participants signed a further consent form and either emailed or posted this back to me. It was made explicit that no data would be utilised without full and continuing consent of the participants and, at all stages, it was made clear that participants were free to withdraw from the research study at any point. The GDPR

specifically clarifies that consent should be genuine or free choice and result in no detriment to someone who withdraws consent (Information Commissioner's Office, 2020).

In my case, this was a consideration, which was given particular attention, specifically due to the potential for 'power-imbalance' between myself and colleagues with whom I was working, given my role at the time as Deputy Dean within the Faculty. Having generally very positive relationships with my colleagues, I did not perceive that their participation should necessarily cause any tensions but nonetheless, I was keen to ensure that it did not and therefore made every effort to ensure there was no perceived obligation on their parts to participate. Fortunately, I was not in the position of direct line manager for any of the participating colleagues so that was also a helpful starting position. Permission was sought from both the Executive Dean of Faculty (my line manager at the time) and the Head of the Department of Initial Teacher Education with the explicit agreement that should anyone choose not to participate, or to later withdraw from the research, that their wishes would be fully respected with no expectation of any reasons being required at any point.

Data gathered throughout the survey has been stored in a password protected folder on personally held equipment. Data on the original recording device is to be deleted and all data pertaining to the study will be permanently deleted once it is confirmed that it is acceptable to do so. Data entered into statistical systems for analysis, including both the SPSS statistical package and NVivo, the package used to support qualitative analysis was anonymised prior to the data entry stage. This meant, in particular, that no actual names were entered into these systems. Interview participants were given code names comprising letters and numbers prior to the inputting stage. Online Surveys, an online tool for creating surveys and run by Jisc and utilised extensively across the university sector was my tool of choice at the questionnaire stage (Jisc, 2019). Compliance with GDPR is taken seriously by

Jisc and explicitly considered on their website. Matters of anonymity and confidentiality are significant ones and need consideration at all points. In writing up the research findings every care has been taken to ensure that participants and their respective institutions are not identifiable. Where MTERs are particularly well-known within the sector, additional care was required to ensure that any contextualising information was meticulously considered so as to ensure their anonymity was maintained.

During research activity, a researcher should be aware of their particular responsibilities should a participant disclose a matter of concern. So, for example, should a participant disclose a matter which raises a safeguarding concern or a criminal offence including specifically a terror related matter then the researcher has a duty to follow appropriate procedures.

Researchers have a responsibility to stakeholders. I can confirm that no funding was received for this piece of work; in fact, this doctoral degree has been self-funded and time spent as largely been personal time: evenings, weekends and use of holiday entitlement. My place of work therefore would not explicitly count as a stakeholder other than being a beneficiary when staff obtain higher level qualifications.

An informed decision was taken to utilise the Davey framework as a methodological tool for this research and I can confirm also that I have no personal connection with Davey in a sense which means that I have any reason to promote Davey's work in order that someone might benefit from this action. I have been clear in the context of my work of the reasons for selecting this framework and also provide justification for the critical realism stance that I have adopted in analysing the results of the research. As a courtesy, I contacted Davey to explain that I had been impressed with the framework and my intended use of it as a means of organising my research. My responsibility to disseminate my research is discussed in Chapter 7.

3.4 Initial Overview of the Sample Demographics

In total 361 email invitations were sent out via the online survey system in spring 2018. Given the strategy described above, it was not unsurprising to receive 50 'undeliverable' messages in return. These and several others who were not currently MTERs were removed from the list; the remaining 297 email addresses appeared to represent a maximal collection of individuals who matched the survey parameters, viz., these were individuals who were involved either in the Mathematics Education of Teachers, or Research into that topic. While it is true that those who did respond clearly matched the survey parameters, given that there is no information on non-participants, I cannot definitively say whether this was due to the participants being targeted incorrectly, or whether they simply chose not to respond. A total of 144 questionnaires were completed which, out of the total 297 possible, gave an overall response rate of 48%. This is a comparable rate to the 44% of academics who responded to an online survey in 2001 (Bryman, 2008, p652).

By way of a further comparison, a similar empirical study undertaken in China by **Wu et al. (2017)** concerned a sample of 68 secondary MTERs; while Masingila's more extensive US-based study focused on MTERs in the primary/elementary phase (a Faculty member from 825 institutions participated in the study by providing information about the target group within their institution) (**Masingila et al., 2012**).

3.5 Approaches to Analysing the Data

Analysis of the data was undertaken as follows:

3.5.1 For the Questionnaire data:

(1) An initial examination of the demographics, including details of age-phase taught, length of time in career, qualifications, country of focus etc.

(2) A section-by section examination of the responses to each of the Likert-scaled items, together with the open-response items. These were examined in relation to both age-phase focus and career stage. Where appropriate, statistical tests were carried out to determine whether differences between subgroups were statistically significant.

(3) For the open response items, coding activity using a method of "emerging categories" arising naturally by working systematically through the MTERs' commentaries, classifying, collating and splitting as appropriate, using a constant comparison approach to produce "open coding" categories (Strauss and Corbin, 1990), using a set of principles derived from Bryman (2008, p.233). The methodology used can be found in Appendix E1.1.

(4) A full statistical analysis of the Likert-scaled items, looking for relationships in the data, and using Factor Analysis techniques to determine whether the correlations between items yield components which reflect the Davey (2013) Framework categories.

In this initial analysis, attempts were made to understand relationships appearing in the data, first of all by attempting to find underlying meaning within an explanatory schema, normally in terms of the literature or personal experience of working in the field. The relationships and the models themselves used to understand them, are treated cautiously, and it is these which are subjected to further scrutiny using the interview data.

3.5.2 For the Semi-structured Interview Data

Analysis of the qualitative data arising from the interviews involved the process of coding, but the methodology adopted here was different to that above, simply because of the nature of the data and its extent. The full process is described below.

The interview transcripts were uploaded into the NVivo system to support the coding activity. By this point in the study, the hypotheses (set out in Chapter 6) had already emerged from analysis of the questionnaire data; these were to be systematically investigated using the data held within NVivo. To explore these hypotheses, topic searches were carried out, revealing both data supporting the hypotheses as well as counter-case data. These were then used critically to examine each hypothesis in keeping with a critical realist approach.

The process of coding responses started with a careful reading of the transcripts, to determine the kinds of material which would be relevant to the topic under consideration, for example, *research* or *values*, formed two such areas of interest. The particular topic or theme was then sub-themed by an inductive process, that is, as related ideas were identified in the text (the interview transcripts in the NVivo system) they were noted and grouped into new emerging sub-categories of the main theme, again using “Grounded Theory” principles (Glaser and Strauss, 1967).

Where this resulted in a large number of sub-categories being formed, re-reading and further consideration took place. This process of internalising others’ thoughts, and seeking to find meaning, is by necessity a form of interpretation. However, when processes are applied methodically, that is: coding decisions are reviewed carefully and revisited; the process is repeated; and, categories are revised until the researcher is satisfied consistency of decision-making is reached, it is expected that the process could be followed by a second researcher with very similar results being

obtained. This is an attempt to meet the criteria of *dependability* and *inter-observer consistency* as noted in Section 3.3.2 above.

Furthermore, the degree to which there is interpretation of a participant's statements and phrases will clearly impact both on the reliability and the validity of any conclusions. Where the direct words of a participant are reported, as is done within sections of this study, any misinterpretations by the researcher of the participant's meaning is clearly more open for scrutiny by peers when the work is published. Within this study, I have provided examples of both utilising the exact words of participants to form a narrative around a particular idea, and also used coding to explore particular themes affecting MTERs in the hope of extracting deeper understandings. This is an attempt to meet the criteria of *transferability* and *confirmability* in section 3.3.2 above.

The process I followed in regard to coding the data was based on that of **Bleiler (2015, p.237**), who created her methodology by adapting the recommendations of Smith, Flowers and Larkin (2009). This was a four-stage method, including

(1) Reading and re-reading:

> *A holistic reading of the transcripts, and listening to audio files; marking the text to indicate initial observations and relevant comments.*

(2) Initial noting:

> *Highlight key words/phrases related to the theme; assign codes to sections/words/phrases of text which share commonalities.*

(3) Developing emergent themes:

> *Note emergent themes; devise category names and descriptions to encapsulate these themes. Continue reading, assigning sections, phrases and even words to the emerging themes. Use constant iteration to refine.*

(4) Searching for connections:

> *Look for how themes might be grouped into "super-themes", or themes split into "sub-themes". Search for connections across the emergent structures both within themes, and across themes.*

A more detailed version of this procedure is to be found in Fig E1.3 in Appendix E1.2.

Whilst all interview transcripts were contained in the NVivo system, and the system enables coding to take place in the manner described, I also found it helpful, in terms of supporting the thinking processes taking place whilst reading and re-reading themed material to create hand written notes and word documents containing the statements categorised into emerging themes. This was a purely personal choice rather than a limitation of NVivo. Paper-based versions were helpful in visualising statements and ideas, and allowed them to be grouped and regrouped; this proved to be more manageable than continuing to use the system. Although facilities in Nvivo such as the word clouds and tree maps were investigated, they did not fully support the type of analysis I needed on this occasion.

A fuller treatment of this synopsis is to be found in Appendix E1.2, where there is an extended account of the coding process, including a worked example in Section E1.2.2, showing how the four-stage process was applied to the topic of "*Values*", together with an example of how the material was used for respondent validation in the case of Survey item QS8.3 (Section E1.3).

3.6 The Potential Validity, Reliability and Generalizability of the Research

It is now useful at this point to consider the reliability and validity of the individual research methods involved, the design decisions made, and whether these can

allow triangulation in the manner intended, in order to achieve coherent results. That is, to examine whether the approaches are sufficiently independent as to allow the possible differences on viewpoints to converge on the same data, thus providing a more comprehensive understanding of each of Davey's aspects, and whether the possible deficiencies or weaknesses in one method can be compensated for by the strengths of the others. It is further necessary to enquire about the potential generalizability of findings. Bryman (2008, p. 611) suggests that such triangulation can be used as a way of "cross-checking" the data, as well as enhancing the study by using multiple ways of examining the same concept.

3.6.1 The Questionnaire: Its format and structure

The purpose of the questionnaire is to address a gap in the literature to fulfil three needs:

(1) To examine a large group of MTERs with diverse interests and experiences;

(2) To document who these people are, and to describe the group profiles - their qualifications and background;

(3) To explore their experiences and attitudes over the whole range of topics within the Davey framework.

A survey approach is the obvious choice to achieve the first aim; it obtains as broad a picture as possible of the community of MTERs, and the ideal would be to address MTERs wherever in the world they teach. Clearly, this is not possible, but at the outset, I did not wish to limit the set of respondents only to those working in the UK. This was for two reasons: firstly, I had hoped to be able to persuade sufficient colleagues from abroad to undertake the survey as to make a comparison of UK MTERs and those working elsewhere a viable prospect; and secondly, there are academics on academic exchange or visiting professorships in the UK, and many UK MTERs also work abroad. It was not feasible to tease out these individuals in

advance. I decided therefore to open up the questionnaire to as many MTERs as possible, simply to see who responded, and defer the decision as to whether any limitation was necessary until all the questionnaires had been completed. It is for this reason that I defer addressing issues of generalizability until after the demographics have been explored in Chapter 4, and after other issues to do with the nature of the data collection process have been made clear.

A questionnaire approach also achieves the second aim, as it allows for the collection of a wide range of demographic information from participants. Such an approach also allows the exploration of a range of attitudinal and factual data, and with a sufficiently large sample, this yields statistical summaries of each of the results, possibly with some indication of its statistical significance. This clearly enhances the *stability* and *internal reliability* of these elements of the study, and in those cases where we find almost complete unanimity, this would suggest that any similar study would replicate these findings – or at least would allow us to report the likelihood that results would be replicated.

The format provided by Online Surveys allows for a range of question types, including Likert scaling, multiple choice, options, yes/no answers and 'open-response' items. All of these types were used in the survey, but predominantly, Likert scaled questions were used to collect attitudinal-type data. The main rationale for this was ease of processing, and the fact that such questions tend to be used in many educational contexts, so that I could be assured that respondents were familiar with the format.

The questionnaire contains both Likert-scaled and open-response items, as it was anticipated that the responses provided in the Likert items would not be sufficiently detailed to allow a full understanding of why individuals chose to respond in a particular manner. Furthermore, as indicated by Bryman (2008), *inter-observer*

consistency on some items might be questionable: respondents might vary in the ways in which they interpret particular items. Therefore, while the responses to particular items might appear to yield reliable results which have statistical integrity (Jenkins and Taber, 1977), we may not be able to understand why people responded in particular ways, or whether their responses to the Likert-scaled items were a valid reflection of their position. This is why the open response items (and the later semi-structured interviews) are a necessary and vital part of the process. These give an opportunity to explore particular issues with respondents, and by means of *respondent validation*, it becomes possible to more deeply understand their questionnaire choices, as well as other issues arising from the study, meeting the criterion of *credibility*.

If many respondents reiterate their questionnaire choices, providing rationales for these, we can be assured that this is a valid reflection of their position, and by inference, we can accept the questionnaire results as likely valid for others who have not been interviewed. On the other hand, if respondents are seen to be addressing different issues than the ones intended in the Likert items, then this would call into question the validity of the response set for those particular items, and while the results might have statistical reliability, they may not accurately reflect the respondents' attitudes to particular issues, and therefore may not be valid. This issue is highlighted by O'Cathain and Thomas (2004), who suggest the use of open-response items as:

> "..an explicit strategy for generating quantifiable 'safety net' data, that is important issues missed by the closed questions, will encourage attention to non-response bias and reliability of coding".
>
> O'Cathain and Thomas (2004, p. 6)

In this research, there will be potential for all of these.

The semi-structured interviews also provide an opportunity for respondents and the researcher to move beyond the Davey framework, and to explore issues which might have been omitted in the literature so far. This addresses another reliability issue – that of *confirmability*, by deliberately moving on from an initial agenda-setting by the researcher in the questionnaire. This ensures that it is not just the pre-determined issues which are explored, but that any issues relevant to the group under study can be allowed to surface, and any conclusions validly reflect the group's concerns. This addresses Bryman's (2008, p.235) concern that closed Likert-style questions lack "spontaneity", and by forcing respondents into categories, this might exclude "interesting replies not covered by the fixed answers".

The number of items used in the Likert scaling was five. I chose this number for several reasons. Firstly, I needed a central "no opinion" position, simply because this was an exploratory study, and I had no good reason to force people into agreeing or disagreeing, especially on items which they may not even have seriously considered previously. This reduces the potential threats to validity.

Secondly, while it is true that each item was contained within a block of similar items focused on the same topic, my intention was neither to collate nor sum the Likert scalings, nor to use the actual values for reporting purposes: the charts in this study primarily report only on agreement, collapsing "agree" and "strongly agree" into one category, and reporting on the total percentage. The only time the actual values are used is in looking at the inter-item correlations, and the statistical tests. These are indicators of reliability.

Given these considerations, a Likert scale with a minimum of three points is required, and this might be seen as sufficient: Jenkins and Taber (1977) established, using a simulation study, that increasing the number of points in a Likert scale has little or no effect on reliability.

On this basis, a three-point Likert scale would seem reasonable in terms of reliability. However, research by Preston and Colman (2000) on the number of items in a Likert scale indicated that having fewer than five options resulted in poor validity; and that in scale construction, validity could be improved by having 7 or more options. As there was no attempt here to construct scales, I opted to use 5 items as the optimum number satisfying all the requirements.

A key issue that needs to be addressed is the validity – and hence the applicability and generalizability - of results arising from the use of a Likert scale. Given the fact that respondents are being asked to agree or disagree with a particular statement constructed in a particular manner, this forces respondents to address a particular issue, in a way which they may not have thought about, or at least considered in that way before this represents a threat to *construct validity*. Furthermore, the nature of the scaling itself, only allows for very broad levels of agreement or otherwise, with no nuanced alternatives. However, as Bryman (2008) points out, the opposite might be the case, and such questions might actually clarify the issues for many respondents.

In order to address any concerns that the Likert-scaled results may not accurately reflect the respondents' real opinions or positions, I felt it was crucial to include open response items to accompany each block of Likert scaled items. These offered an opportunity for respondents to clarify their position, to succinctly provide such nuanced alternatives, and in some cases to allow for detailed elaborations. In fact, as can be seen later, respondents used these items extensively to explain their positions – sometimes confirming the results of the Likert-scaled items, sometimes disagreeing with them. The drawback with open response items, however, is that while these can represent valid and often highly detailed responses from individuals, they raise issues which are untested. One person might mention a particular issue which is important to them; however, we have no idea whether this is an idiosyncratic view or is one which is shared widely across the community.

Given that we have only a few details about each of the respondents, this questions the *comparability* of such responses.

Thus the two approaches used – Likert-scaling, and open response, should be seen as complementary; the five point Likert scaling potentially provides a basis for results whose reliability can be established statistically, but whose validity may be open to question. On the other hand, the open-response items potentially provide for authentic individual responses with potentially higher levels of validity in representing the actual views of respondents, but where the generalisability is untested, and therefore the reliability of the material may not be secure. Where these two coincide to provide mutual support, we can be reasonably assured that the results are, in some measure, both valid and reliable. Where there is seen to be disagreement, this result needs to be flagged up, and any findings interpreted with caution.

One further issue with the questionnaire is its *content validity* in terms of the Davey framework. The items in the questionnaire were devised from the description in Davey (2013, pp. 38-39), and the questionnaire was trialled extensively twice before the final version was published to the respondents. As part of that trialling process, I conducted interviews with subjects who had completed the questionnaire, and part of that addressed the issues of whether, in their opinion, the Likert-scaled statements addressed the issues that they were intended to – first of all the particular "lens", and secondly, the individual aspect of that lens as described by Davey. In some cases, it was clear that respondents did not think that particular questions addressed the correct "lens", and as a result I moved questions from one category to another. With other questions, the choice of wording needed to be altered in order to make the statements more nearly reflect my original intentions.

While it is accurate to say that this clearly improved the *content validity* of each of the questions, as will become clear in Chapter 5, this did not solve the problem entirely, and there were some categories where respondents interpreted the questions in a way that I had not anticipated.

3.6.2 Semi-structured Interviews

Asking respondents to describe in their own words, their beliefs, attitudes and experiences will often result in a rich set of data, full of detail (Bryman, 2008, p 437). Whether this is a valid representation of their actual position will depend on several factors: the perceived relationship between interviewer and interviewee, the perceived status of the research and the expertise of the interviewer in asking questions and probing in order to uncover rationales and descriptions. In this research, I made every effort to ensure *confirmability*: that the interviewees did not feel pressured and allowed them time to express themselves. Most of the responses were descriptions of events, so there was little opportunity or incentive for anyone to dissemble, and where interviewees said things that some might view as uncomfortable or controversial, I ensured that the interviewees spoke with their own voice, with little prompting. In many cases what is reported is verbatim, so that the reader is able to audit the material, and judge for themselves whether the interpretation offered meets the criterion of *dependability*.

I would therefore argue that "what you see is what you get"; in other words, the data as cited in the passages is what the respondents actually said, in their own words, and validly represents their actual point of view. The issues only arise when we try to compare what one person says with what another said, and we try to categorise these statements and enumerate statements of similar type. Clearly such things are necessary, because unless this is done, we have no idea whether there is internal reliability – whether the views are commonly held, or whether this position is unique to this person.

The methods adopted in comparing and collating responses from different individuals, attempt to remain as closely connected to the data as possible. Categories are not imposed beforehand, but arise from the data itself, using words and phrases elicited from the responses. Inevitably, when categories are split or merged, in order to make the categories manageable, decisions will be made based on the researcher's own understandings, and a different researcher might have characterised these somewhat differently. Clearly that calls into question whether in collating the data, we lose out on its richness, and its validity. Therefore, in going through this process, it must be recognised that there are tensions between validity and reliability.

To address these tensions, in the presentation of the data in Chapter 6, I have tried wherever possible, to provide not just a numerical summary of categories, but also comparisons of the kinds of statements made by respondents within those categories. In that way, the reader can *audit* the statements, and thus assess the reliability of any inferences made, as well as being able to see exactly what interviewees actually said as a valid presentation of their experiences and views.

3.6.3 Triangulation

I have attempted to triangulate both within the Questionnaire data, and within the Interview data, in order to balance the potentially competing demands of reliability and validity. This triangulation is done, not just at the overarching level of the study- where the two distinct methods – survey and interviews – are used to elicit and compare responses, but at the level of individual findings, where a result from a Likert-scaled item, will seek clarification from open-responses, and at an even deeper level, where even within the statistical testing, multiple methods are used to determine whether results are significant; addressing potential threats to the validity of one method by employing methods which are designed to address such threats.

The main aim in pursuing two distinct research methods is that these methods should complement one another. First of all, they should compensate for any possible methodological shortcomings: questionnaires are typically higher on statistical reliability, lower on construct validity, whereas interviews are lower on reliability, or at least its correlate, replicability, but potentially higher on validity, providing an authentic voice. Secondly, the focus of each approach would be slightly different but also complementary: the questionnaire focused on the MTER community as a whole, while the interviews focused on individual experiences. What brings the whole together is the use of the Davey framework, in that both approaches can be used to look through each lens. If we are seeing the same sorts of phenomena through each lens, and via both methods, then we can be assured that we have met the challenges both of reliability and validity.

One issue however, which must be noted at the outset: while what I have said in the above paragraph, is, on the face of it, accurate, the restricted sample of primary MTERS used for the interviews would mean that any results for the whole sample is potentially of limited generalisability – that of primary MTERs working in the UK. While it is technically true, that the methods used would only *guarantee* generalisability to this small core group, there are other considerations which will become clear during the course of this study, which mean that the results are potentially generalizable far more widely. This issue will be addressed later on in Section 4.8.

Chapter 4: Presentation and Initial Analysis of Results

Chapter 4 comprises two parts: an initial presentation of results from the survey, concerning the demographics of the sample, together with some preliminary analysis required for the more detailed treatment in Chapter 5.

Details of the response rate

In total 361 email invitations were sent via the online survey system in spring 2018. Given the necessities of using a combination of a 2017 conference delegates list, and university websites, it was to receive 50 'undeliverable' messages. There were various reasons: addresses incorrectly transcribed onto the delegate list or recipients no longer employed at the institution. A further 14 email addresses received replies, either from the person or the organisation, but were removed from the list for a variety of reasons – for example, they were on leave, had moved, or were duplicate emails.

The remaining 297 email addresses represented a maximal collection of individuals who matched the survey parameters, viz., individuals involved either in the Mathematics Education of Teachers, or Research into that topic. The survey responses in Chapter 5, and the data below largely appear to confirm this, with a total of 144 questionnaires being completed, giving an overall response rate of 48%. However, given that the reasons for non-responses are unknown, the claim that the 297 emails all targeted MTERs should be treated as merely plausible rather than definitive.

Demographic Description of the sample

An aim of this research is to provide an overview of MTER identity through each of Davey's five lenses: *becoming, doing, knowing, being* and *belonging*. To do this, it is important to provide sufficient detail of the sample to enable the reader to

understand its demographic basis, and to be aware of any potential sampling biases, so that such effects, where they exist, might caution any conclusions. The detail will also allow judgments to be made about the *comparability* of the survey group to other groups of MTERs to determine the validity of any generalisations made.

Information was collected on each of five different demographic variables:

(1) Country in which the MTER was currently teaching or researching;
(2) Whether they were located in a university or not;
(3) The age phase(s) of schooling that were the main focus of the work;
(4) The length of time they had been an MTER;
(5) Their current qualifications.

The analysis below takes each of these in turn, and considers the overall profile, first of all to determine whether any of the categories within each demographic might be over- or under-represented in the sample, and where possible, compares this to data in the literature. Also examined are possible interaction effects in the sample, for example between two demographic variables, where one category is significantly over- or under-represented as a subcategory of another variable. An example of one such an effect is highlighted in 4.2 below.

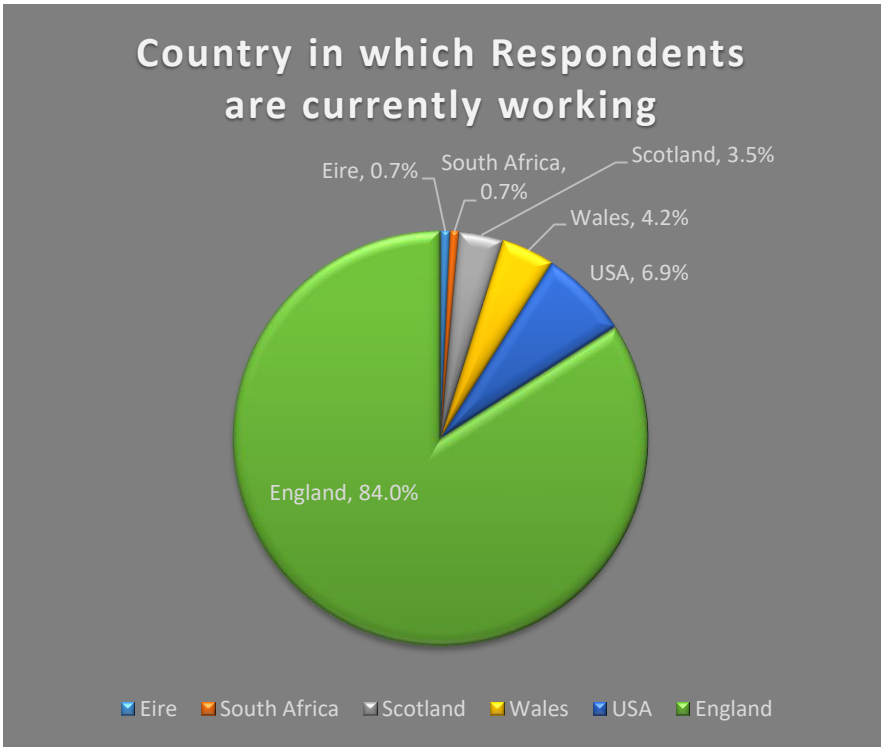
4.1. Country in which the respondents taught

Of the 144 respondents who completed the survey, 132 respondents (91.7%) were based in the UK, with the overwhelming majority (121 respondents = 84.0%) working in England. The majority of the rest (10 respondents = 6.9%) worked in the USA, with one other from Eire and the other from South Africa, but holding a professorship at an English University.

Chart 4.1 illustrates this sampling base, and clearly has implications for any conclusions that can be drawn from this data, as any findings will be heavily skewed towards the experiences of MTERs working in England, and the fact that almost half

the outside-of-England MTERs are based in the USA. While it can be argued that with such a bias towards MTERs in England, it might be better to simply remove the non-England-based respondents from the sample, and concentrate on presenting results which might apply only to MTERs in England, that would mean discounting the responses from 23 MTERs, some of whom spent a great deal of effort in completing the questionnaires. I have therefore decided to leave the questionnaires as a complete set, but be aware that any conclusions may only apply to England, and if there are differences, to point these out. In fact the non-England-based MTER responses potentially actually act as an independent check on the generalisability of findings, which would not be possible if they were simply removed from the analysis.

Chart 4.1 The Countries Represented in the Sample

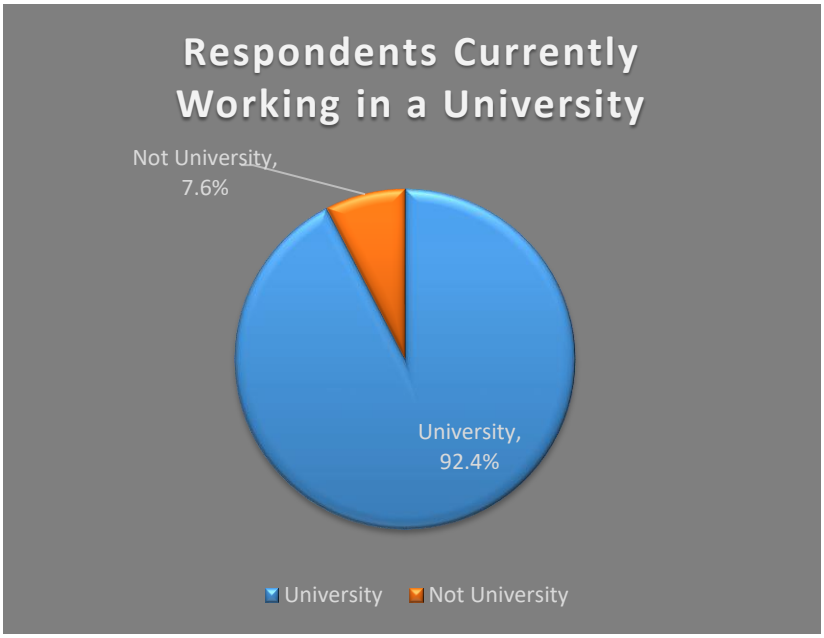


4.2. Association with Universities.

Chart 4.2 shows the majority of respondents (133 = 92.4%) were based in a University at the time of the survey with the other 11 (7.6%) being variously employed by schools or SCITTs (3), FE colleges (1), local authority (1) involved in

research or completing doctorates (2), in mathematics rather than an ITE university department (1), freelance (1) or retired (2).

Chart 4.2 The percentage of MTERs employed within a University



This aspect of the data yields an example of one interaction effect. Table 4.3 below shows the breakdown of those employed by a University or not, broken down by country.

Table 4.3: Breakdown of those working in University by Country.

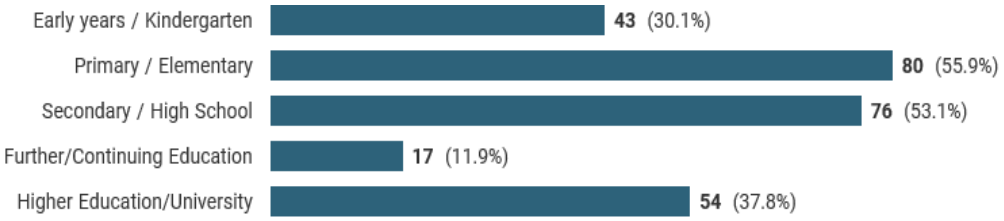
	University	Non-University	TOTAL
England	110	11	**121**
Wales	6	0	**6**
Scotland	5	0	**5**
Eire	1	0	**1**
United States	10	0	**10**
South Africa	1	0	**1**
TOTAL	**133**	**11**	**144**

All of the non-university respondents were from England. This would have implications for any conclusions that might be drawn as to differences between MTERs working in a University versus those who are not. Such conclusions could therefore only apply to English MTERs. In addition, the number of non-university respondents was small, and included people who are retired but were working in a university in the past, so using any conclusions using this as a criterion would be problematic. Given all these constraints, neither of these demographic criteria will be used systematically in any further analysis.

4.3: MTERs' age-phase/schooling focus

Chart 4.4 presents the breakdown of the MTER's declared age-phase focus with which their roles were associated.

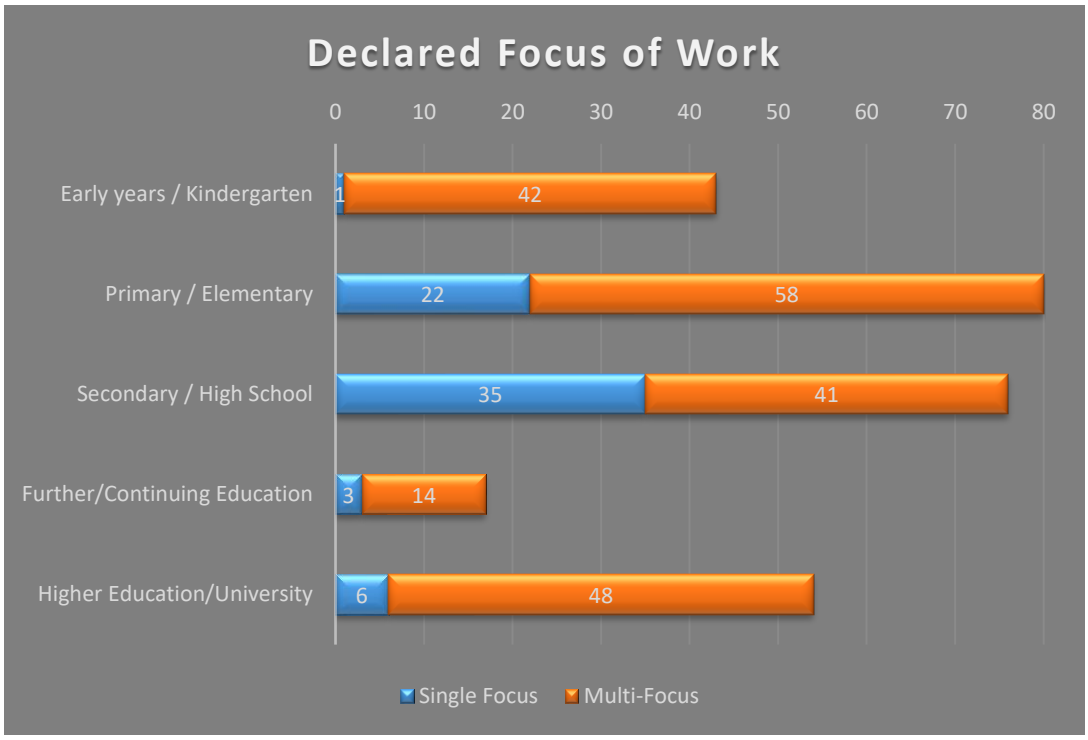
Chart 4.4: The age-phase focus of MTERs



Immediately apparent, is that percentages do not sum to 100%. The nature of the query allowed respondents to select multiple categories (age-phase foci) as appropriate to their roles, reflecting what my experience indicated was the case. In fact, out of the 43 respondents with an Early Years focus, 42 (29.2% of the sample) also declared that they were associated with the Primary Phase, and also contributing to that total of 80, which is 55.9% of the sample of 144.

Some MTERs did declare a single, rather than a multiple focus. These are shown in Chart 4.5.

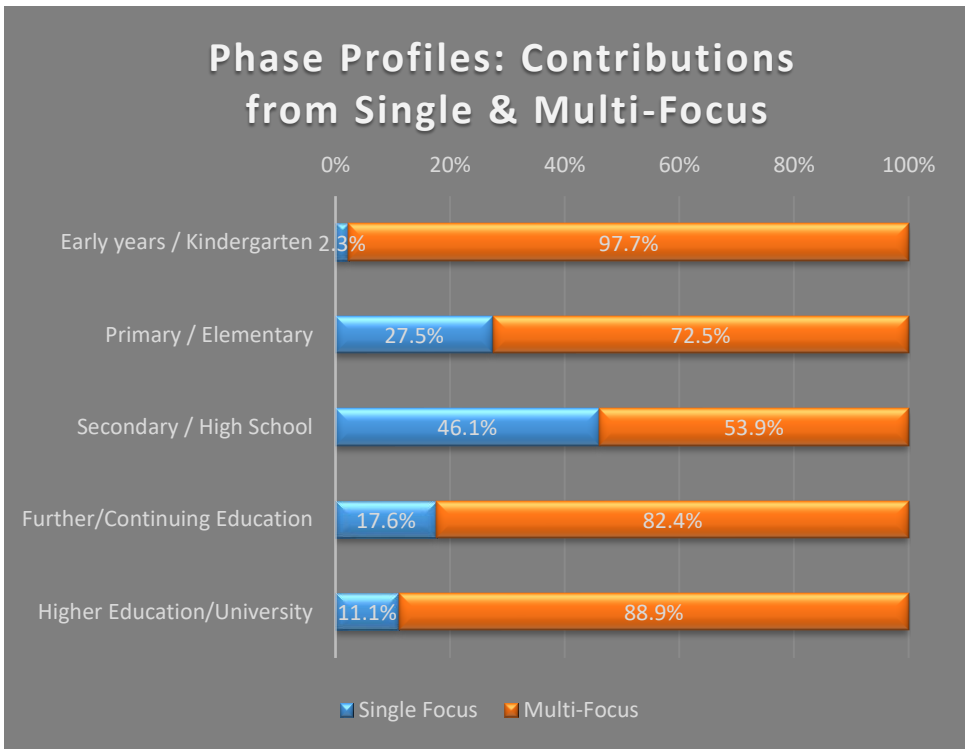
Chart 4.5: Number of MTERs by Phase Focus: Single and Multiple Focus MTERs



An obvious feature of this data is that in every category, there are more "multiple focus" MTERs contributing to the overall total, than there are "single focus" MTERs.

Chart 4.6 highlights this issue further.

Chart 4.6: Phase Profiles: Relative Contributions: Single and Multiple Focus



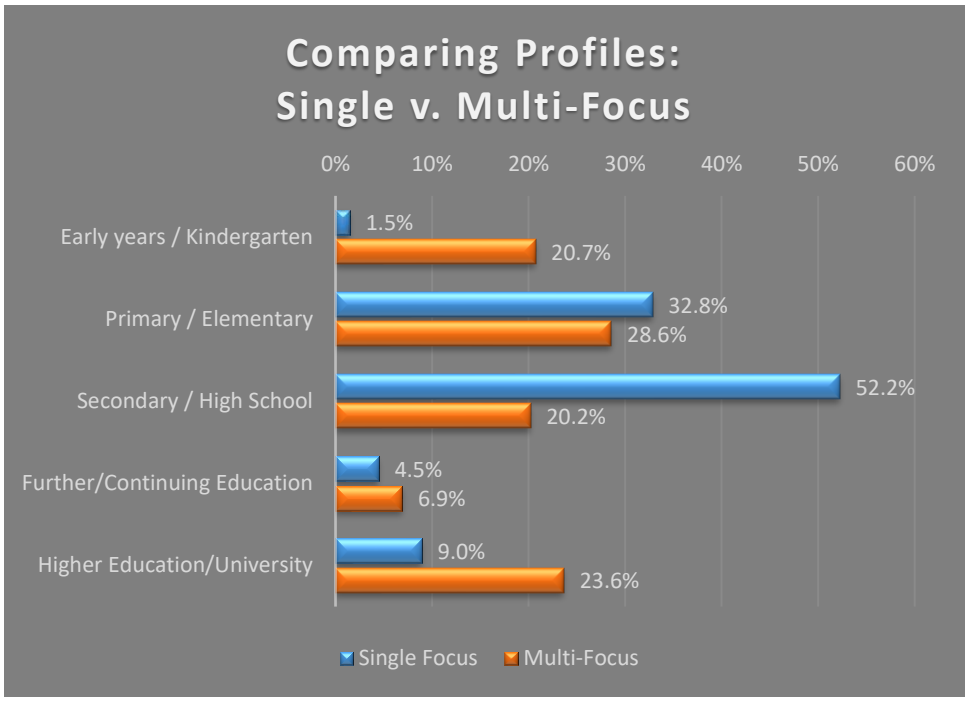
The chart compares the declared foci of the 67 respondents who declared a single focus, with that of the 77 respondents who declared in multiple categories. The bars for each phase show the relative contributions from those with a single focus (blue) and those with a multiple focus (orange). So, for example of the 54 who declared a Higher Education (HE) focus, only 6 (11.1% of 54) focused solely on HE, whereas 48 (88.9% of 54) declared foci in other categories also.

The majority of responses in every category are from those with multiple foci, some almost entirely so. It is therefore crucial to bear in mind that when these categories are used for analysis, this does not imply that the responses are from individuals who have spent their careers solely working in that age-phase, but is more likely to be a "collective view" of those who are involved in this age-phase as part of their everyday work. This is particularly true of the Early Years and HE foci.

On examining the responses in detail, it also seems that the "Higher Education/University" has been used somewhat indiscriminately by some respondents, since a core of the respondents in each category also included "Higher Education/University" as a focus – 37% of Early Years, 57% of Primary , 56% of Secondary and 22% of FE. Given that 92.4% of the sample are university-based, it may simply be that the HE category was included by some respondents to reflect their situation as university tutors, rather than implying they actually had a focus on university-level mathematics teaching.

Chart 4.7 examines the extent to which the overall distribution across the phases is the same for single versus multi-focus MTERs, via a category by category percentage comparison.

Chart 4.7: Comparing Profiles across Phases: Single versus Multi-focus MTERs



For example, in the Primary phase, the blue bar represents the 32.8% (22 out of the 67) of responses with "single focus" as Primary The equivalent orange bar represents the 28.6% (58 out of the 203) of responses who has a "multiple focus". Note that the single and the multiple foci figures each sum to 100%.

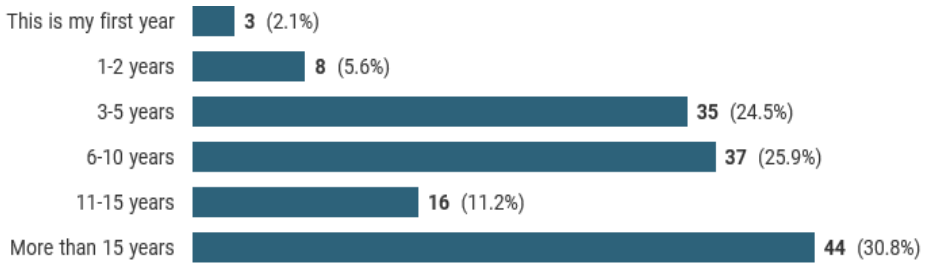
As has been noted, the majority of responses in each phase will be from multiple foci MTERs. If these profiles were similar, it may not matter. However, Chart 4.7 immediately highlights specific issues. There is clearly a substantial over-representation of multiple focus MTERs in the Early Years, and an under-representation in Primary and Secondary. There is also over-representation in HE.

The result of this analysis is that I should exercise caution when using "Age Phase" as an independent variable comparing the experience, opinions or the qualifications of those in one age–focus with another. In particular, I am going to ignore the "HE" focus altogether for the reasons given, and view results using the "Early years" focus as tentative.

4.4: MTERs' time (in years) working in Teacher Education

Chart 4.8 below summarises the lengths of time that the 143 who provided responses have been an MTER.

Chart 4.8 The MTERs' time (in years) involved in Teacher Education

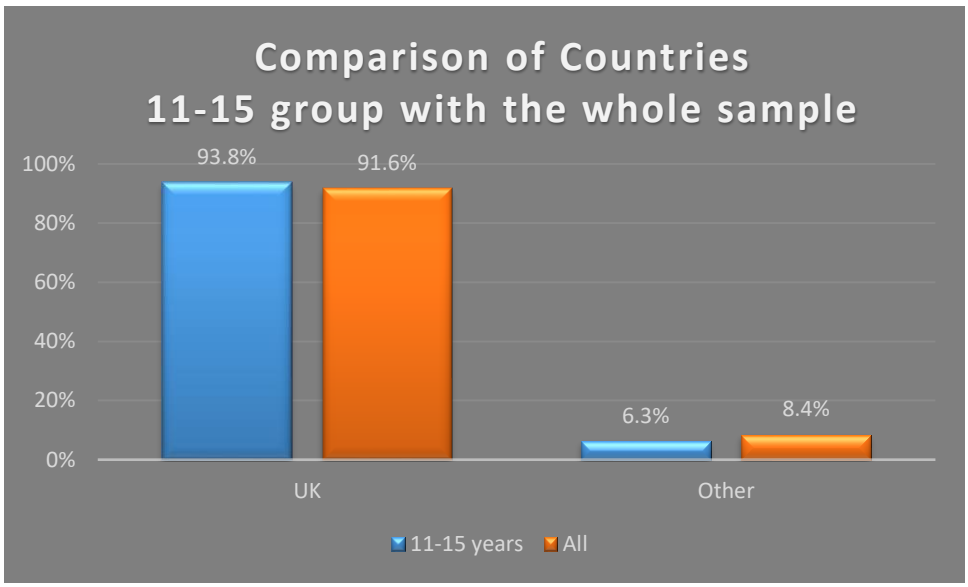


There are imbalances in the numbers in each category, but there are good reasons why this might be so. For example, it might reasonably be expected that in any random sample there might be more in the 15+ category than any others given the open-ended timeframe, and there might also be low numbers in the first three categories, since they only represent one or two years as opposed to five. Totalling the numbers for the first five years gives 46 MTERs, not all that different from 37 in the 6-10 years, and the 44 in the 15+ years categories.

However, there does not seem to be any particular reason why the number of MTERs in the 11-15 category would be less than half those in other categories. While this seems to be an anomaly, it may not impinge on the analysis if the characteristics of the 11-15 group resemble the other groups with respect to the other demographics.

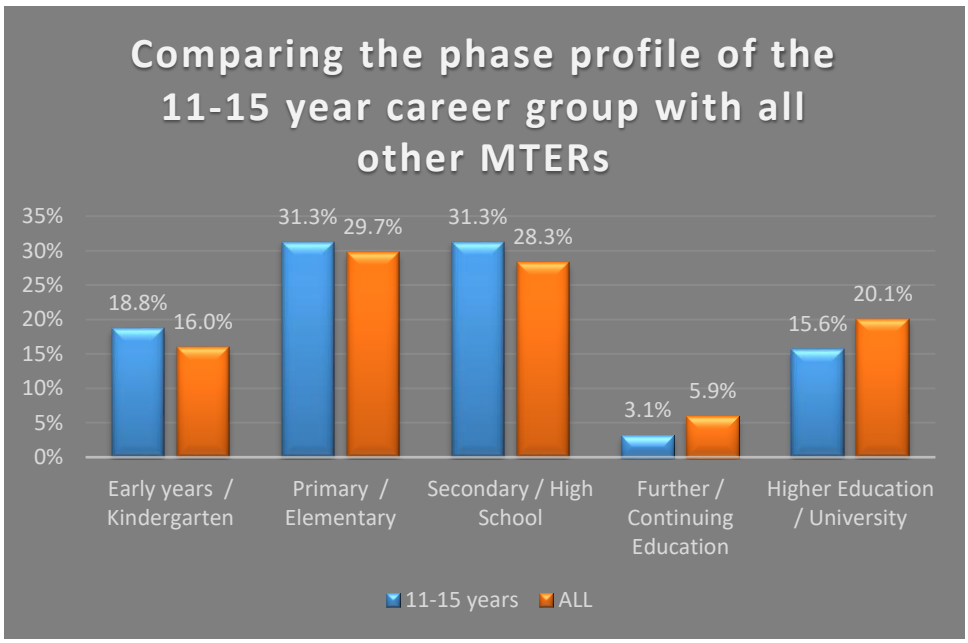
Chart 4.9 shows that the locations in which MTER respondents in the 11-16 year career stage work are very similar if we divide the data into UK and non-UK locations.

Chart 4.9: Location of MTERS; comparing the 11-15 year group and the whole sample.



Similarly, Chart 4.10 shows the percentage distributions across each phase are roughly similar for the 11-15 group as the whole sample, possibly there being a slight under-emphasis on FE and HE, and an over-emphasis on the first three phases. However, this is marginal at worst.

Chart 4.10 Comparison between the phases taught by the 11-15 year career group and all MTERs.



On this basis, there seem to be relatively few issues with using the age-profile as an independent variable to compare groups of MTERs at different stages of their careers.

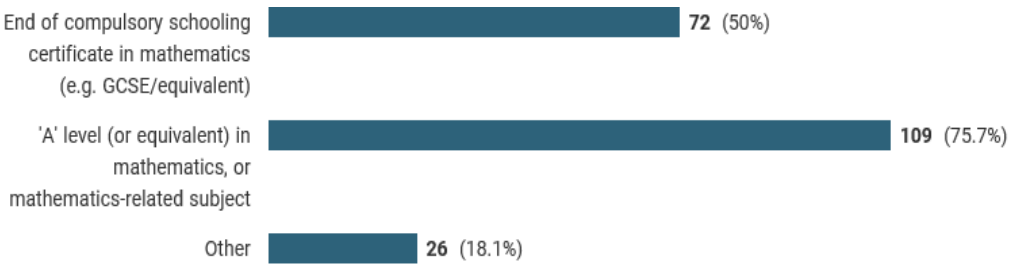
4.5: Mathematics Qualifications

Respondents were asked to identify their mathematical qualifications at pre-university level, and then to clarify whether the content of qualifications obtained in Higher Education were mathematics or mathematics education-based or neither.

4.5.1 Pre-University Qualifications

Chart 4.11 summarises the pre-university qualifications obtained by the MTERs in the sample.

Chart 4.11: What pre-university mathematics qualifications have you gained?



Respondents were able select multiple categories, so the total is greater than 100%. As a result of this, the data needs to be examined more closely.

Respondents seem to have interpreted the question somewhat differently than intended, and maybe even differently from one another. The low numbers of MTERs reporting a GCSE in mathematics is clearly unrealistic, given the fact that a GCSE in Mathematics (or its equivalent) is a necessary criterion to enter Initial Teacher Education at least in England. (UCAS, 2019b)

From reading the explanations given in the open response item here, it appears that some respondents misunderstood the question. My intention had been to capture all qualifications. However, one respondent who did not select "GCSE" wrote:

"I completed Open University courses in mathematics in later life having achieved a GCSE in mathematics."

It seems likely therefore that some respondents interpreted this category as meaning "highest school qualification", and assumed that A-Level or their degree supplants GCSE, whereas others have included both GCSE and A-level as was intended.

Despite these issues, around three-quarters of the sample reported that they had obtained an A-level in Mathematics, or a mathematics-related subject. Given the discussion above, this may be an under-estimate of the true figure; therefore, it can be said that *at least* 75.7% of the MTERs in the sample have obtained an A-level in mathematics, or a mathematics-related subject.

This result is interesting in its own right, since A-level mathematics is taken by around 10-15% of each 'A'-level cohort per year. In 2015, the UK figures were 14.7%, (Ofsted, 2015), an increase from previous years from around 10% in 2001 (DfE, 2013).

The fact that at least three-quarters of the sample have A-level, strongly suggests that people who eventually become MTERs have a lifelong affinity to the subject, going back to their schooldays, rather than it being something which they aspire to later in their careers.

It is worth, at this point examining the extent to which these overall figures are replicated across each age-phase focus. Table 4.12 shows this data.

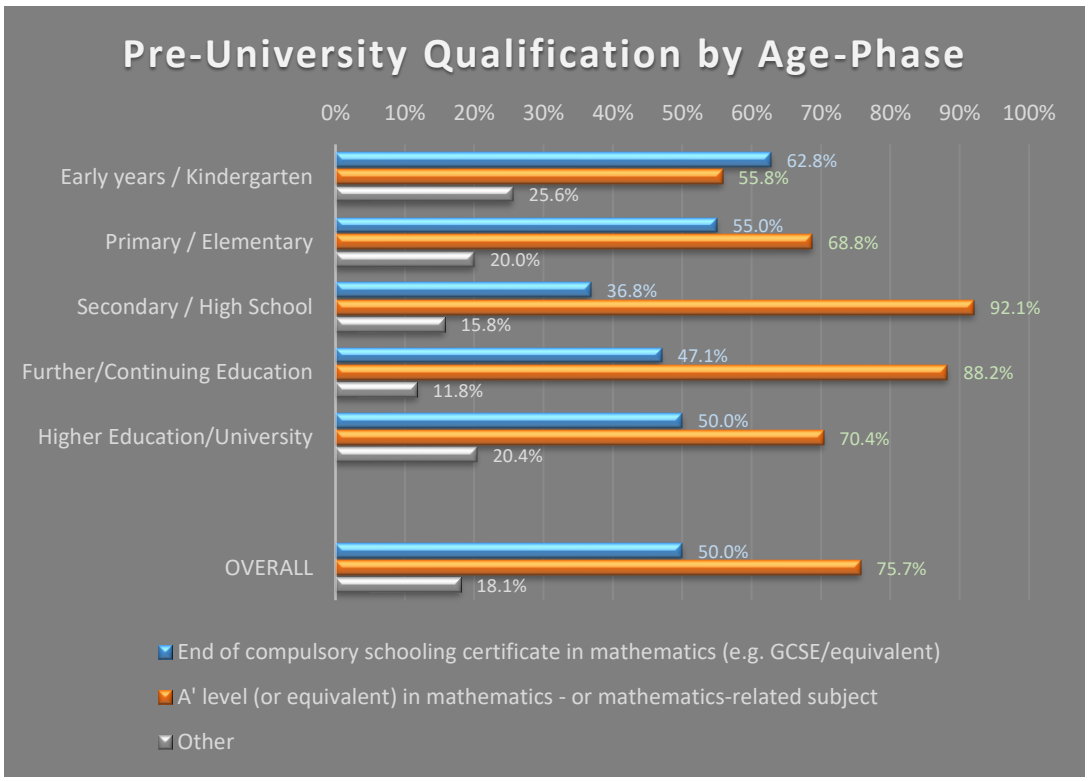
Table 4.12 Pre-University Qualifications gained against age-phase focus of MTERs (raw numbers)

Which phases of mathematics education/schooling are you concerned with? (Check all that apply to your role)	What pre-university mathematics qualifications have you gained? Please choose all that apply:			No answer	Totals
	End of compulsory schooling certificate in mathematics (e.g. GCSE/equivalent)	'A' level (or equivalent) in mathematics, or mathematics-related subject	Other		
Early years / Kindergarten	27	24	11	0	62
Primary / Elementary	44	55	16	0	115
Secondary / High School	28	70	12	0	110
Further/Continuing Education	8	15	2	0	25
Higher Education/University	27	38	11	0	76
No answer	1	0	0	0	1
Totals	**135**	**202**	**52**	**0**	**389**

It must be noted that in this table generated automatically by BOS**,** *both* the age-phase and the pre-university qualifications allowed multiple choices by the respondents, hence the totals are the total number of responses in each category, rather than the total number of respondents (144). While it is useful to see the actual numbers involved, this data needs to be contextualised.

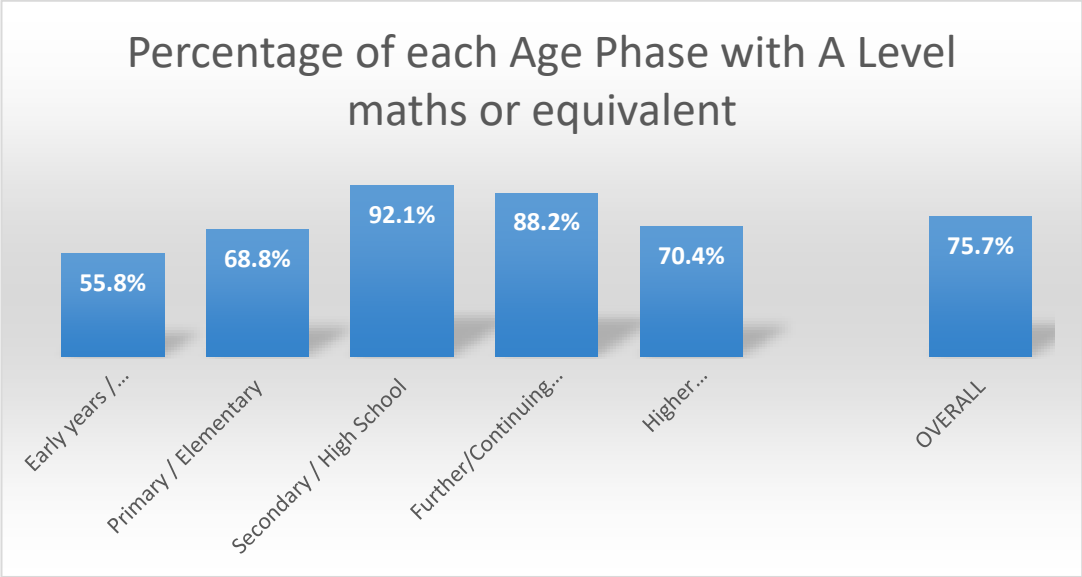
Chart 4.13 below shows the same data, but normalises each phase to 100%, by dividing through by the total number of responses for each phase, so as to allow comparison of the percentages of A-level, GSCE equivalent, and other qualifications held by the people teaching in that age-phase.

Chart 4.13 MTERs' Pre-University Qualifications versus age-phase focus (in percentages)



This clearly shows the issue with GCSE, which in almost every case has an unrealistically lower percentage than A-Level. Furthermore the "other" category is unclear, since although respondents had the opportunity to clarify, very few did so. The only category which we can be reasonably confident about are the A-level percentages – which may be underestimates. Chart 4.14 summarises the A level percentages in mathematics, or mathematics-related subjects by Age-Phase.

Chart 4.14: Percentage of MTERs with an 'A'-level or equivalent maths qualification

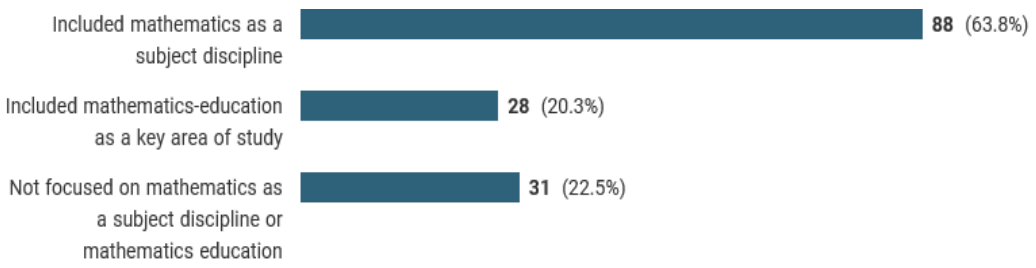


It is perhaps not unexpected to find that more MTERs with a secondary and FE focus studied mathematics at A-level than did those MTERs with a focus on Primary or Early Years/Kindergarten (EY). Whilst the EY-focused MTER group has the lowest percentage with A-level or equivalent in mathematics or a related subject this still represents a minimum of 55.8% of MTERs within that group. This is an interesting observation, given the previously-observed fact that almost all of this group is composed of those who also teach in other phases.

4.5.2 University Qualifications / First degree

Chart 4.15 below shows the content of first degrees. The nature of the question here also allowed for multiple choices, and so the percentages are for comparison only, and do not sum to 100%.

Chart 4.15 Undergraduate Degree or equivalent



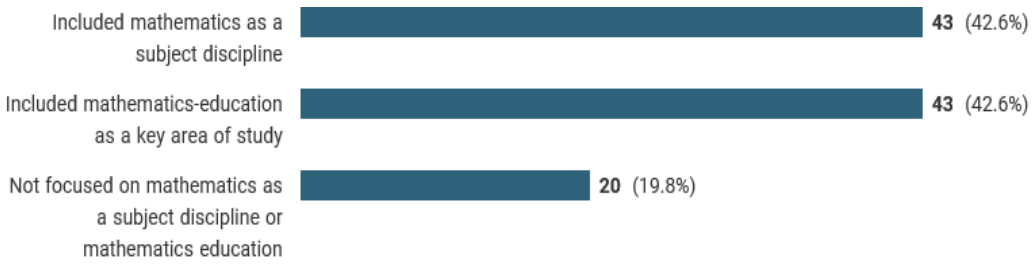
Mining into these results further, reveals that six respondents did not answer this question, while some respondents answered in more than one category. Of the 138 responses, only 31 (22.5%) said that their degree was not related to mathematics or maths education. Of the remaining 107 (77.5%) of respondents, 79 (57.2%) said their degree was mathematics related; 19 (13.8%) said their degree was mathematics education related, and 9 (6.5%) said it was both.

Almost two thirds of MTERs claimed to have studied a degree at undergraduate level which had significant mathematical content; for almost all of these respondents this would have been prior to any involvement in education, and certainly the education of teachers.

4.5.3 PGCE Qualification or equivalent

Chart 4.16 below shows the content of Postgraduate Certificates. As with first degrees, multiple categories could be selected, with the total of percentages exceeding 100%.

Chart 4.16 …: PGCE Qualification or equivalent

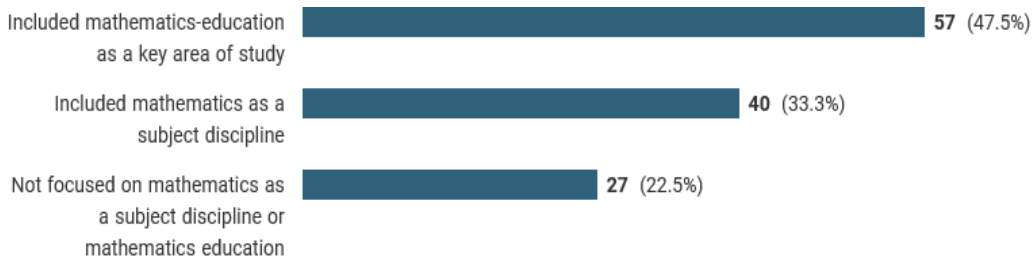


Only 101 respondents said they had a Postgraduate Certificate. Out of these, 20 (19.8%) said that their certificate was not related to mathematics or mathematics education at all. Of the remaining 81 (80.2%) of respondents, 38 (37.6%) said their certificate was mathematics related; another 38 (37.6%) said their degree was mathematics education related, and 5 (5.0%) said it was both.

4.5.4 Master's Degree or equivalent

Chart 4.17 shows the content of Master's degrees. As before the total is over 100%, because of the multiple categories.

Chart 4.17 MTERs holding a Master's Degree or equivalent

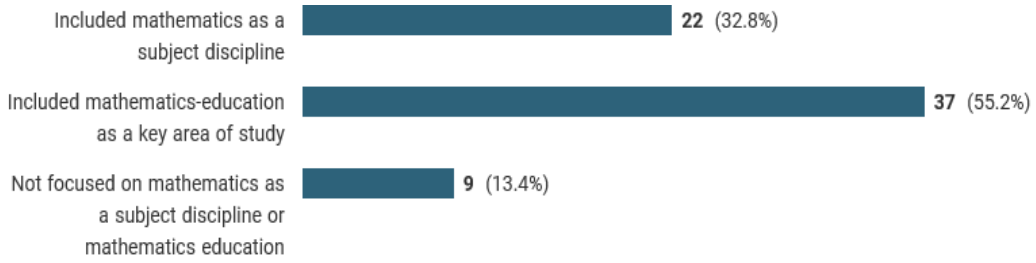


Here, 120 respondents said they had a Master's degree. Of these, 27 (22.5%) said that their degree was not related to mathematics or mathematics education. Of the remaining 93 (77.5%) of respondents, 36 (30.0%) said their degree was mathematics related; another 53 (44.2%) said their degree was mathematics education related, and four (3.3%) said it was both.

4.5.5 Doctoral level Degree or equivalent

Chart 4.18 shows the content of doctorates. Once again the total exceeds 100%.

Chart 4.18 Doctoral level Degree or equivalent



Just under half (67) of the 144 respondents (46.5%) said that they had a doctorate. Of these, 9 (13.4%) said that their degree was not related to mathematics or mathematics education. Of the remaining 58 (86.6%) of respondents, 21 (31.3%) said their degree was mathematics related; another 36 (53.7%) said their degree was mathematics education related, and one person (1.5%) said it was both.

4.5.6 Highest Qualification in Mathematics or Mathematics Education

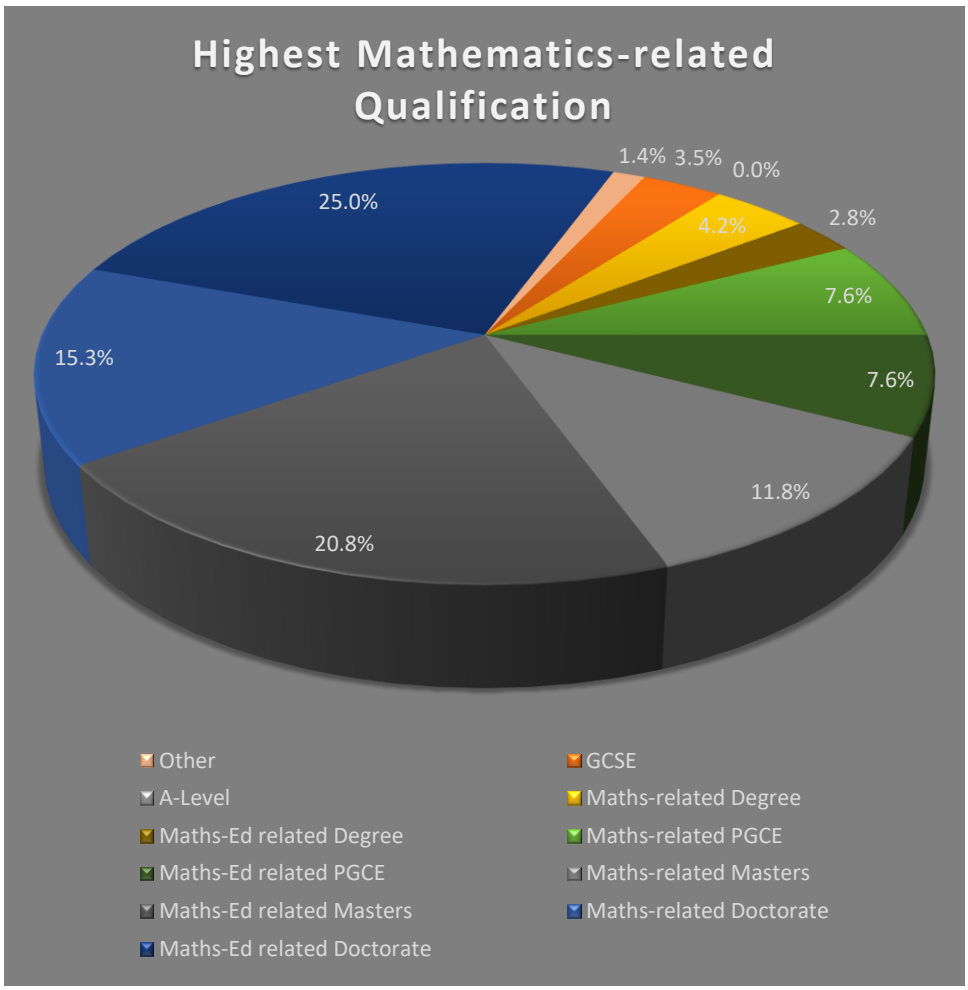
In order to put these qualifications into context, and to reflect the fact that some respondents appear to have omitted school-based qualifications in favour of degrees or higher degrees, the data has been analysed to extract the highest relevant Mathematics or Mathematics Education qualification achieved by respondents. Table 4.19 was compiled by assuming that the order in the table represents a "higher", more "relevant" qualification, the further we go down the table.

Table 4.19 MTERs' Highest Qualification relating to Mathematics or Mathematics Education (raw data)

HIGHEST MATHEMATICS OR MATHEMATICS EDUCATION QUALIFICATION	Number
Other	2
GCSE	5
A-Level	0
Maths-related Degree	6
Maths-Education related Degree	4
Maths-related PGCE	11
Maths-Education related PGCE	11
Maths-related Master's	17
Maths-Education related Master's	30
Maths-related Doctorate	22
Maths-Education related Doctorate	36
TOTAL	144

In the analysis below, this is taken as representing the "highest *relevant* qualification" of each of the 144 respondents. This table omits degrees which did not have a specific Mathematics or Maths Education focus. For example, while 67 Respondents had a doctorate, 9 of these doctorates were excluded as not directly relevant to being an MTER. In the table above, the remaining 58 are split between Mathematics Education (36) and Mathematics (22) related. The same data is presented as percentages in Chart 4.20 below.

Chart 4.20: MTERs' Highest Qualification relating to Mathematics or Mathematics Education (as percentages)



In total 72.9% of the sample have higher degrees in Mathematics or Mathematics Education as their highest *relevant* qualification, with just over 40% having a *relevant* doctorate. Of the remainder, the highest *relevant* qualification is their PGCE (15.2%) or their first degree (7.0%). There are five MTERs whose highest *relevant* Mathematics or Mathematics Education qualification is their GCSE.

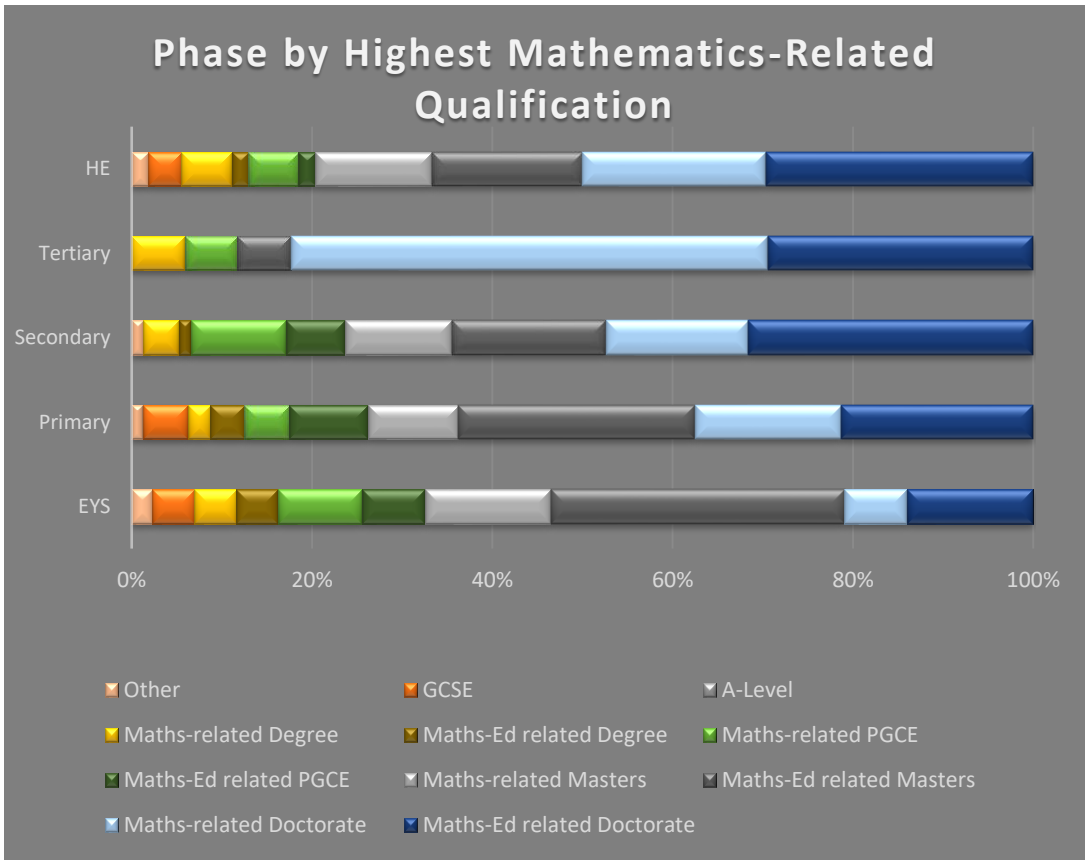
In discounting the 9 people with doctorates, I wished to ensure that this is not biasing the remaining sample, and to make sure that these individuals are being accurately represented in another appropriate category. This highlighted an important point about the diversity of the academic background of MTERs. Two of these discounted 9 respondents have relevant Master's qualifications, five have a

relevant Postgraduate Certificate, and one has a relevant first degree, so eight of these nine are still credited with University-level *relevant* qualifications.

Only one respondent appeared to have no relevant qualifications beyond GCSE. However, checking the CV on the University website revealed extensive experience including a doctorate in a cognate discipline, then as a teacher and as a mathematics leader in school, prior to being appointed at University with an extensive research profile in Mathematics Education. This epitomises the diversity of the MTER population, that there is no "one size fits all" career pathway into the profession, and that different MTERs bring a wealth of different experiences to the profession. In what follows, this point should be kept firmly in mind.

Chart 4.21 below shows the breakdown in terms of the highest relevant mathematics, or mathematics-education qualification held by each MTER according to the age-phase/schooling that forms part or all of their focus.

Chart 4.21 MTERs' Highest Qualification relating to Mathematics or Mathematics Education by Phase

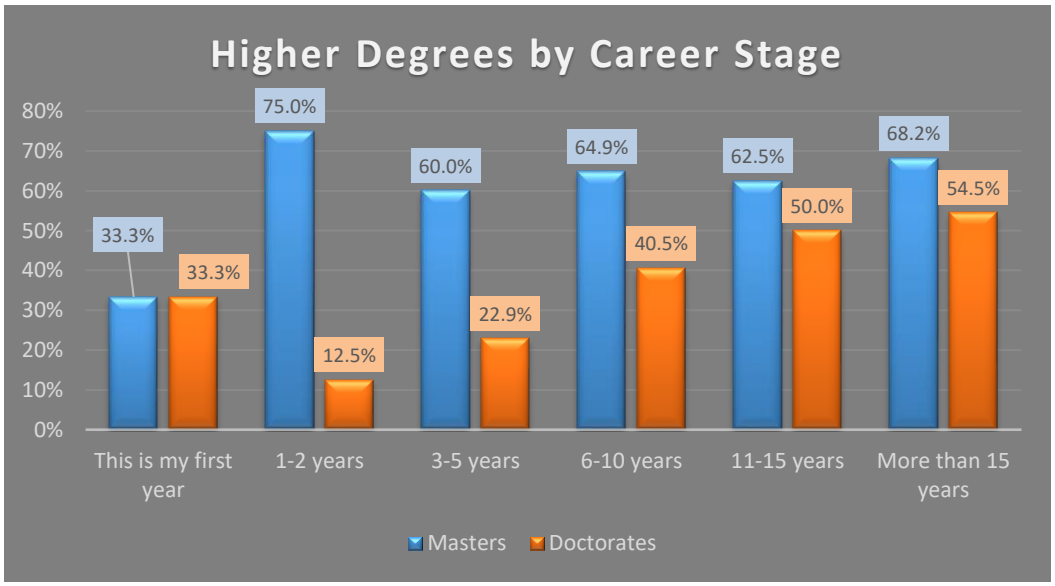


For phases other than HE there is clearly an increasing profile of the proportions of all relevant mathematics or mathematics education related Higher Degrees held, moving from EYS(67%), Primary(74%), Secondary(76%) and FE(88%), with a similar increasing profile in Doctorates: EYS (21%), Primary(38%), Secondary (47%), and FE(82%).

One immediate conclusion is that while the vast majority of MTERs possess a Higher Degree in a mathematics related area, this clearly does not seem to be a pre-requisite for being an MTER. An interesting question therefore is at which point in their careers do MTERs or intending MTERs study for their Master's degrees or doctorates?

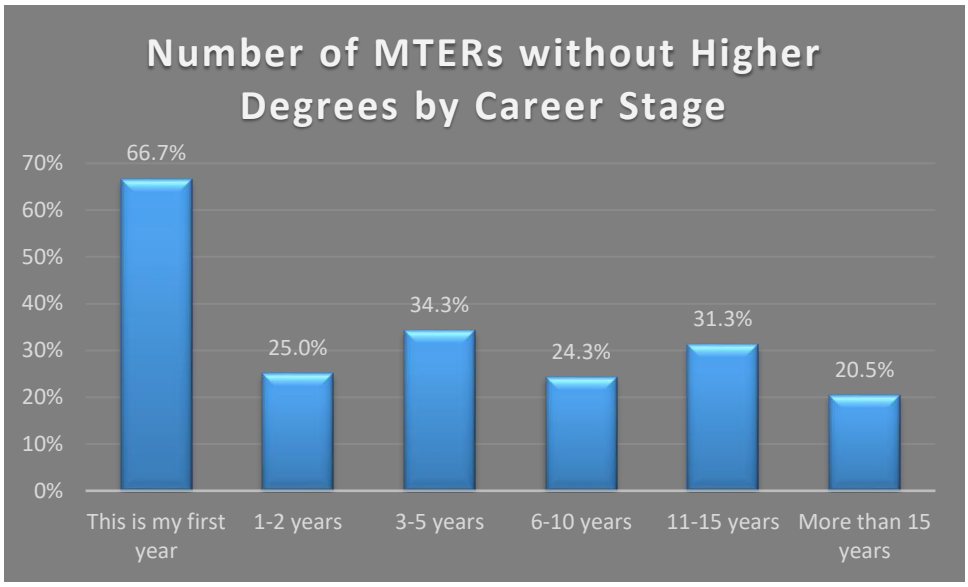
Chart 4.22 below shows the percentages of MTERs at each stage of their career who possess a Mathematics-related Master's degree or Doctorate. In many cases, MTERs will possess both. There are 12 MTERs in total who possess mathematics-related Doctorates, but do not have mathematics-related Master's Degrees.

Chart 4.22: The percentage of MTERs' with higher degrees at each career stage.



The chart suggests there may be an increase in the number of MTERs possessing a relevant doctorate as the time in post increases. The percentage of Master's degrees does not show the same increase, however. In fact, one of the less obvious features of this chart is that around a quarter to one-third of respondents did not report having a higher degree. This can be seen clearly in the chart 4.23 below.

Chart 4.23: Percentage of MTERs' without Higher Degrees at each career stage.



The high percentage of "first year" MTERs was due to a small sample effect. Only one of the three had relevant higher degrees.

Table 4.24 lays out the numbers of highest relevant mathematics-related Higher Degrees for each career stage.

Table 4.24: Number of MTERs' Highest Qualification relating to Mathematics or Mathematics Education by Career Stage.

	Master's	Doctorates
This is my first year	0	1
1-2 years	5	1
3-5 years	15	8
6-10 years	13	15
11-15 years	3	8
More than 15 years	11	24
TOTAL	**47**	**57**

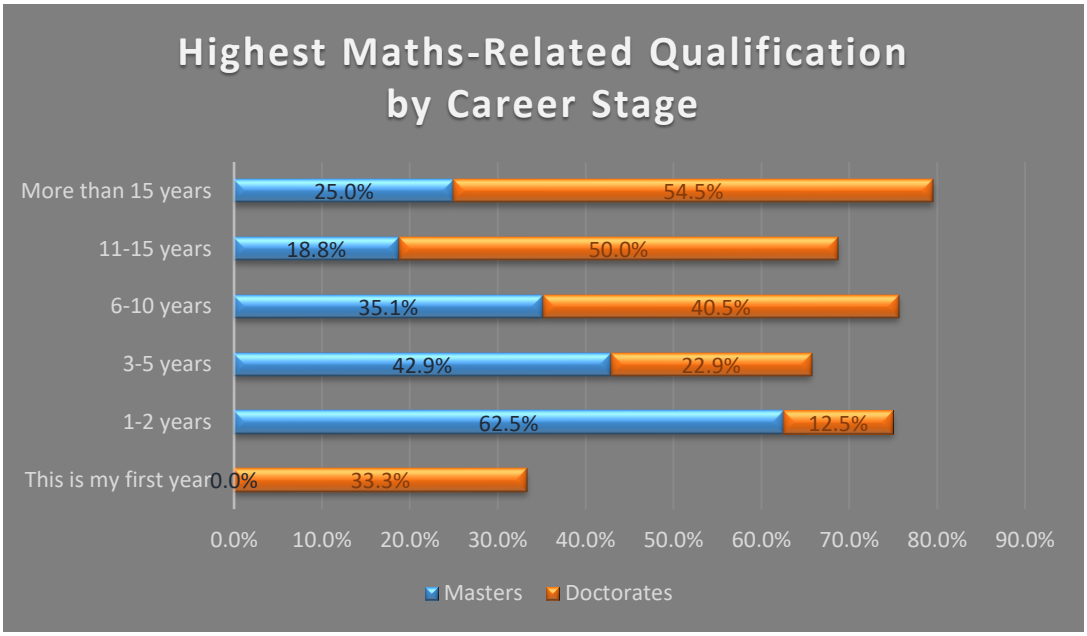
*The 11-15 years group was smaller than the 6-10, 11-15 & 15+ groups

**One MTER with a doctorate declined data on career stage.

This suggests that for MTERs in the earlier stages of their career, the highest qualification is likely to be a Master's degree rather than a doctorate, with the situation reversed in the later stages, after 10 years.

Chart 4.25 below presents this data as the highest qualification by percentages of MTERs in each stage of their career:

Chart 4.25: Percentages of MTERs' Highest Qualifications relating to Mathematics or Mathematics Education by Career Stage

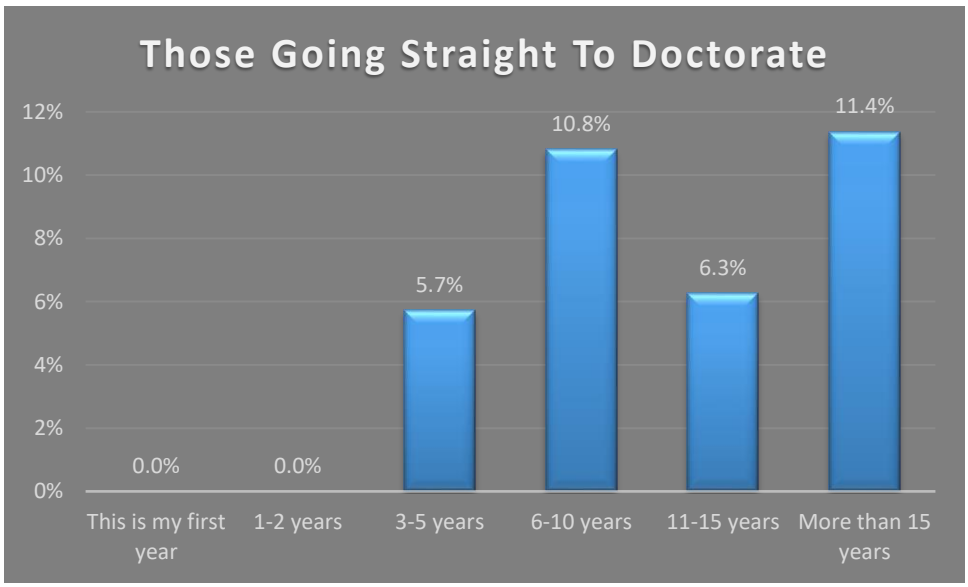


Apart from the first year, the data again shows that the total proportion of MTERs with relevant Higher degree qualifications seeming to be around two-thirds to three-quarters for each stage of the career, with only a slight overall increase with time. This reiterates the earlier point that about one third of all MTERs do not have a relevant higher degree, but this reduces slightly over the career stages.

One hypothesis which might explain this data is that a significant proportion of MTERs may be "upgrading" their Master's degrees to doctorates as their career progresses. On the other hand, the people in the later stages of their career may have been appointed at earlier times, and have gone straight to a doctorate, without acquiring a Master's degree.

Chart 4.26 below shows the percentages of those in each career stage who have a doctorate, but no Master's degree.

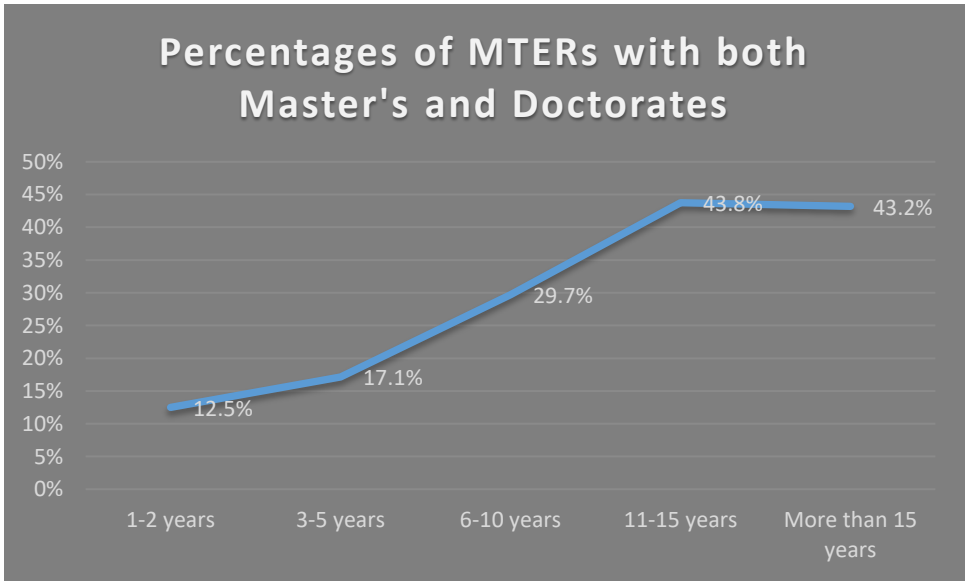
Chart 4.26: Percentage of MTERs' at each career stage with Doctorate, but no Master's Degree.



While some MTERs may have taken this route, there still seems to be around 20%-30% of MTERs who obtain doctorates while in post, over the course of their careers, "upgrading" an existing Master's qualification.

Chart 4.27 below clearly illustrates this trend

Chart 4.27: MTERs at each career stage possessing both a Master's and a Doctorate.



Some caution may be advised here, though, since some of the charts are based on low sample sizes. While Chart 4.27 is based on data from 45 respondents, Chart 4.26 is based on data from only 12 respondents, rendering any conclusions as highly tentative.

Since these data were based on the whole sample, the analysis in Chart 4.22 was replicated for largest sample subgroup, England-based MTERs (Chart 4.28) versus those based elsewhere (Chart 4.29). In both of these, the trends identified above (slight increase in Master's degrees, and increase in Doctorates by career stage) are far more apparent in the England-based data than they are for those based elsewhere. This may be due to the low sample numbers in the "rest of the world" data (N=23), 15 of whom had a Master's degree, and 12 of whom had a Doctorate. Thus, in this case, even if the effects noted here are real, then they may only apply to MTERs working in England.

Chart 4.28 Results for English MTERs

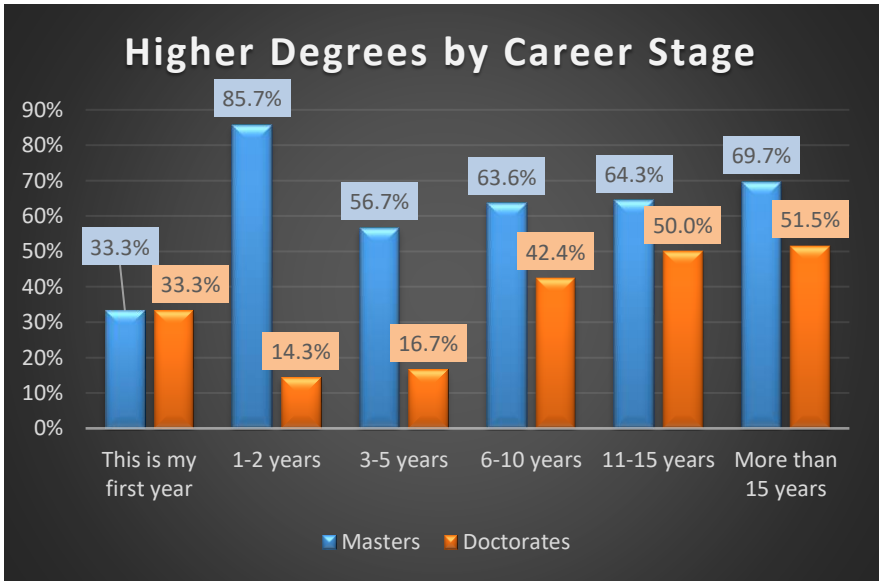
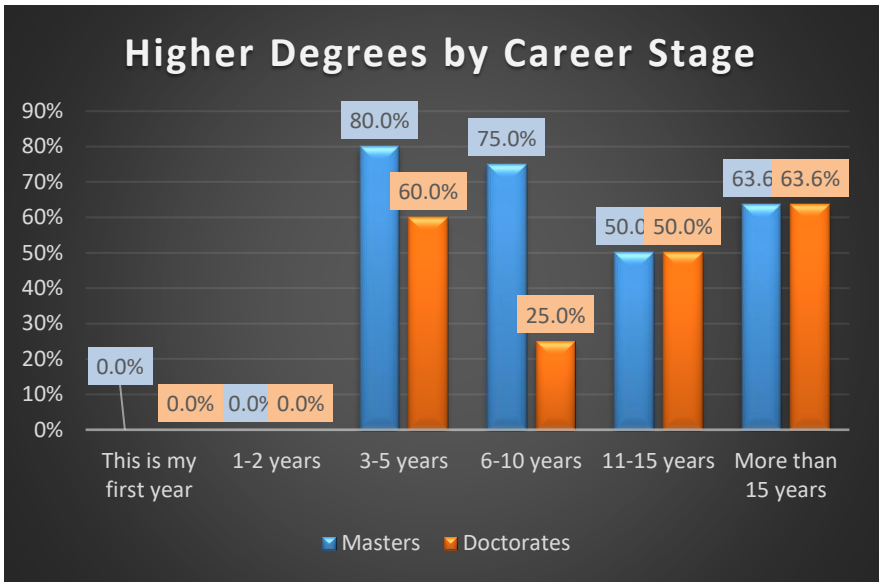


Chart 4.29 Results for the rest of the world



4.6 Comparisons between Groups: Age-Phases and Career Stages

This section explains the methodology used to compare responses from different age-phases and those who are at different stages in their career.

4.6.1 Age phases:

As noted in 4.3 above, when respondents were asked to identify whether their work "concerned" EYS, Primary, and Secondary, FE or HE, multiple choice was allowed, with some respondents identifying all five. Tables 4.28 and 4.29 shows the extent of this. For example, out of the 43 (100%) of respondents who declared they were concerned with EYS, 42 (97.7%) of these were also concerned with Primary, 10 (23.3%) with Secondary, 4 (9.3%) with FE and 20 (46.5%) with HE. In fact only one respondent was concerned with purely EYS and no other age-phase.

Table 4.28: Numbers of Respondents in each age phase who are also concerned with other phases.

	COLUMNS	Number of respondents declaring a focus in other phases				
ROWS:		**EYS**	**Primary**	**Secondary**	**FE**	**HE**
Respondents who declared a focus in that particular phase	**EYS**	43	42	10	4	20
	Primary	42	80	23	5	31
	Secondary	10	23	76	14	30
	FE	4	5	14	17	12
	HE	20	31	30	12	54

Table 4.29: Percentage of Respondents in each phase who are also concerned with other phases.

	COLUMNS	Percentage of respondents declaring a focus in other phases				
ROWS:		**EYS**	**Primary**	**Secondary**	**FE**	**HE**
Respondents who declared a focus in that particular phase	**EYS**	**100%**	97.7%	23.3%	9.3%	46.5%
	Primary	52.5%	**100%**	28.8%	6.3%	38.8%
	Secondary	13.2%	30.3%	**100%**	18.4%	39.5%
	FE	23.5%	29.4%	82.4%	**100%**	70.6%
	HE	37.0%	57.4%	55.6%	22.2%	**100%**

Note: The ROWS show the 100% respondents with a focus in that phase, and the COLUMNS show what proportion of these respondents also teach in other phases. This means the table is not symmetrical, since, for example, 42 out of the 43 EYS (97.7%) also teach in Primary, the same 42 is only 52.5% of the total of 80 whose declared focus is Primary.

This is an interesting result in itself, and clearly reflects the reality that most MTERs do not have as focus a single age phase. However, this does call into question whether it is legitimate to use an "age-phase" construct as an independent variable, for example comparing the results from "EYS" MTERs with results from "Primary" MTERs, since in reality, most MTERs teach and research in different age phases. To resolve this, in comparing results of different groups, I am taking the view that the comparisons are not between specific "EYS MTERs" and specific "Primary MTERs", but between "the group of MTERs concerned with EYS" and "the group of MTERs concerned with Primary", and in any further analysis I will need to recognise that these groups are not independent of one another.

There is one further issue: as has already been noted, the HE category seems to have been regarded differently by different respondents. I therefore propose to remove the "HE" category from the analysis, and concentrate on the other four phases. Any results must be viewed in the light of this discussion, and any statistical analysis that is done needs to reflect the fact that the four categories merely reflect the views of the group of people who share a particular focus, and are not independent. These issues surrounding the construct validity of "age-phase" will need to be revisited throughout the study.

4.6.2 Career Stages

In contrast, categorisations on Career Stages are relatively straightforward. In the survey data, respondents were asked to identify how long they had been in role by selecting one of six different categories. The results of this are shown in the top line of Table 4.30. However, some of these, for example the "first" year, contains only three MTERs, so using this as an independent variable makes little sense, and would be unlikely to yield any useful results; furthermore, the first three categories are much shorter time-periods than the other three. It therefore makes sense to consolidate the first three categories as "1-5 Years", making three categories of five years, and the final one open-ended. Given the fact that there are lower sample numbers in the 11-15 category, then for some analyses it may be more appropriate to consolidate further, into just two categories. The details of this are shown in the bottom line of Table 4.30.

Table 4.30: The original Career stage categories and the two "consolidations"

This is my first year	1-2 years	3-5 years	6-10 years	11-15 years	More than 15 years
3	8	35	37	16	44
		1-5 Years	6-10 Years	11-15 Years	15+ Years
		46	37	16	44
			1-10 Years	11+ Years	
			83	60	

4.7 Methodology for Comparing MTERs' Responses

The purpose of categorising MTERs into "Age-Phase" and "Career Stage" is primarily to determine whether there are differences in responses to specific items. For example, we might reasonably expect that MTERs in the earlier stage of their careers might answer "becoming" items somewhat differently, to those in later

stages of their careers, who were busy “being MTERs”. The categories established above will therefore be used to compare responses, subject to the caveats stated.

Presentation of Likert-scaled data can be done in several ways, such as summarising the percentage of agree/strongly agree, and calculating the mean score. The first of these is understandable, but discards much of the data. Presenting results as means uses all the data but is less understandable, and often results in charts where all bars are around 3.0, and barely different from one another.

For these reasons, the main comparisons will be made on the total percentages of respondents agreeing (either Agree or Strongly Agree). However, it will be useful to determine whether group differences are statistically significant. In these cases, the entire set of data will be used, comparing means. In such circumstances an Analysis of Variance (ANOVA) can be used. The originator of the test, R.A. Fisher, describes this as: “*separation of the variance ascribable to one group of causes, from the variance ascribable to other groups*” (Fisher, 1925).

4.7.1 Statistical Tests to be used

Given the centrality of the Likert-scaled data to this research, it is important to discuss the extent to which results arising from this data are statistically significant, indicating that they are likely to be replicated in any equivalent study, and hence can be regarded as reliable. In order to achieve this, it is crucial to examine the nature of the data yielded and the tests available, and consider whether such tests are appropriate to be used, and whether they are sufficiently robust to still be regarded as valid, in the cases where their assumptions may be violated.

The assumptions underlying a parametric test such as ANOVA require data to be Normally distributed, with the observations independent, and with homogeneity of

variance (homoscedasticity) (Van den Berg, 2019). In this study, the data is Likert-scaled, and so is not Normally distributed. However, research has shown that parametric tests still can be valid *"even when statistical assumptions—such as a Normal distribution of data—are violated, even to an extreme degree"* (Sullivan and Artino, 2013, p.542). Furthermore, research by Schmider, Ziegler, Danay, Beyer and Bühner (2010, abstract), which looked at simulations of ANOVA, found that *"…comparing the outcomes of the ANOVA calculations for the different types of distributions, gives reason to regard the ANOVA as robust",* even when the assumption of Normality is violated.

However, given the Likert Scaling, the assumptions of homoscedasticity will clearly be brought into question. In cases like this, some authors (Glen, 2019a; Lund and Lund, 2018) recommend that a Levene's test be run on the data beforehand to rule out a violation of homoscedasticity. In such a case, an Analysis of Variance can be carried out via a Kruskal-Wallis nonparametric test (Heidel, 2019; Mangiafico, 2016; Glen, 2019b). This test, is also noted to address the concerns of Normality (Arnold, Brownrigg, Curtis, King, Stokes and Witham, 2003; Glen 2019b; Landau and Everitt, 2004).

In summary, therefore, since ANOVA can be considered to be a robust test, it will be considered valid for Likert-scaled data provided that the data does not fail a Levene's test. In such cases, since ANOVA uses the whole data, and not merely rankings, it will be considered the better and more indicative test. Kruskal-Wallis is used primarily as a back-up in cases where the assumption of homogeneity fails.

4.7.2 A Note on Error Levels

There are 55 items which are each to be subjected to analysis by two different criteria (Age Phase and Career Stage), making 110 analyses in all. At the 5% level, it would be expected, even in the case of no actual differences between groups, that

around 5 or 6 of the tests should show statistically significant results. Caution will therefore clearly be needed when drawing any conclusions from this process, and we should ideally demand much lower error levels than 5% for evidence that an effect is generalizable from the data. This provides an additional reason for undertaking two tests: to ensure that both tests concur, and so reduce the possibility of reporting "false positives". In all relevant cases the p-value will also be reported to make it clear precisely how significant the results are.

4.7.3 Independence of Samples

One final issue is that of independence. As the values for Career Stage arise from separate individuals, they can be considered to be independent from one another; however, as has already been observed, the Age Phase categories are not independent, since one individual's score occurs in different categories. This could potentially call into question the legitimacy of any statistical test undertaken using the Age-Phase construct. Therefore, no firm conclusions about age-phase differences should be made on the basis of statistical evidence alone. For differences between age-phases, there should be other, more pertinent evidence, with the statistics merely providing supplementary support.

4.7.4 Summary of the Methodology to be used

The methodology used for statistical analysis of each section will therefore be as follows:

- The overall percentage agreement (Agree or Strongly Agree) will be noted.
- Following this, the percentage agreements for each Age Phase and each Career Stage will be visually compared, and any obvious effects noted. Specifically, what will be looked for are systematic differences in the profiles of agreements- either an increasing or a decreasing trend across the groups or large differences between groups – for example where those in the earlier stages of their career respond differently from those in the later

stages, or those dealing with older age phases respond differently from those in younger age-phases.

- A Levene's test, an ANOVA and a Kruskal-Wallis Test will be conducted on each item for both Age-Phases and Career Stages using the original data. Where any of these turn out to be significant at the 5% level, this will be noted, and the implications discussed. Although all items have been subjected to testing, these will only be mentioned where the results are significant.
- Where appropriate, the open ended items in each section will be analysed to elaborate on and possibly interpret the findings, seeking confirmation or otherwise. The methodology here will use a grounded theory approach as noted earlier (Strauss and Corbin, 1990).

It is important to note that throughout this process, what is being sought are potential patterns or differences which make sense as a consilience of data from all the different avenues of scrutiny. Any conclusions reached should be made on the basis of multiple lines of evidence, and should be abduced into a model which makes sense in terms of what is known about the practice of MTERs.

4.8 Validity and Reliability of the Demographic Descriptions

It is necessary to ask how the constitution of the sample impinges on the intention to generalize the results of this study wider than simply to the sample itself.

There are three separate issues here:

(1) Whether the descriptions within each section are a valid representation of the qualifications and experiences of the respondents;

(2) Whether the sample itself has the potential to provide a valid and reliable basis from which we can explore the research questions; and,

(3) What is the group of MTERs to which we are able to generalise such results?

There is no reason to doubt the validity or the reliability of the core demographic data in this section. Respondents were chosen on the basis of their university associations, and there is no reason to doubt items such as length of time in role, or the country in which they are teaching. As already noted in Section 4.6.1, there were issues with the age-phase focus of respondents, in that this has proven challenging to capture, and there are some issues with the qualification data, especially concerning pre-university qualifications as discussed in 4.5.1. Given the classification methodology described earlier in this chapter, the categorisations are reliable, but characterisations such as "highest relevant mathematics (related) qualification" are a construct of this research, and while it appears reasonably robust and reliable, its validity can be questioned.

In consequence, all results relating to age-phase categories are treated very cautiously throughout the research, especially any breakdown of the data which tries to compare one age-phase with another. Here there are issues of both reliability and validity. For example, if the question had been asked in a slightly different manner, requiring respondents to identify their main age-focus, then the data may have been categorised differently. It is not clear that if the same respondents were asked the same question at another time, they would respond in the same manner, since individual MTERs might be focusing on different age-phases at different times.

For the career stage data, however, while it is possible to query the numerical breakdown of the different categories, they being different in length, and consequently containing disproportionate numbers of MTERs in each, there is no reason to doubt that the actual data is valid or reliable. In this case, by a judicious conflating of categories as described in Section 4.6.2, it will be possible to use this as a valid and reliable basis for comparison.

As has been seen in Section 4.2, the majority of respondents are from the UK, with 132 out of the sample of 144 working in the UK, of whom 121 are based in England. That means, only a small minority of the sample are from the rest of the world, 10 of whom are based in the US. However, in all but one case, which is highlighted below, in terms of the sample demographics, there seems to be no appreciable differences between the demographics of the UK and non-UK based respondents. Clearly, given the low sampling numbers of non-English-based MTERs, we cannot draw the positive conclusion that MTERs from England and from the rest of the world possess similar characteristics, but rather state, that on this data, apart from one particular case, that of the acquisition of higher degrees by particular career stages, we have no evidence of any obvious statistical differences between the two groups.

For this reason, and for reasons already stated in Section 4.1, I intend to continue to use all the data, rather than artificially remove the non-English based respondents. In doing this, it will be necessary to keep a close eye on any category in which there appears to be a difference in response between MTERs based in England and those outside England. Any obvious differences will only be reported where they occur. The outcomes of the questionnaire data will therefore in principle be taken as representative of MTERs based in England, extending this in most cases to the UK, since the Education systems across the UK are similar, and many colleagues collaborate with, or are external examiners to, institutions in other parts of the UK. Also, given the fact that the data contains a small number of respondents based outside the UK, it will be possible to identify where those MTERs based outside England might deviate from the pattern observed within England. This issue of generalisability and representativeness will need to be addressed again when I examine the Interview data, which only uses a subset of the questionnaire respondents and focuses more predominantly on those identifying as primary MTERs.

Chapter 5: Analysis of Likert-Scaled Items

5.0 Introduction

This chapter addresses Research Question 1 (RQ1), and in particular RQs 1.2 and 1.3, examining the different aspects of MTER professional identity and community through each of Davey's five lenses, by examining the Likert-scaled and open-response items in the questionnaire.

The two central questions to be answered using the methodology outlined in 4.7 are:

(1) What do each of these lenses individually reveal about MTER identity, and what aspects of identity are viewed differently by different MTERs?
This is the concern of 5.1-5.6

(2) How effective is this framework in capturing all the different aspects of MTER identity?
This is addressed in 5.8

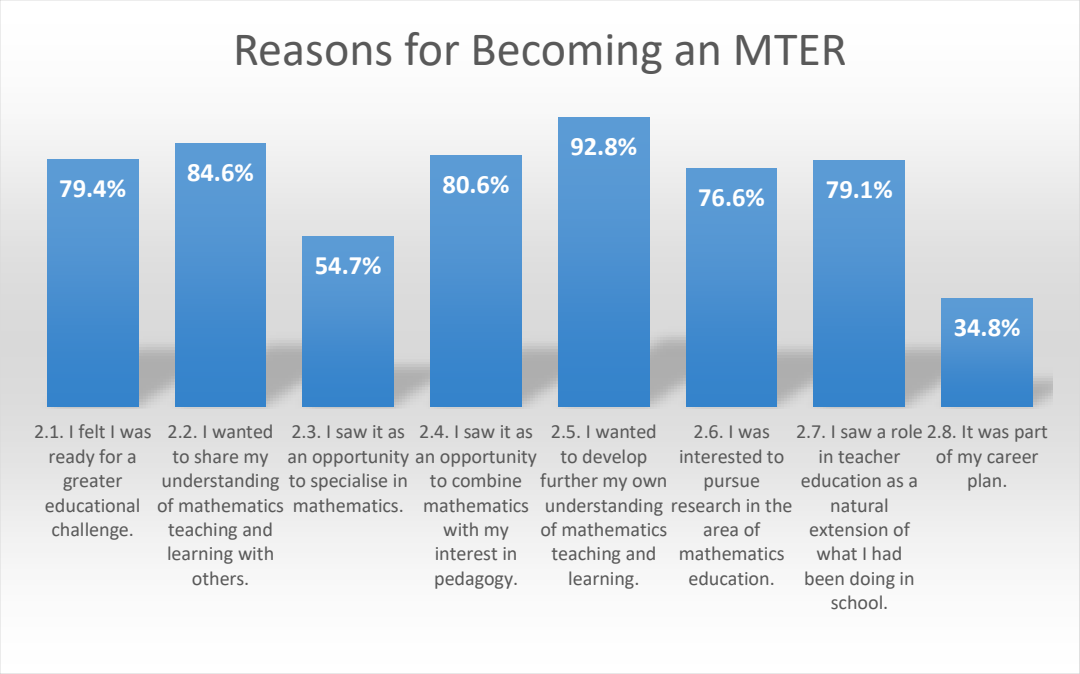
Note: The abbreviations QS1, QS2 etc. below are used to refer to the Questionnaire Section numbers as given in Table 3.1.

5.1 Becoming (Questionnaire Sections 2, 3 & 4)

5.1.1 Questionnaire Section 2: Reasons for Becoming an MTER

The overwhelming majority of MTERs agreed with almost all statements in QS2. Respondents wanted to develop their own understanding of mathematics teaching and learning (QS2.5 - 93%), and to share that understanding with others (QS2.2-85%). Almost four-fifths (79%) of MTERs-agreed that pursuing an MTER role would be a greater educational challenge (QS2.1), and an extension of their work in school (QS2.7) and which allowed them to combine an interest in both in mathematics and pedagogy (QS2.4), and to undertake research (QS2.6). Less important was specialisation (QS2.3), but still cited by the majority of respondents (55%).

Chart A1: MTERs expressing agreement or strong agreement with possible reasons why they became MTERs



Only around one-third of respondents (35%) considered that the MTER role was part of a definite career plan (QS2.8); in fact, 44% of respondents disagreed that becoming an MTER was part of a definite career plan.

Chart A2 (QS2.3) shows that more Primary (63%) and Early Years (63%) phase MTERs viewed the role as an opportunity to specialise than did Secondary (46%) and FE (47%) MTERs.

We might abduce that since almost all Primary and Early Years teachers will have routinely taught aspects across the curriculum, whereas those teaching in Secondary and FE are already likely to be specialists in the subject, then this might explain why the idea of specialism is more important to Primary and Early Years MTERs. However, the differences between phases just fails to be statistically significant (ANOVA p=0.064; K-W p=0.065).

On QS2.7, fewer of those in FE viewed the role as an extension of school-based work. This too might be abduced into an understandable model, since MTERs with an FE focus could be less likely to have worked in schools. The differences between Age Phases are statistically significant (ANOVA p=0.029; K-W p=0.023), and there are statistically significant differences between Career Stages: 94% of those in the profession 11-15 years agree, compared with 70% of those in the profession 15+ years (ANOVA p=0.044; K-W p=0.018). Such results are harder to abduce into a model, and may be an artefact of the sampling process.

Such cases caution that even when results are detectable, and can be abduced into an existing framework, and are statistically significant, critical judgment is still required.

Chart A2: Percentages of those agreeing with the reasons for becoming an MTER by Teaching Phase.

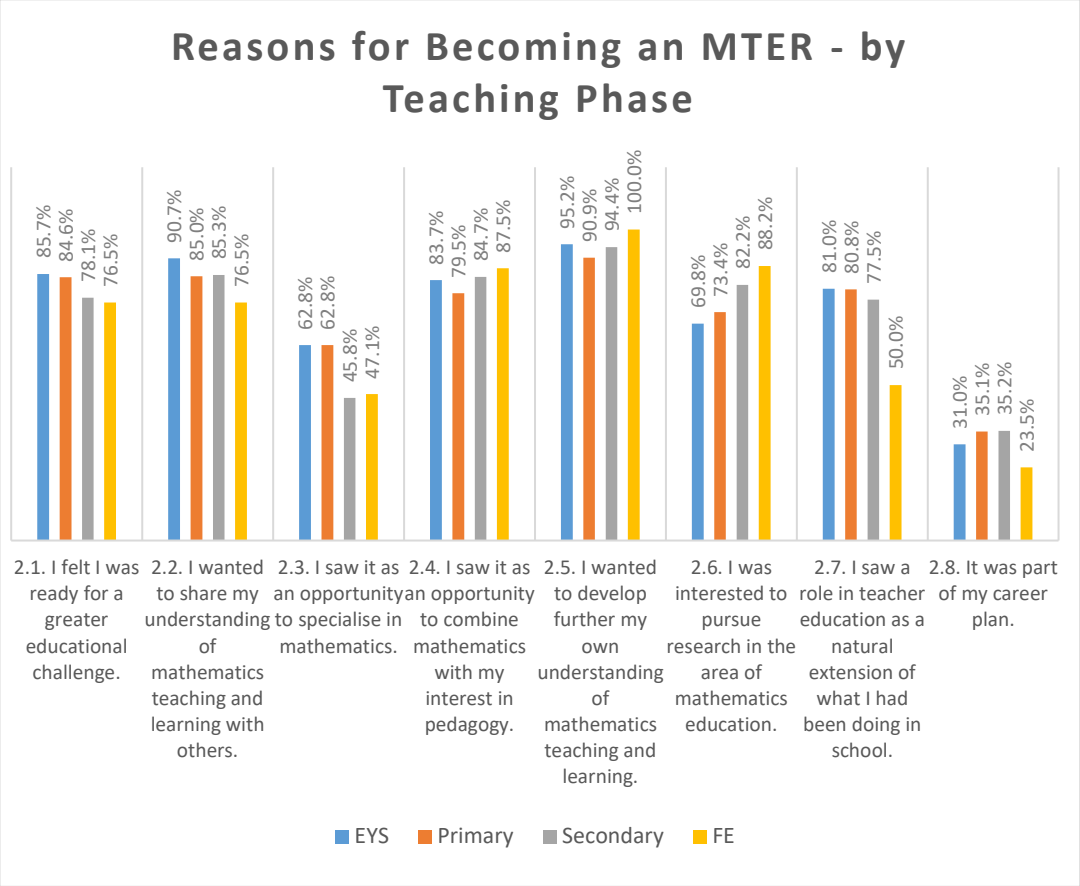
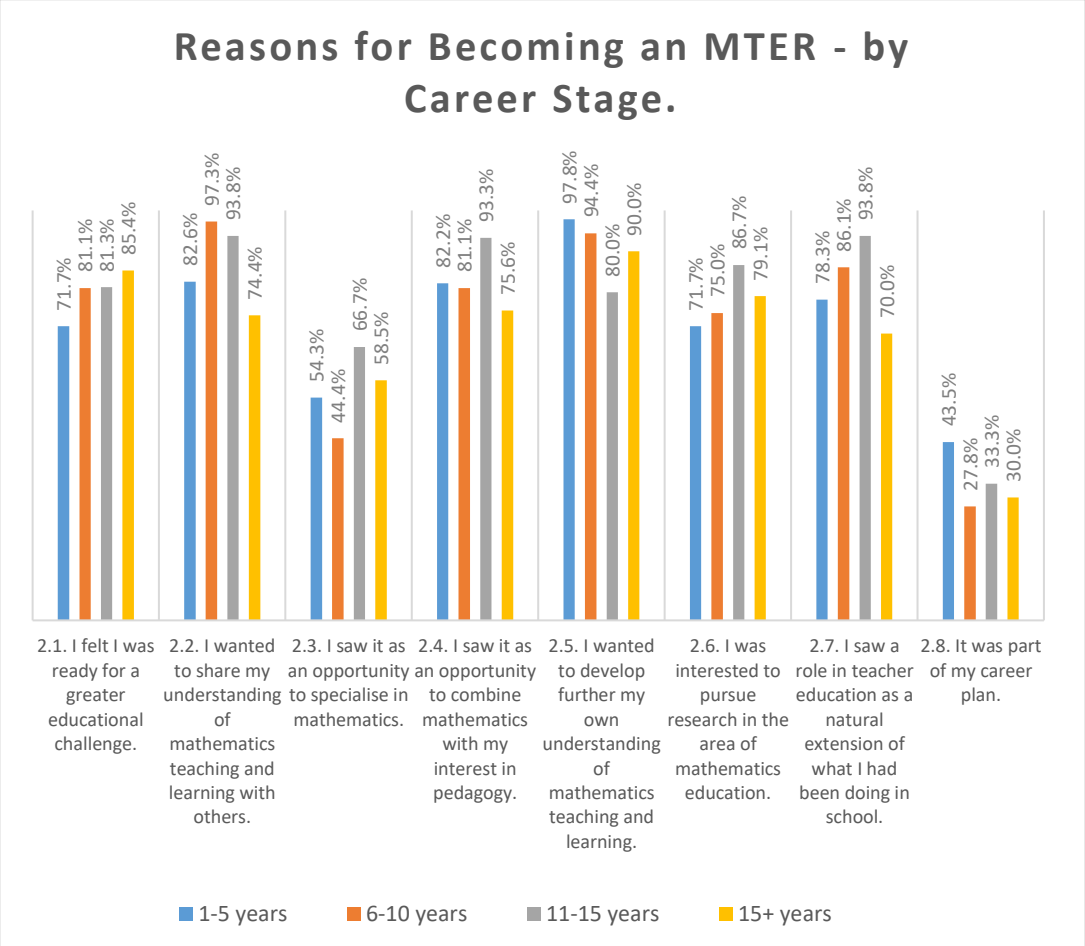


Chart A3: Percentages of those agreeing with the reasons for becoming an MTER by Career Stage.

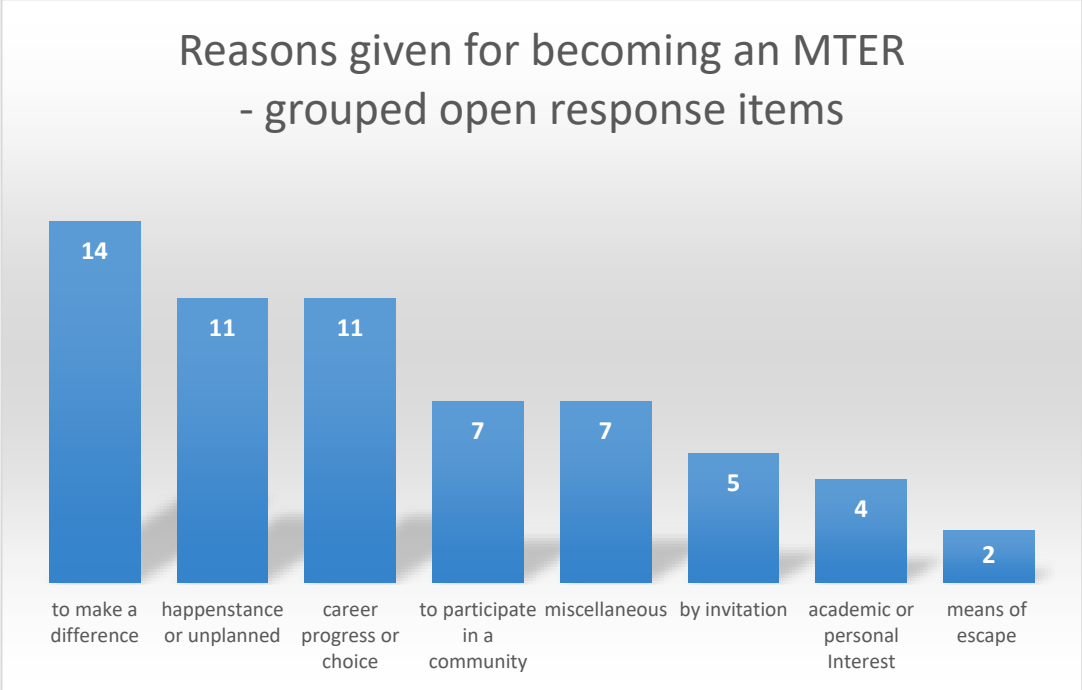


Open Response Items

58 of the 144 respondents provided additional motivations in open response items as to why they became an MTER, summarised in Chart A4.

As this is the first occasion in which the open response items are used, it is useful just to comment here on how the categories in Chart A4 were derived, and to illustrate some of the material which has contributed to it. The full details of how the open response material was analysed can be found in Appendix E1, together with references to some of the tools used to achieve this.

Chart A4: Reasons for becoming an MTER derived from open response categories, showing number of respondents.



The method adopted was that outlined in Bryman (2008) for the post-coding of open questions, consisting of three principles:

> "… categories generated must not overlap…
>
> … the list must be complete and therefore cover all categories …
>
> … there should be clear rules about how the code should be applied…"
>
> (Bryman, 2008, p. 233)

The categories emerged naturally from the text, and initially the names of the categories were derived from the words used by respondents themselves. The first category presented as *"make a difference*" in Chart A4 above was originally *"Drive to show I had something to offer/ make a difference / Influence others"*, and motivation for part of this text can be seen in the response of one MTER who wrote:

> "… for me there was a strong desire to show those in my department doing research in theoretical mathematics that I was capable of publishing research myself."

Each statement – or part of a statement - from an MTER was placed in one category only, and there was constant comparison with the text at the head of the category. Sometimes this was widened by including part of a text, hence the lengthy category titles, which on occasions had to be split if they became unwieldy.

There were 58 statements or parts of statements which were classified in this manner. 14 of these 58 included text which indicated that they had entered into the profession, or progressed within the profession, because they felt they had something to offer and wanted to make a difference.

For example:

> "I wanted to influence mathematics teaching more widely than within one school."

> "I was keen to extend my impact on raising standards pupil learning outcomes." (sic)

Although "making a difference" was mentioned in QS2.2,-some MTERs had alternative views on this:

> "I would add that I am not so much about 'sharing my understanding' (see second question above) but about working with prospective teachers' understanding."

All of the 14 statements classified within this category can be viewed in Appendix E1, where there is further discussion on the validity and reliability of the coding method adopted. In later sections of this chapter, this method will be assumed and merely reported on, but in each case, sufficient examples will be provided for the reader to judge the accuracy of the classifications, and to obtain an overall sense of the respondents' views, similar to that provided in the rest of this section.

For the next highest category, eleven people (19%) agreed that their entry into the MTER role was unplanned, echoing the result of QS2.8, that they had not followed any career plan:

> "… I sort of fell into doing maths ITE"

> "… there is an element of randomness in my career - following things that interest me and seeing what happens."

> "To be honest, I did not fully understand the breadth of my role when I first took it on."

A further eleven however, said that they did see becoming an MTER as a definite career choice:

> "I had been a maths coordinator in primary school so when I applied to become a lecturer it seemed the natural best fit."

> "I had been working with my university … and so this almost felt like a natural progression."

> "Saw a university position as an opportunity to continue in a similar way to consultancy, but also to begin to engage in research."

Seven people talked about the fact that they were joining a community:

> "[an] opportunity to engage with a community in a way that leads to self-satisfaction both through publishing and travelling to conferences."

> "To be part of a vibrant and engaged community of like-minded people."

> "It provided an opportunity to work with other MTERs whose work I respected."

Respondents became MTERs for a variety of reasons; for a very small minority this may have been a means of exit:

> "A chance to escape from challenges and pressures in current Primary school climate."

Summary

There is wide variation in the different motivations for becoming an MTER, and different ways in which respondents became MTERs. The motivations concerned personal development and interest in the subject, the desire to make a difference, sharing understandings with others, and helping others towards understanding. For some there was a desire to join a community of like-minded individuals (even though one person objected to the term "like-minded"), to pursue research, and an opportunity to specialise. Becoming an MTER for many was not part of an overall career plan; opportunities occurred and they took advantage of them. Very few viewed the MTER role as a stepping stone. There is evidence that more experienced MTERs, when reflecting on their motivations, may hold slightly different views from those in the earlier parts of their careers.

5.1.2 Questionnaire Section 3: MTER Induction

96% of the respondents cited previous experiences and knowledge as significant help in enabling them to become an MTER (QS3.1). 55% said that they had a role model (QS3.4), and in the early stages, were able to observe, plan and work alongside other MTERs (QS3.2 - 61%).

Only a minority of MTERs (41%) reported undergoing any kind of formal induction process (QS3.3).

Chart B1: Percentages of MTERs agreeing or strongly agreeing with statements about Induction Experiences

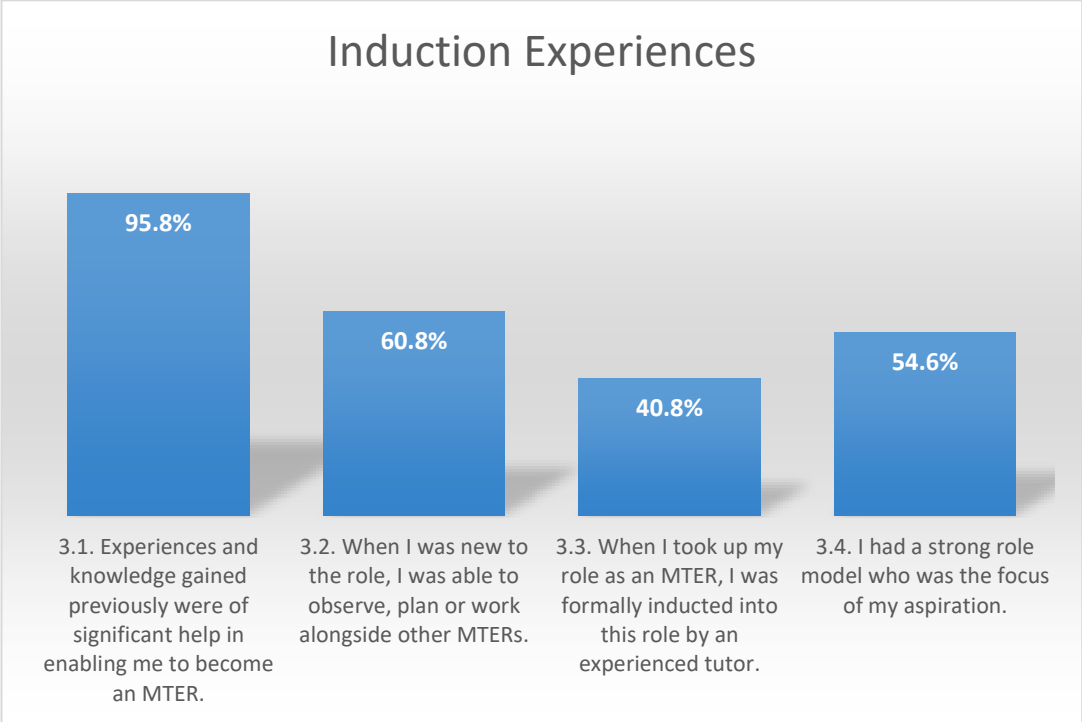
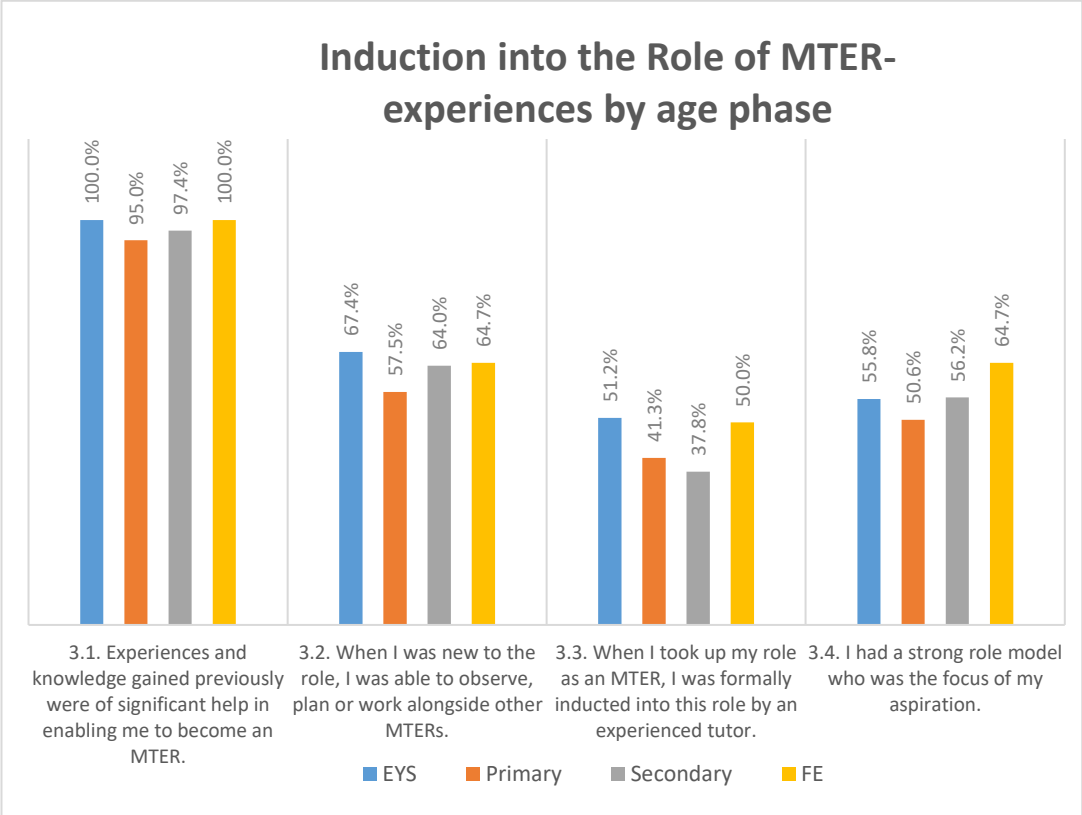


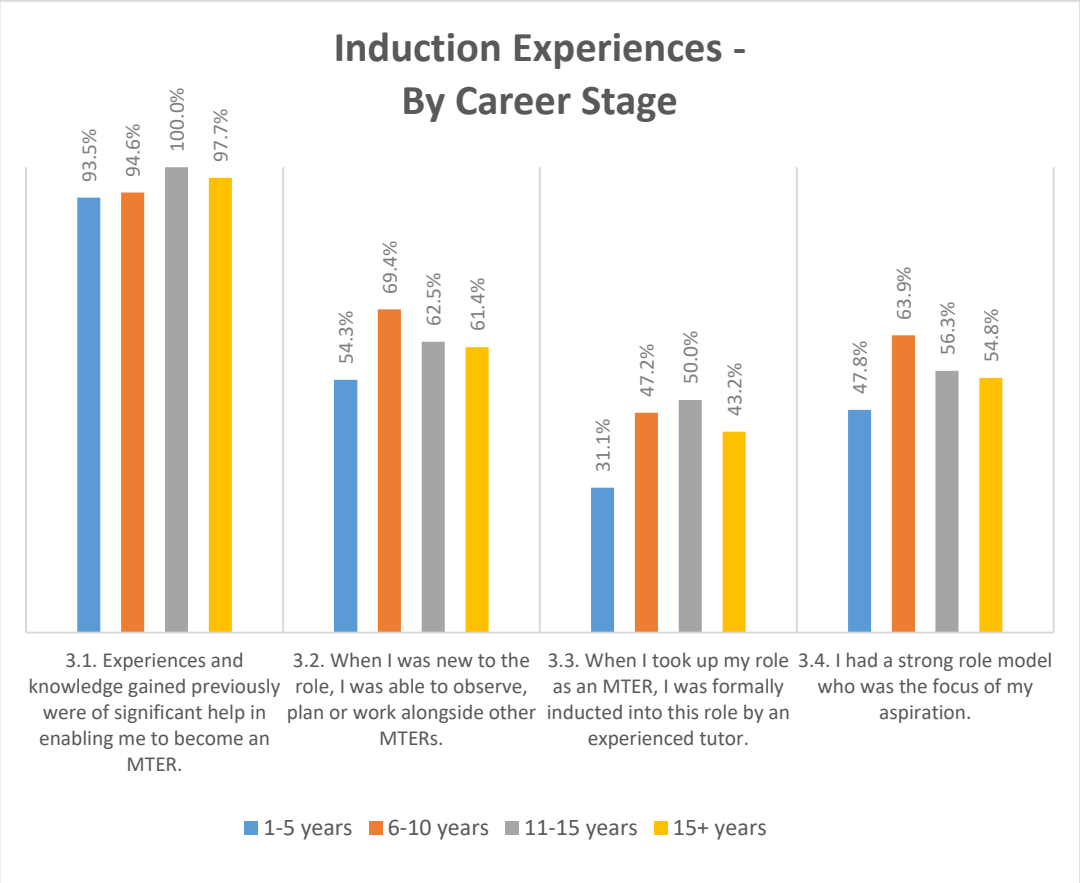
Chart B2: Agreement with statements about Induction Experiences by Age Phase



In Chart B3, fewer of those recruited to the profession in the past 1-5 years reported experiencing induction processes (QS3.3), having role models (QS3.4), or initially working alongside other MTERs (QS3.2). None of these differences is statistically significant, and this effect may be a sampling artefact, as within this category on both QA3.2 and QS3.3 lower scores are recorded for the 1-2 and 3-5 year categories than for those in their first year.

However, in QS3.3 only around one third (31%) of MTERs appointed in the past 5 years reported undergoing any kind of formal induction process; this is approximately the same for each of the three groups comprising the 1-5 year category.

Chart B3: Agreement with statements about Induction Experiences by Career Stage



Open-Response items.

In the open-response items in, 62 respondents commented on their early experiences. Many were positive; others less so. The responses have been categorised below.

Experiences with Mentoring

There were some positive experiences with mentoring:

> "I was fortunate to have a mentor who was a mathematics specialist."
>
> "I was lucky enough to have an excellent colleague who informally inducted me into my MTER role and has guided me throughout my career as an MTER."
>
> "…an exceptional mentor and role model who continues to guide my development."
>
> "… my professional mentor was critical to my development."

Sometimes mentoring was minimal or non-existent, sometimes with profound effects:

> "I had very little formal induction",
>
> "When I first started, I was simply given Powerpoints and expected to deliver these."
>
> "The previous incumbent could not get out of there quickly enough and I was thrown in feet first. … it was partly good to have free rein, partly terrifying."
>
> "I was more or less left with a blank canvass to design an ITE curriculum."

Support from Peers

Informal advice and support from colleagues was seen as important:

> "informal support and advice from other colleagues was also hugely helpful."
>
> "My team of experienced lecturers have given me fantastic, pertinent advice."
>
> "I was lucky to join a very supportive team of maths teacher educators. Support and guidance therefore flowed informally from the team, it was not a formal process."

Collaborative Working

Other respondents cited the benefits of working collaboratively as a means of induction:

> "… working alongside more experienced colleagues"
>
> "Working with outstanding teacher educators (one in particular) who supported my development and helped me to understand what it meant to be a good teacher educator."
>
> "I joined a team of 4 or 5 primary maths teacher educators. We planned together which was very supportive. I learnt a huge amount from the team."
>
> "Strong team of MTER in department. Opportunities to share and move forward together."

For one MTERs their initial entry into the profession posed distinct challenges, and may have been the cause of some anxiety:

> "I somewhat doubted my expertise as a 'master' teacher and often worried that there may be gaps in my practice."

Another felt that the whole idea of induction and mentoring was unnecessary, and that working collaboratively was far more important:

> "I do not think treating new MTERs as 'novices' makes a lot of sense. MTERs are already experienced professionals on the whole. It was important to me that my v[ery] experienced colleague and I worked together closely but not as expert and novice, as colleagues, learning from each other."

Summary

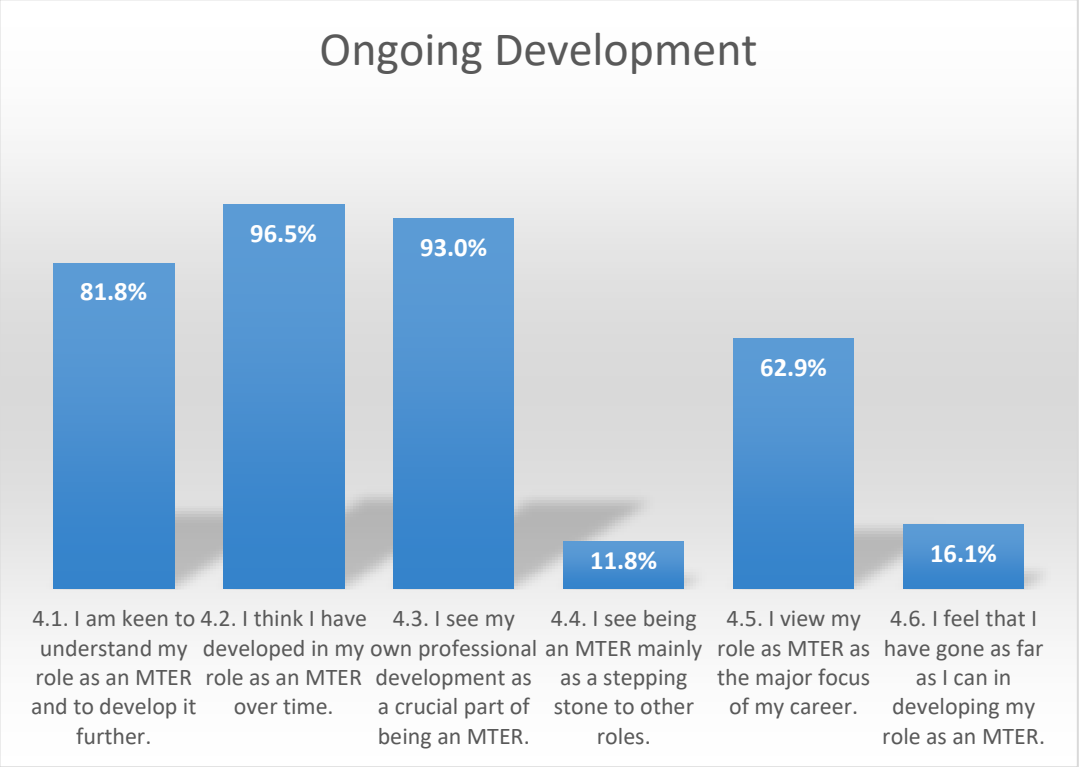
Previous experience and knowledge are seen as crucial in the early stages of becoming an MTER. Less important is the idea of a role model; instead, many cite working alongside other, more experienced MTERs, as an important factor. There is relatively low incidence (41%) of formal induction processes, and this might even have been reduced in the past 5 years. Many reported positive influences from mentors, and from peer support and collaborative working – either involving colleagues within the organisation or from elsewhere.

5.1.3 Questionnaire Section 4: Ongoing development as an MTER

From Chart C1, 93% of respondents see professional development (QS4.3) as a crucial part of being an MTER, and claim to have developed during their time in post (QS4.4 = 97%). Almost as many (82%) wish to deepen their understandings and further develop the role in future (QS4.1).

63% of respondents view being an MTER as the major focus of their career (QS4.5), and very few MTERs (12%) see the role as a stepping stone (QS4.4), or think they have reached the end of what they can achieve (QS4.6 = 16%).

Chart C1: Respondents expressing agreement or strong agreement with statements about their ongoing development as MTERs



From Chart C2, more of those with an FE focus saw the MTER role as a stepping stone (QS4.4), and fewer saw being an MTER as their main career focus (QS4.5). This latter result straddles the border of significance (ANOVA p=0.052; K-W p=0.044). However, even if the effect were real, it would still only apply to a very small minority of MTERs teaching in FE, all of whom said that they were keen to develop their ongoing role, and only 6% saying that they had gone as far as they could in developing the MTER role.

Chart C2: Ongoing development as MTERs by Age-Phase

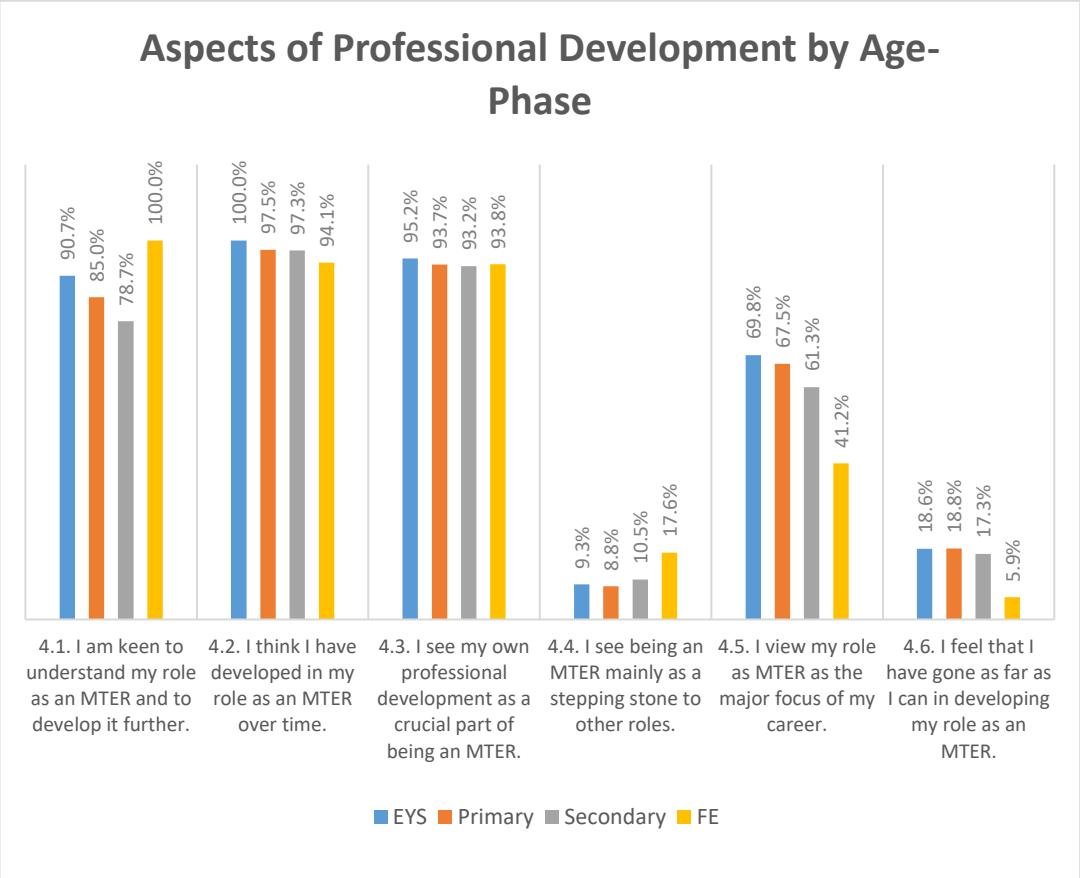
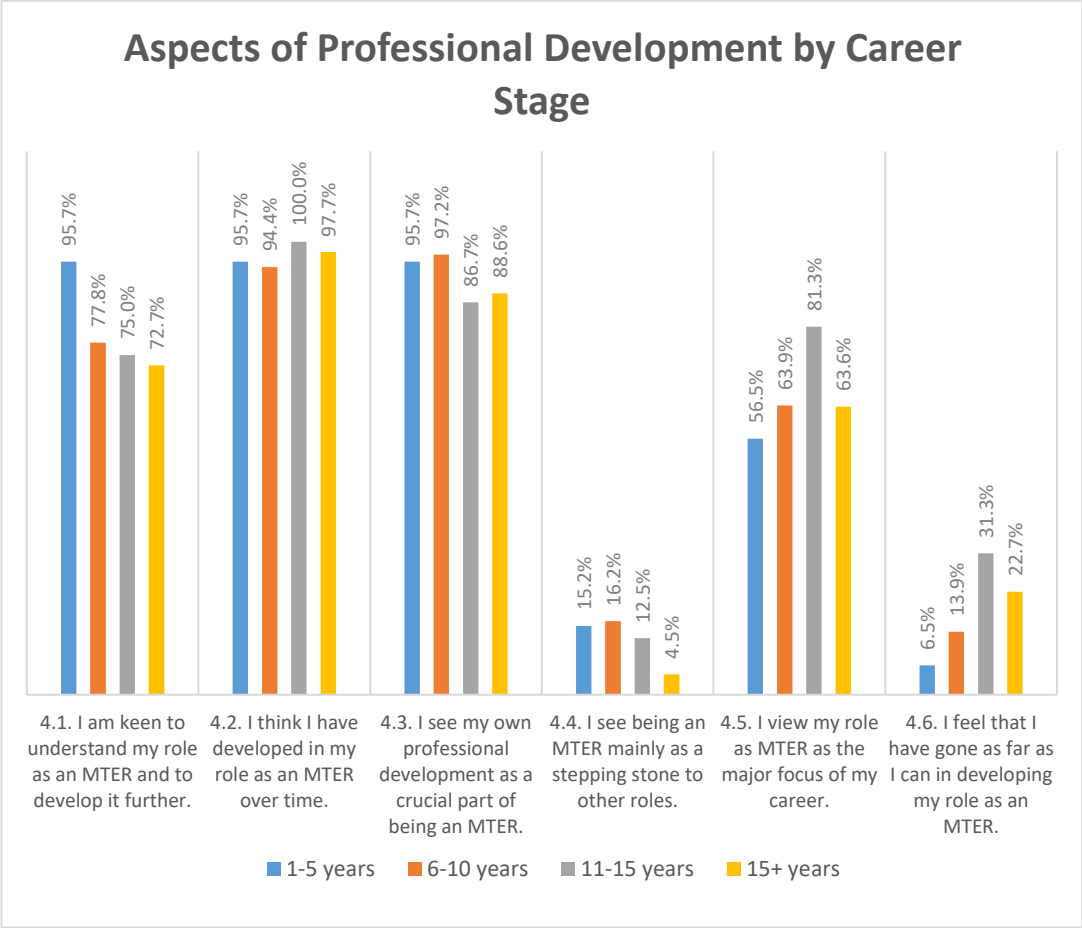


Chart C3 shows differences between MTERs' opinions in each career stage.

More MTERs in earlier stages of their career say that they are keen to understand their role and develop it further (QS4.1); this is statistically significant (ANOVA p= 0.023; K-W p = 0.010). Paradoxically, the proportion of MTERs of over 15 years standing, saying that they have gone as far as they can in developing their roles is only around one third of the proportions in earlier years (QS4.6). Here ANOVA yields p=0.040, and K-W yields p = 0.063; however, the data fails the Levene's test (LH: p=0.013), so the result is not statistically significant.

Chart C3: Ongoing development as MTERs by Career Stage



Open Response items

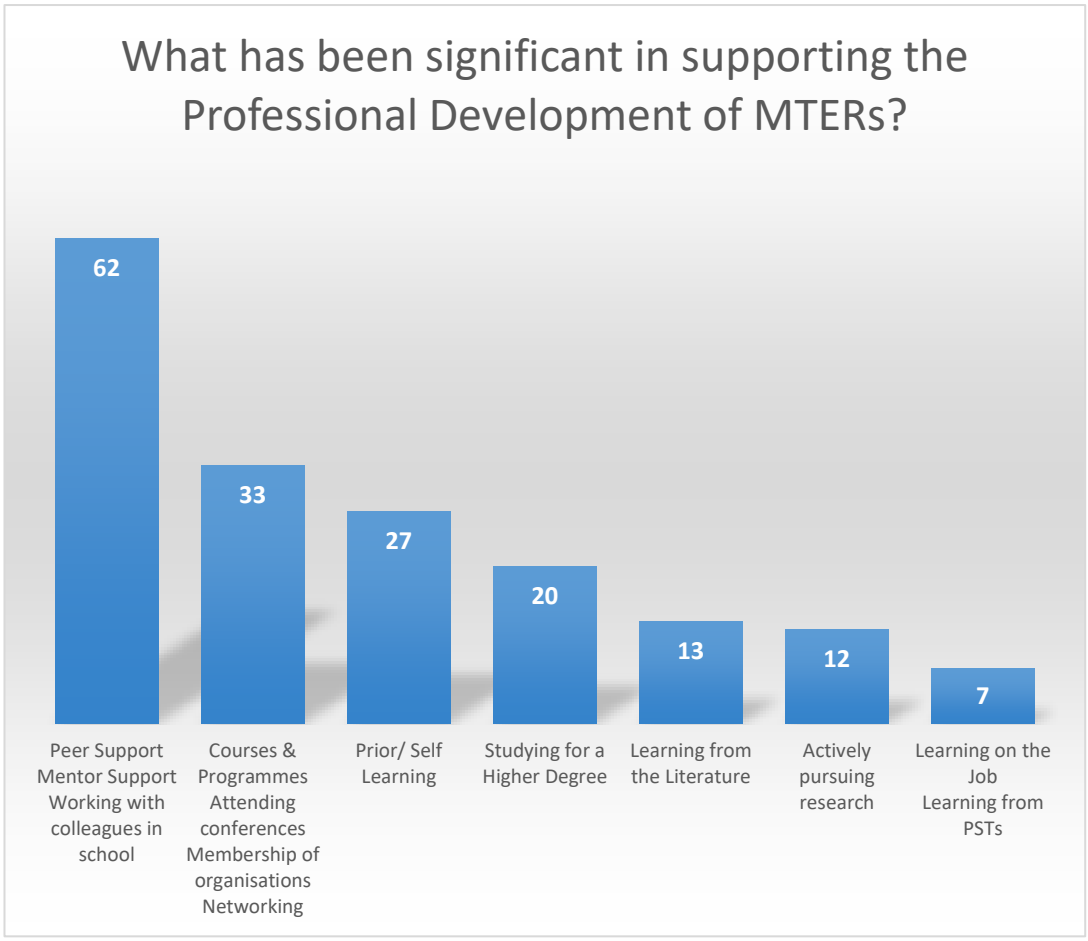
Charts C4 and C5 summarise the comments from the 112 out of 144 (78%) respondents who completed the open response section. There were 174 separate comments on issues related to professional development (Chart C4), and 95 comments about the challenges faced (Chart C5).

Chart C4 below shows that the previous induction-related issues mentioned of mentoring, peer support and collaborative working appear in over one-third of the comments.

Other issues mentioned were: courses and conference attendance; self-learning; and studying for a higher degree, with some respondents viewing professional development as a combination of all of these:

> "Starting my PhD, working alongside experienced MTERs, attending conferences and other CPD, reading up around teacher training, experience."
>
> "Engagement in reading and research, partnership with schools and being involved in wider groups related to mathematics education. My Master's study involved research in mathematics education and this was particularly useful and my current PhD study is informing my development too."

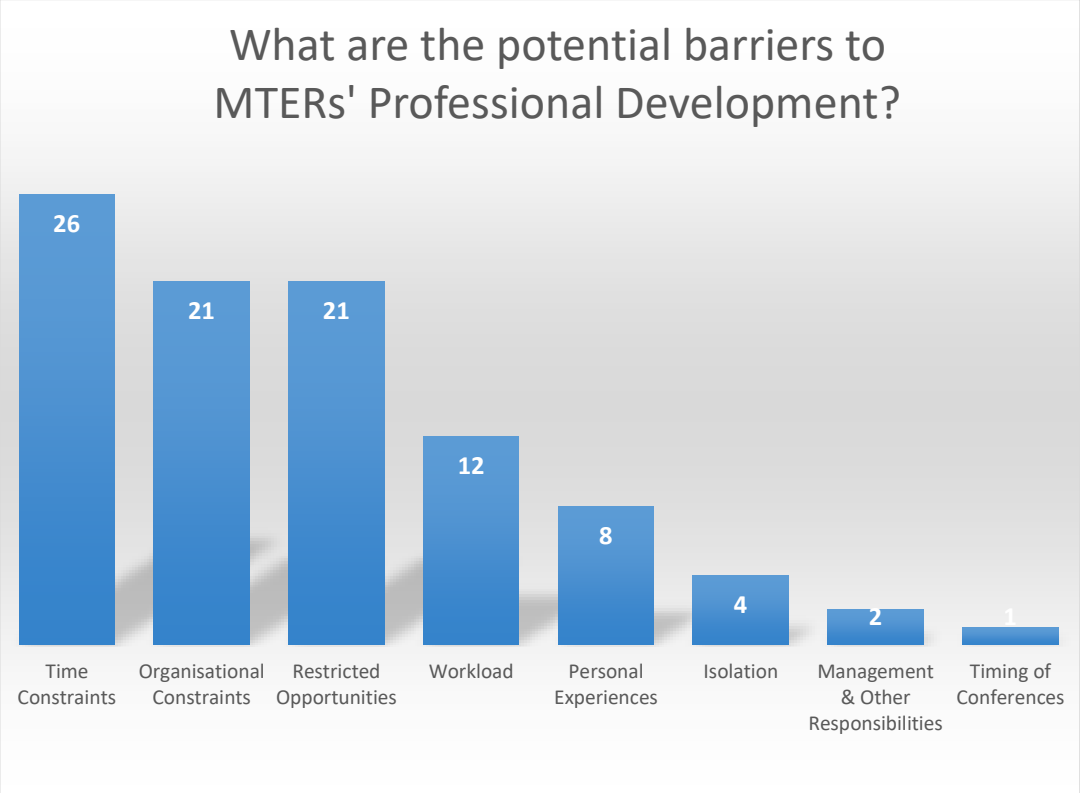
Chart C4: Categories of Professional development as reported by MTERs.



The barriers to professional development (Chart C5) seemed to revolve around time, workload and organisational constraints:

> "Time - there are many other requirements within my current role which mean I cannot spend as much time as I would like developing the role. "
>
> "Time constraints which prevent me from spending time on research and developing my role. Completing too much admin and 'firefighting' issues."
>
> "There is a significant level of administration and auditing which takes time away from what could be much more productive use of my time in terms of my own development."

Chart C5: Barriers to Professional development as reported by MTERs.



The responses show that MTERs highly value their professional development experiences, but many appear to be struggling to fit these into busy schedules in any systematic manner. Attending courses and conferences, and studying for a higher degree are all valued, but these do not seem to be the main sources of professional development cited; instead collaborations and discussions with peers form the main sources of development, as well as self-study, scholarly activity and the pursuit of research.

Summary

There is a clear drive in MTERs for professional development, both to deepen understanding and to maintain their progress in the role. Almost all MTERs claim that they have developed as professionals during their time in post. There are very few variations across age-phases, and those which may be apparent are ambiguous. There are some differences in terms of career stage – for example, in the earlier career stages, there was greater motivation to understand the role and develop it. Only a small minority of those in any career stage thought that they had gone as far as they could in developing their role, even – and especially- those who had been MTERs for 15 or more years.

Respondents cited as significant contributing factors for professional development: collaborative working with others; courses and conferences; research activity, and self-study. Barriers to professional development are time and organisational constraints, often resulting in restricted opportunities, with many MTERs citing workload-related pressures. Given these facts, and my personal knowledge of Universities, it is possible to abduce a model of MTERs striving to develop as professionals, yet being thwarted by the organisational systems in which they find themselves. In these circumstances it would perhaps not be surprising if the main source of professional development were via collaborative working with others, self-study or research activity.

5.2 *Doing* (Questionnaire Sections 5, 6 and 7)

This section is mainly concerned with job descriptions and how MTERs view the focus of the role.

5.2.1 Questionnaire Section 6: The Roles and Responsibilities of an MTER

Chart D1 shows that fewer than 40% of MTERs claimed to have a full job description (QS6.1), with over 80% of MTERs agreeing that that they set their own agendas of priorities and commitments (QS6.3), and around three-quarters of MTERs (73%) that it is not possible to provide a comprehensive list of all the activities associated with the MTER role (QS6.2).

There is a slight association with age phase in the results of QS6.2 and QS6.3 (Chart D2), with more of those in Secondary and FE phases agreeing than those in Primary and Early years phases: for QS6.3 (the setting of own agendas) the difference is statistically significant. (ANOVA p=0.010; K-W p= 0.005).

QS6.2 (Chart D3) shows a difference between Career Stage (Chart D3), with more of those in later stages of their careers agreeing that the role cannot be encapsulated within a job description. On QS6.3, over 80% of those in post six or more years, claim to set their own agendas. However, neither of these is statistically significant. For QS6.1, fewer than 15% of those who have been in post for 15 years or more claimed to have a job description, less than half the percentage for those at other career stages. The differences here are statistically highly significant (ANOVA p= 0.001; K-W p= 0.001).

Chart D1: Respondents' Agreement with Statements about Roles & Responsibilities

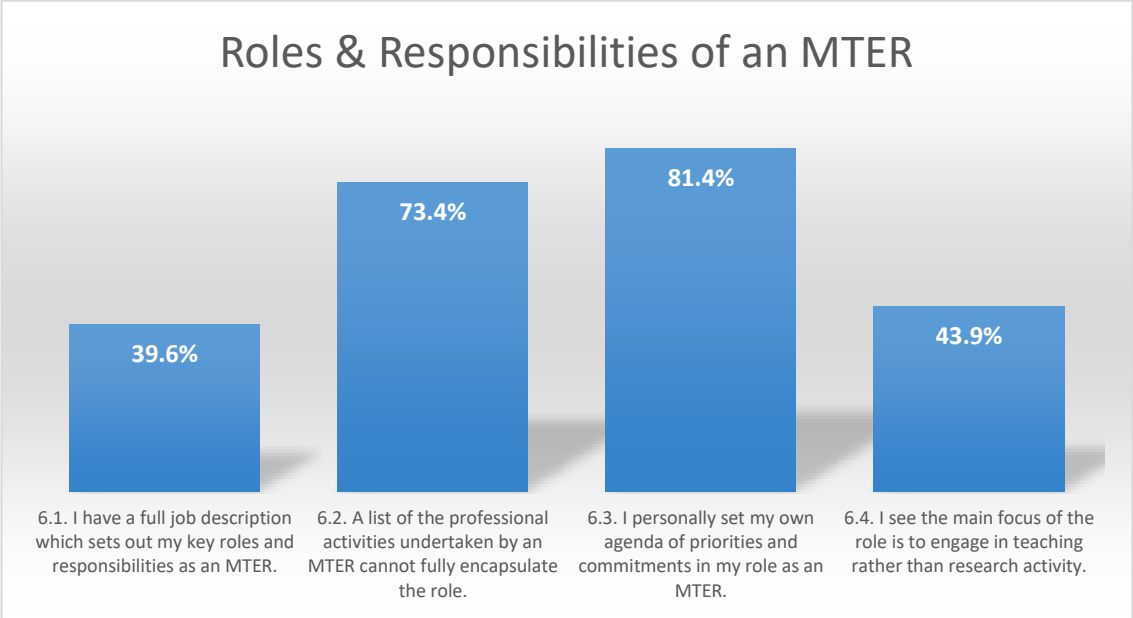


Chart D2: Agreement with Statements about Roles & Responsibilities by Age Phase

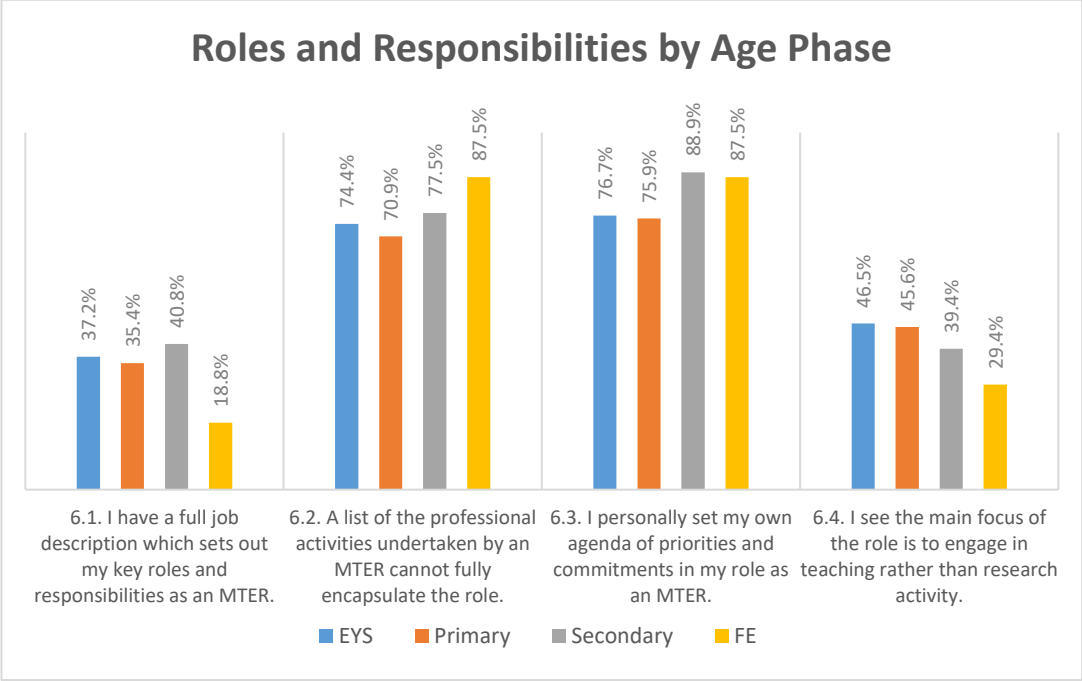
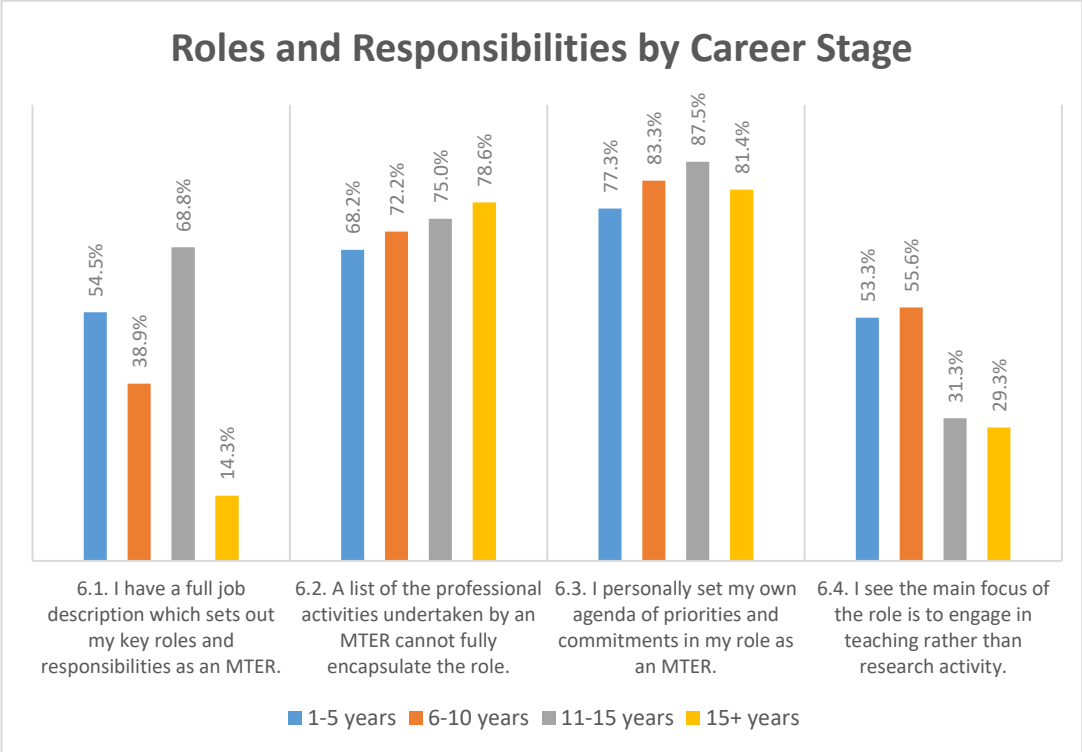
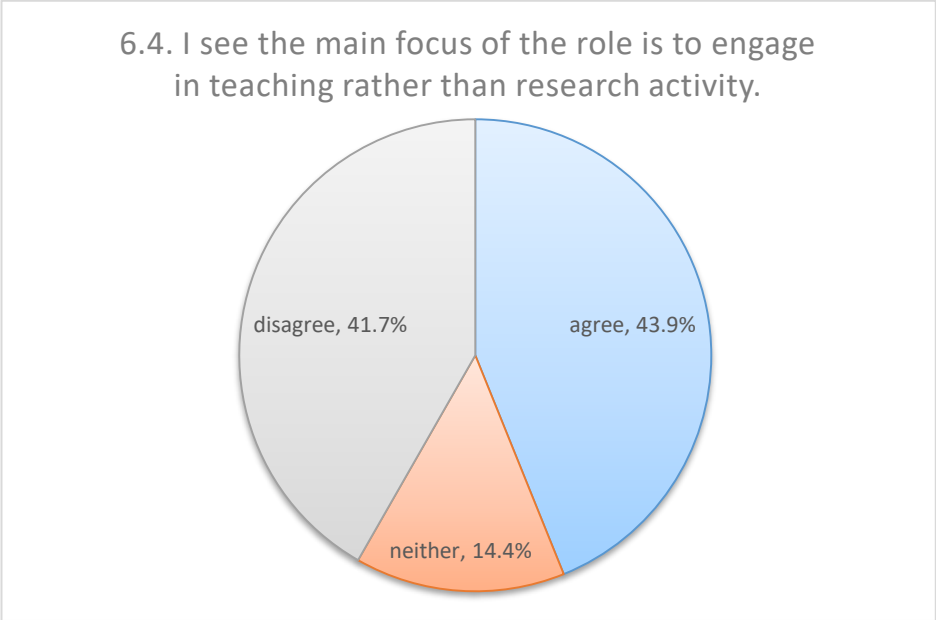


Chart D3: Agreement with Statements about Roles & Responsibilities by Career Stage



A crucial question is what MTERs see as the main focus of their role. An analysis of QS6.4 (Chart D4) shows a divergence of opinion as to whether this is teaching or researching, with just over 40% agreeing that teaching is the main role, around the same number disagreeing, and just under 15% not expressing an opinion. There figures here for EYS (47%) and Primary (46%) are higher than the other phases. Around 55% of those in the first 10 years see teaching as their main focus, but this drops to around 30% after this period (Chart D3). Neither result is statistically significant however.

Chart D4: Item 6.4: Main focus of MTER Role – Teaching versus Researching?



5.2.2 Questionnaire Section 5: Main Focus of the Current Role

Role focus was further explored in QS5, giving a list of alternatives to describe the main focus of an MTER's role. Chart D5 shows that around one-third of MTERs consider their main focus to be the mathematical education of teachers and prospective teachers (PSTs), with only 7% citing research in mathematics education as their main concern. This might appear to conflict with the results in chart D4, where the figure for "teaching" was 43.9%. The difference in wording here is crucial, however.

In terms age-phase and career stage (Charts D6 & D7), around half of all secondary-phase MTERs agreed that the mathematics education of teachers/PSTs was their main focus, but in the other phases this proportion was 30% or even lower. Only 20% of those who had been in the profession for 15 years or more saw the mathematics education of teachers/PSTs as their main focus compared with at least 30% of those in earlier stages.

Of the 61 respondents (43.9%) who prioritised teaching over research on QS 6.4, just over half (51%) declared that the main focus of their role was the mathematical education of teachers/PSTs, with one-fifth (21%) saying that their role includes both teaching and research and a further one-fifth (18%) that mathematics education is only one of their areas of interest. In fact, the forced choice on QS6.4 (Chart D4) caused two-thirds (31/47=66.0%) of those who declared that their main role was the mathematical education of teachers/PSTs to choose teaching over research, and a third (13/39=33%) of those who said that their role focuses on *both* research and teaching to choose teaching when forced into a direct choice of priorities.

In terms of career stage, majority - 32% of the 43.9% who prioritised teaching, were in their first 10 years. This complements the result from chart D6 that the majority of those who saw research into maths education as being their main focus were in fact MTERs who had been in role 15 years or longer.

However, as is noted below, even this picture is complex.

Chart D5: Overall Best Current Role Description

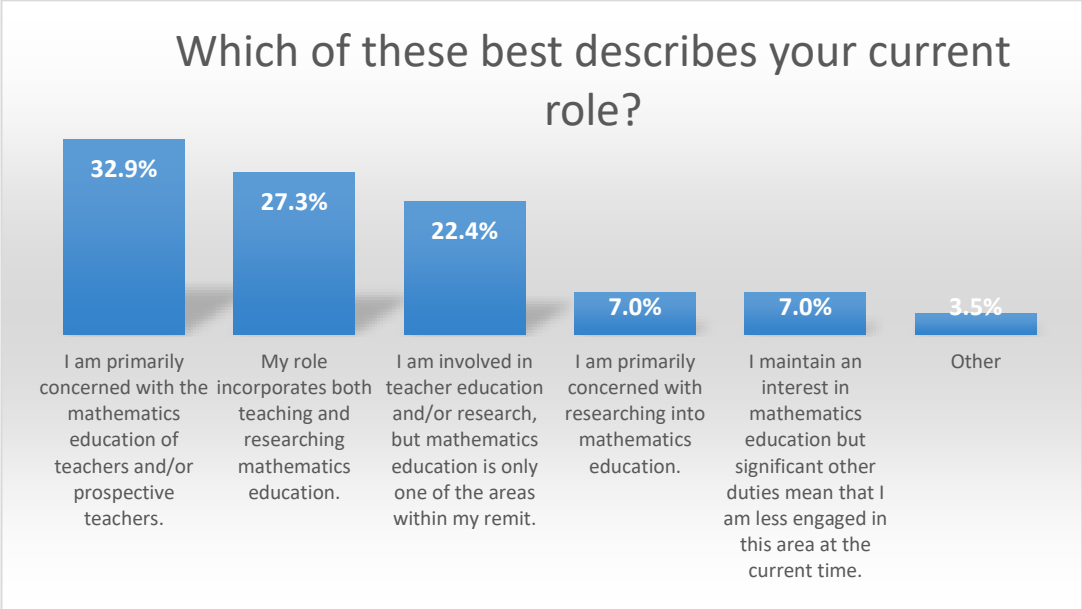


Chart D6: Overall Best Current Role Description by Age Phase

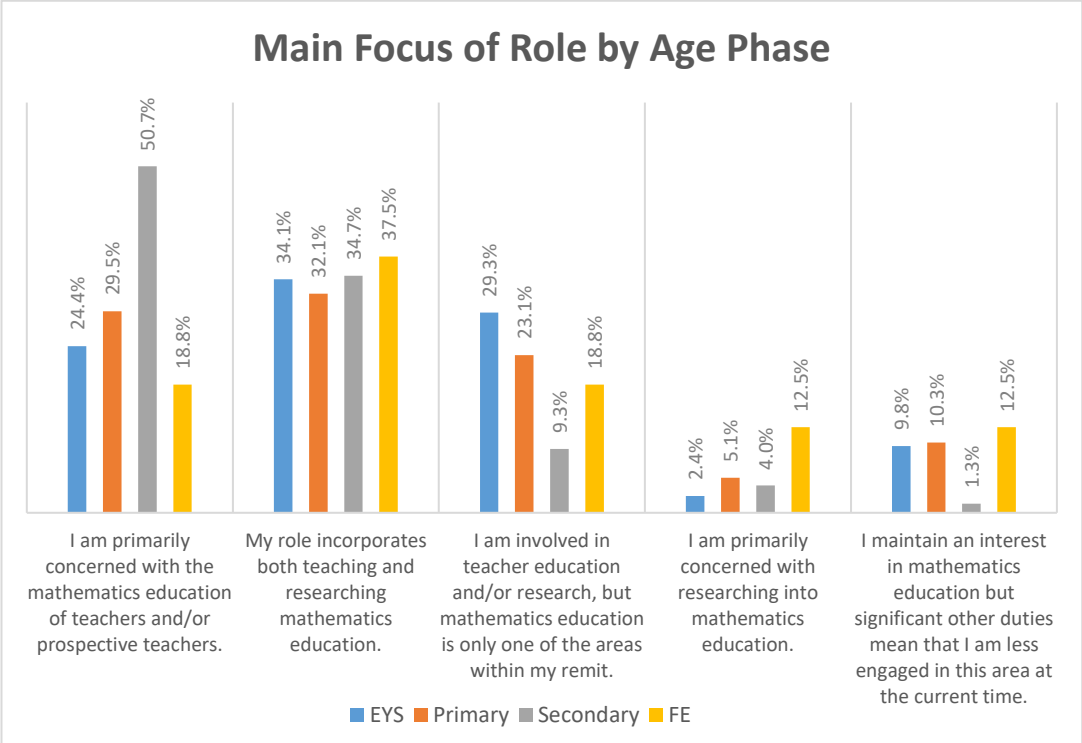


Chart D7: Overall Best Current Role Description by Career Phase

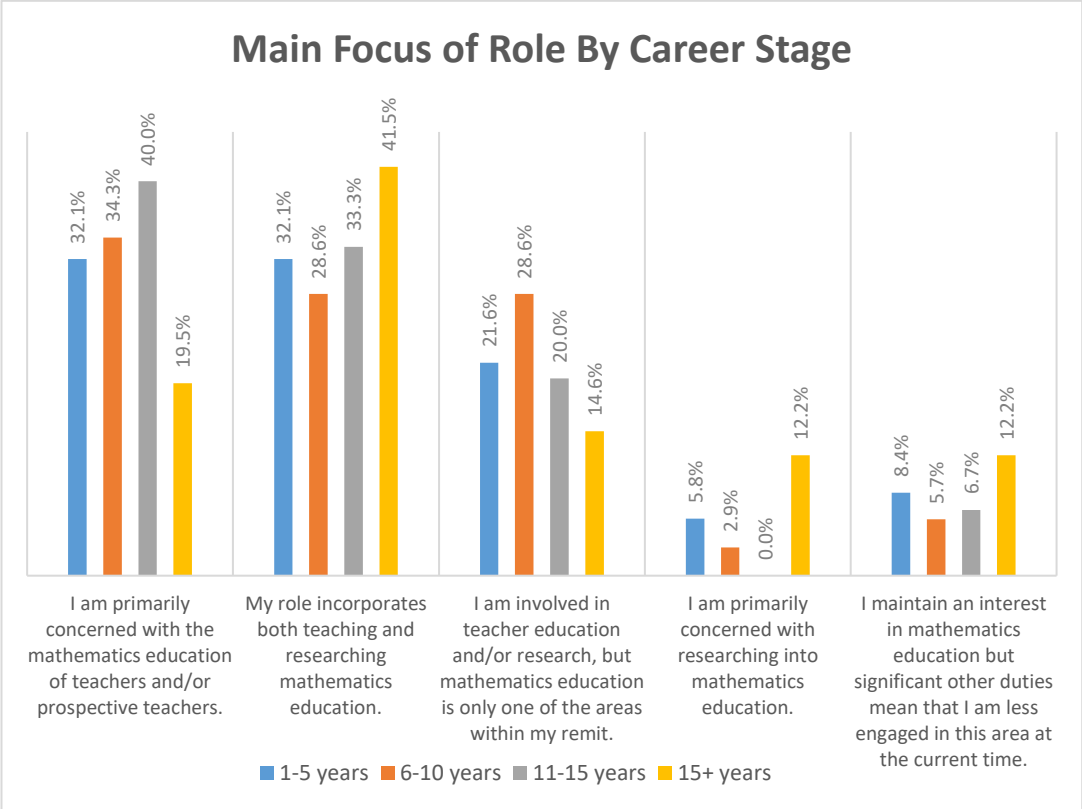
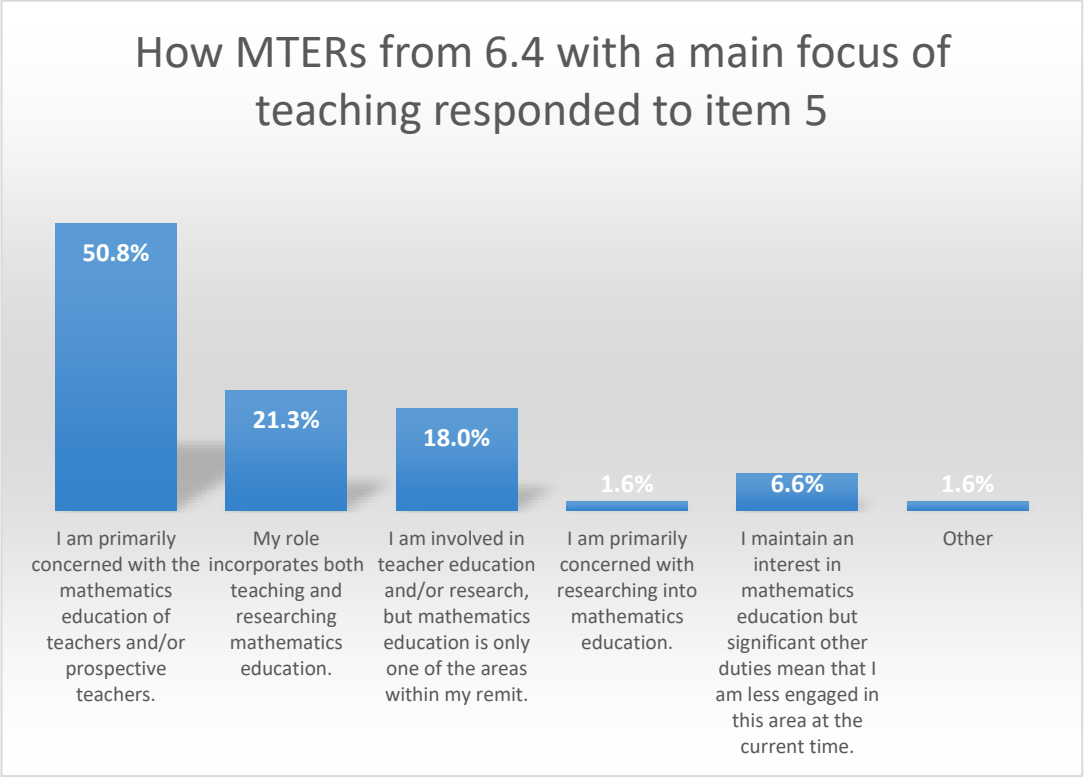


Chart D8: How the MTERs who think their main focus is teaching see their roles



In QS5, respondents were invited to clarify aspects of their role. Some of the issues highlighted above are well-illustrated by one respondent who wrote:

> "My role combines both mathematics education of teachers and/or prospective teachers, and research in mathematics education - however currently the research side is difficult due to large cohorts of mathematics trainees and pressure to recruit."

This serves to show that how MTERs see their role may well be conditioned as much by the day-to-day exigencies as by their aspirations. In this case, perhaps suggesting a simplistic "teaching versus research" dichotomy may itself be inappropriate. All of these factors perhaps explain why in chart D1, almost three-quarters of respondents said that it is not possible to give an overall description of the role of an MTER.

5.2.3 Questionnaire Section 7: Elements of the MTER Role

QS7 asked respondents to select from a list of activities which elements they undertook in their current role. In Chart D9, the main activities are: teaching on ITE programmes (76%), devising and planning such programmes (70%), and assessing students on placement (69%). However, a large proportion of MTERs spend their time on research-related activities, including: conducting research (68%), contributing to colloquia and conferences (60%), teaching and supervising master's and doctoral students (57%), with a minority of MTERs peer reviewing and editing publications (34%) and actually organising colloquia and conferences (24%).

Chart D9: Activities undertaken by MTERs as part of their current role

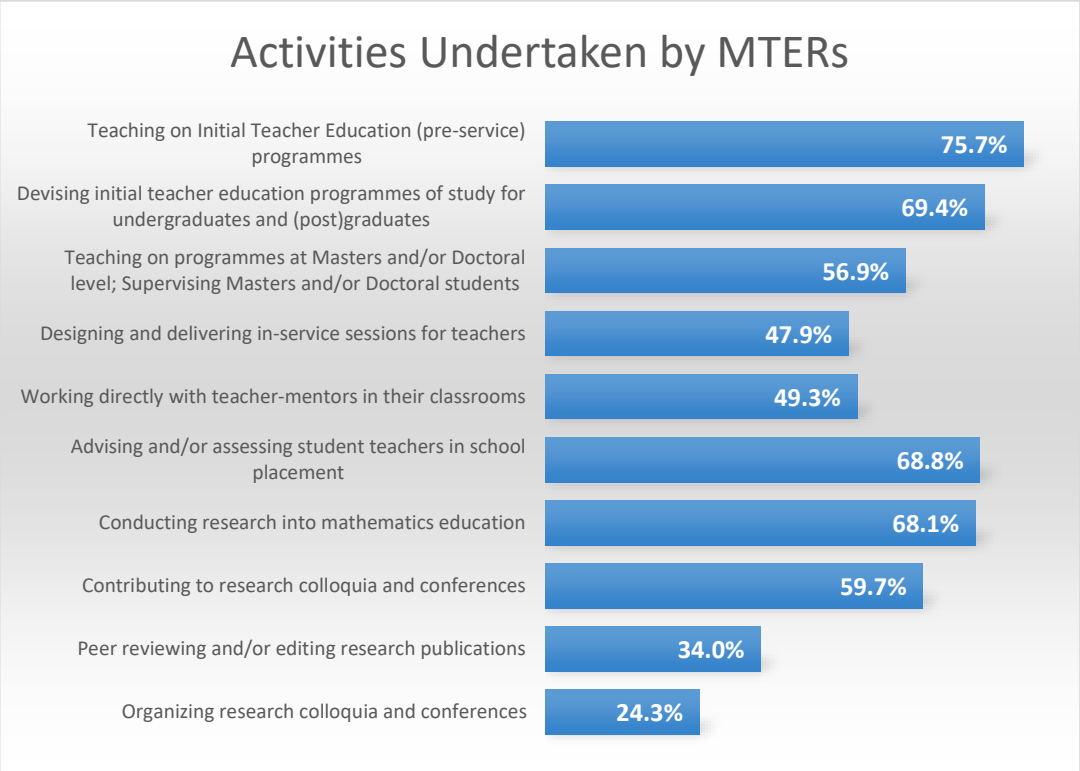


Chart D10 Activities undertaken by MTERs by Career Stage

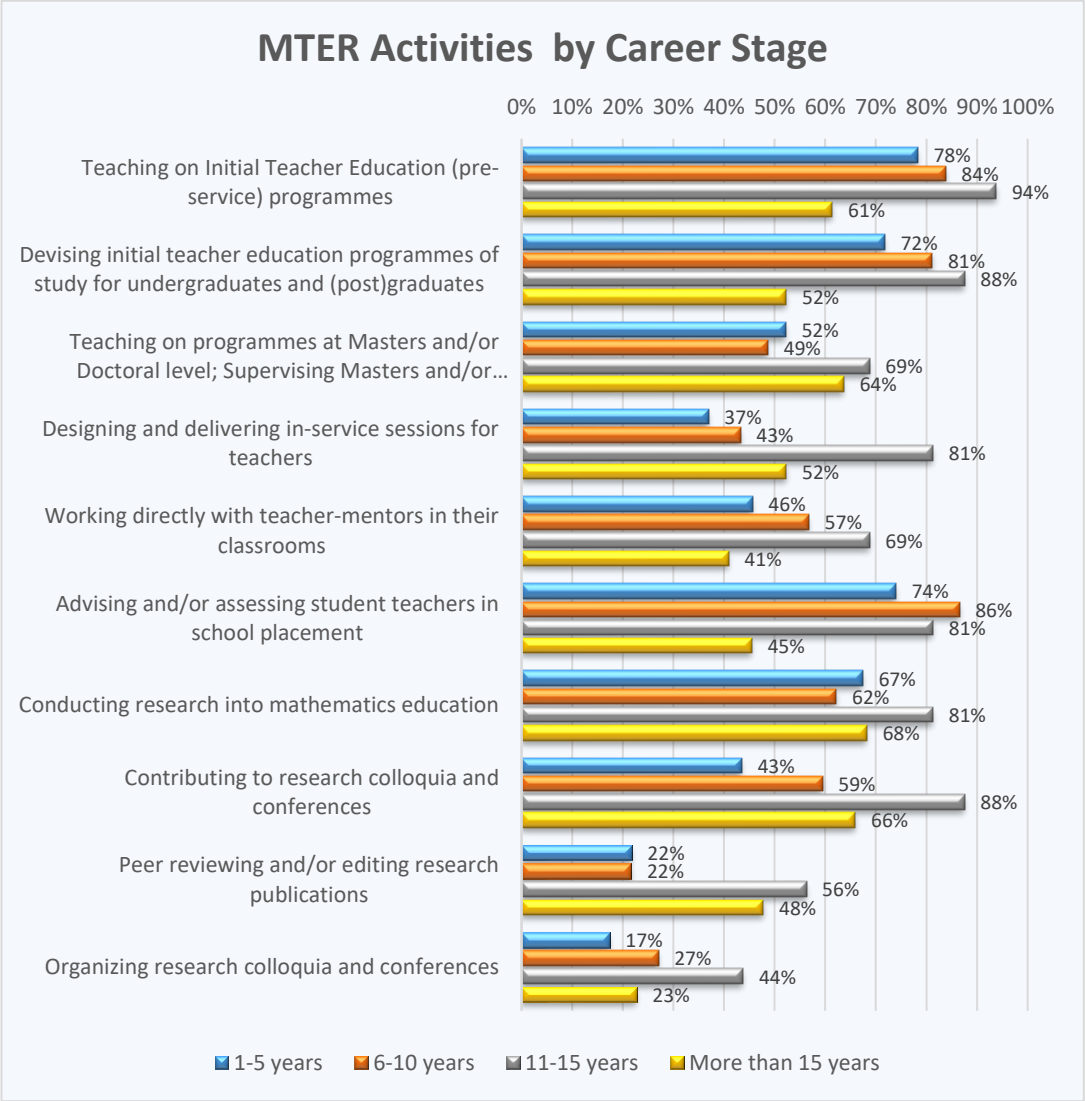


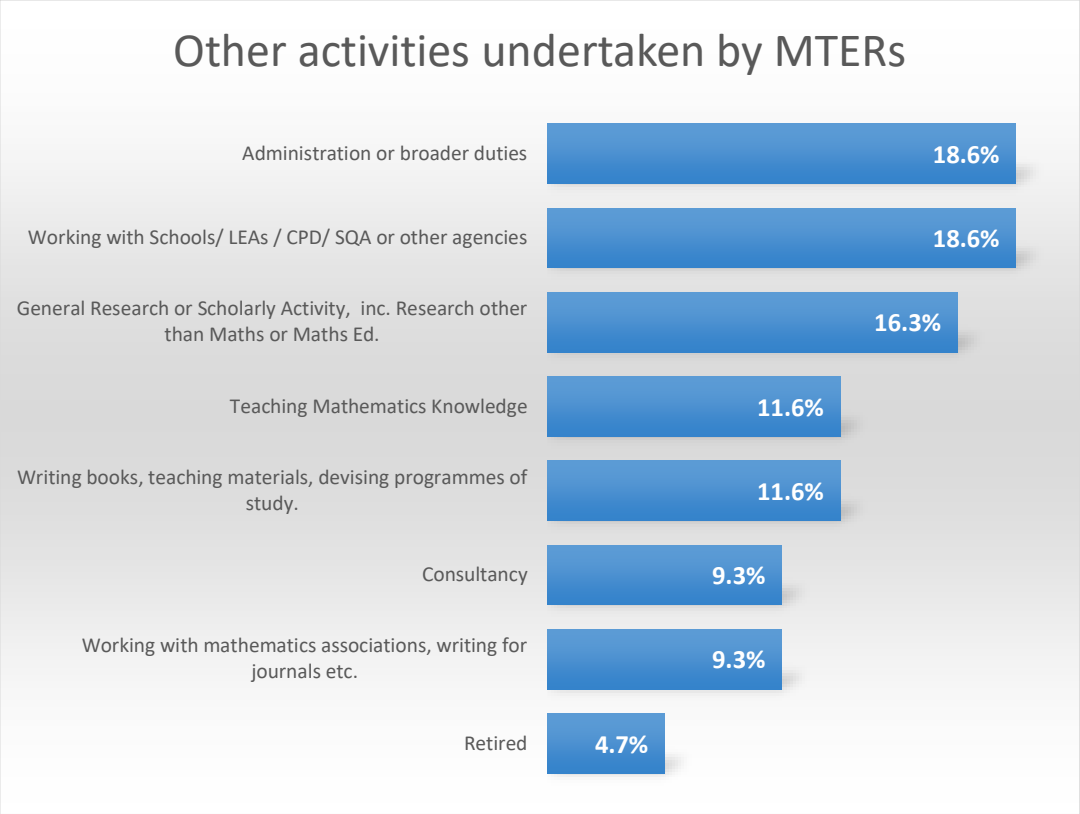
Chart D10 shows the same activities specified by Career Stage. The main observations here is that all of the activities are undertaken by MTERs at whatever stage of career they are. There is modest evidence of a shift over time towards research-related activities in MTERs, with less emphasis on teaching ITE students for those who have been in the role 10 years or more, as this group tended to do more teaching on Master's and Doctoral programmes, design and deliver in-service programmes with teachers, pursue research, organise colloquia and conferences, undertake peer review and edit publications.

Two ‘pen portraits’ from experienced MTERs, who have both been in role more than 15 years, provides a flavour of the breadth and depth of activities:

> “Managing colleagues' workload. Subject knowledge enhancement. Externally funded, expert consultancy both nationally and internationally”
>
> “Cpd for practising teachers; working with subject leaders and head teachers to improve mathematics teaching; designing opportunities for pupils, staff and students to promote mathematics; teaching in China with students to further explore pedagogical approaches.”

The open-response items in QS5 and QS7 allowed respondents to clarify or expand upon roles and tasks undertaken which they felt had been excluded from the prepared options. The 43 separate responses are categorised in Chart D11.

Chart D11: Other activities undertaken by MTERs



There are clearly a range of activities which had not been captured, including the amount of time MTERs feel they spend on administrative duties. A substantial amount of activity is also undertaken with partners in the region, and beyond, including consultancy work. Some MTERs are also called on to teach mathematical knowledge, typically in the form of subject knowledge enhancement.

Summary:

This section paints a picture of MTERs as being relatively autonomous, setting their own agendas and priorities, with only a minority having a formal job description. Indeed, most MTERs in the sample thought that it was not even possible to encapsulate the role in that manner**.** There are some indications that while this picture is a good description of many MTERs with a Secondary and/or FE focus, that it applies to fewer MTERs with an EYS or Primary focus. The picture also better describes the experiences of MTERs later, rather than earlier in their careers.

The dual aspects of teaching and researching provide an interesting window through which to view the role, and to see how MTERs both combine its demands and manage their personal interests, as well as the various ways in which the MTER role is played out in different institutions. Around one-third of MTERs said that their main focus was on mathematical education of Teachers and PSTs, with only a very small minority focusing on research. Again here, those MTERs whose main focus is on research, tend to have been in the role longer.

This section poses some challenges, since the questionnaire items in QS6 were few in number and limited in scope, and those in QS5 and QS7 offered set options. Most of the detail here has come from the open response sections. While this a useful starting point, it provides only a very broad brush on what is clearly a complex topic.

5.3 *Knowing* (Questionnaire Sections 8 & 9)

This block consisted of two sections: QS8 on Knowledge Requirements, and QS9 on Sources of Information.

5.3.1 Questionnaire Section 8: Knowledge Requirements as an MTER

QS8 focused on the knowledge required and the skill sets demanded for MTERs to carry out their role. The results here are complex, and have been grouped into sections.

(1) Items 8.2, 8.6, 8.7, 8.8.

From Chart E1, the overwhelming majority agree that MTERs require a thorough understanding of pedagogical approaches (QS8.6 = 96%), together with an extensive knowledge base about teaching and learning (QS8.2 = 93%). They also need an understanding of how student teachers learn to teach (QS8.7 = 88%), and a detailed knowledge of relevant school curricula (QS8.8 = 85%).

Two of these four items (QS8.7, QS8.8) have a reducing profile of agreement by age-phase, and for QS8.8 this result is statistically significant, reducing from 95% in EYS to 81% in Secondary and FE (ANOVA p=0.008, K-W p=0.009). QS8.8 yields statistically significant differences between career stages: Only 73% of those who have been MTERs for over 15 years (Chart E3), agree, compared to between 87% - 94% of those in post for shorter periods of time (ANOVA p=0.046; K-W p=0.018).

The results from item 8.7 are less clear: there is a clear decreasing profile across the age-phases with EYS at 98% and FE at 82%, but this is not statistically significant, and although the results for career stage do demonstrate differences – with only 75% of 15+ years MTERs agreeing, compared to over 90% of those in post for shorter periods of time, the tests merely straddle significance levels, with ANOVA (p=0.034) significant, but K-W (p= 0.063) not significant.

(2) Items: 8.1, 8.4

In Chart E1, just under four-fifths of the sample (79.6%) agreed that there were specific minimum requirements for the role (QS8.1), with little variation between phases or career stages. A similar percentage (80.3%) agreed that MTERs required a

deeper understanding of mathematics subject knowledge than most classroom teachers (QS8.4). Only on Item 8.4, was there any statistically significant differences: for age phase, agreement reduced from 93% in EYS to 65% in FE (ANOVA p= 0.004, K-W p= 0.010), and while there was no observable systematic variation with career stage, individual percentages varied from 75% for the 6-10 years group to 94% for the 11-15 years group (Chart E3). The results from testing are once again ambiguous, with ANOVA (p=0.122) suggesting that it is not significant, but with K-W (p=0.035) suggesting that it is. This may be an artefact of low sample numbers in the 11-15 group.

(3) Item 8.5

Only 57% of respondents thought that the skill-set of MTERs was different to that required for the education of teachers in other subjects (Chart E1); there was little variation in this figure with age-phase (Chart E2), but in terms of career stage this figure rises to around 70% for respondents who have been an MTER for 11 years or more than, compared to 45-53% for those with less experience (Chart E3). This result is statistically significant (ANOVA p=0.012, K-W p= 0.016).

(4) Item 8.3

Only 12% of MTERs thought there was a single consistent view of how to teach aspects of the subject (Chart E1). This varied concomitantly with phase and career stage: 21% of MTERs with EYS focus thought there was a single consistent view, and this consistently reduced by phase until it reached 0% for MTERs with FE focus. This result is statistically significant (K-W: p =0.014). ANOVA here is an invalid test due to the rejection of Homogeneity. The effect for career stage was less dramatic, reducing from 15% for those teaching 5 years or less to 7% for those teaching 15 years or more, and was not significant.

Taken together these results are complex: however, one possible abduction here is that MTERs consider there to be differences in the types and levels of knowledge and understandings required of MTERs teaching in different phases. However, even if that is correct, what these differences are is unclear from this data. This item is used as a case study exemplar of *respondent validation* in Appendix E1.2.

Open Response Items

In the open-response item, some respondents replied at length, giving detailed lists of the knowledge, understanding and skill set they perceive are required of MTERs.

> "Strong subject knowledge; excellent teaching skills; excellent understanding of the curriculum and how children learn; excellent understanding of school needs; excellent understanding of students and how they learn; an ability to make maths accessible; a love of maths and of teaching in the classroom."

> "Good mathematics subject knowledge. Knowledge of research into general pedagogy and mathematics pedagogy in particular. Skills in working with students with different levels of subject knowledge of mathematics, including those who have a fear of mathematics themselves. The ability to inspire students with confidence and enthusiasm for teaching mathematics to all learners."

As can be seen from these examples, there is a long list of different items suggested via each of the open responses which proved problematic to disentangle. However, some of these were suggested multiple times by different respondents:

- a detailed understanding of pedagogy;
- a comprehensive knowledge of the research base;
- a knowledge of the curriculum and its socio-political context;
- a knowledge of mathematical content;
- a knowledge of how learners learn;
- a good experience base of classroom practice;
- an ability to engage and empathise with students;
- currency of knowledge;
- good presentation and communication skills;
- a passion for the subject;
- An ability to make connections between different elements.

This set of categories is a good starting point for a discussion on what are the precise aspects of knowledge, skills and understanding required by MTERs.

Chart E1: Respondents' Agreement with Statements about Knowledge Requirements

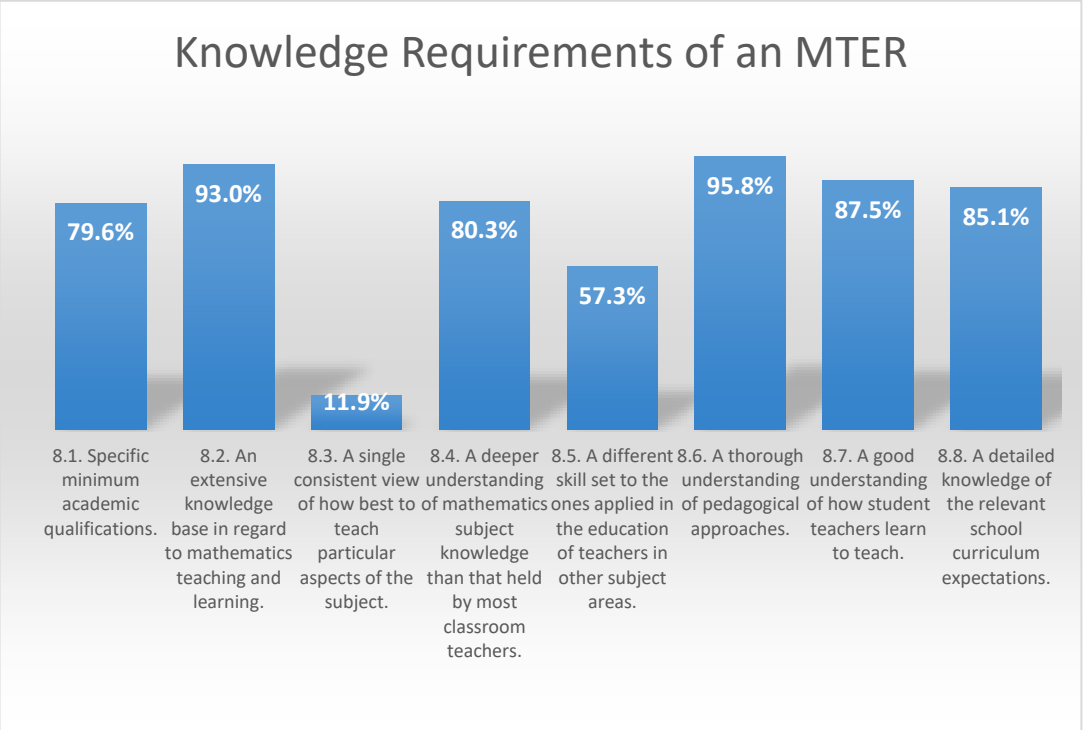


Chart E2: Agreement with Statements about Knowledge Requirements by Age Phase

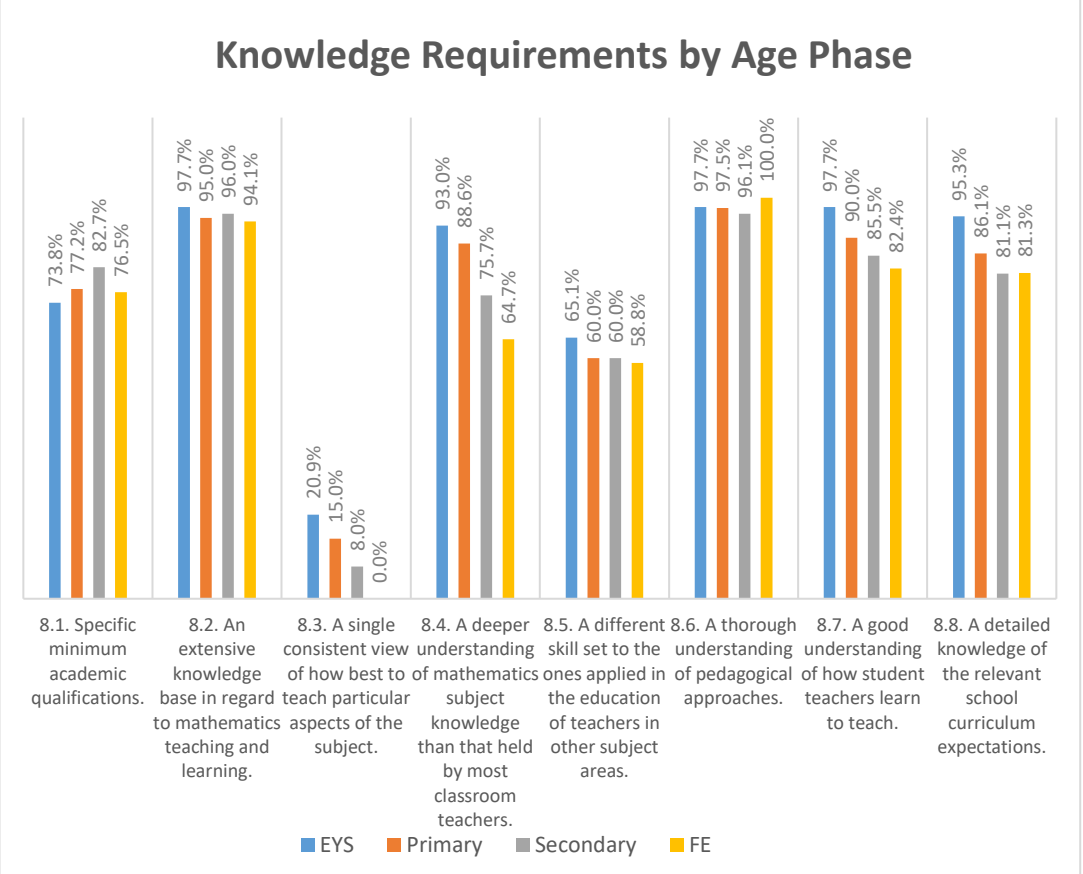
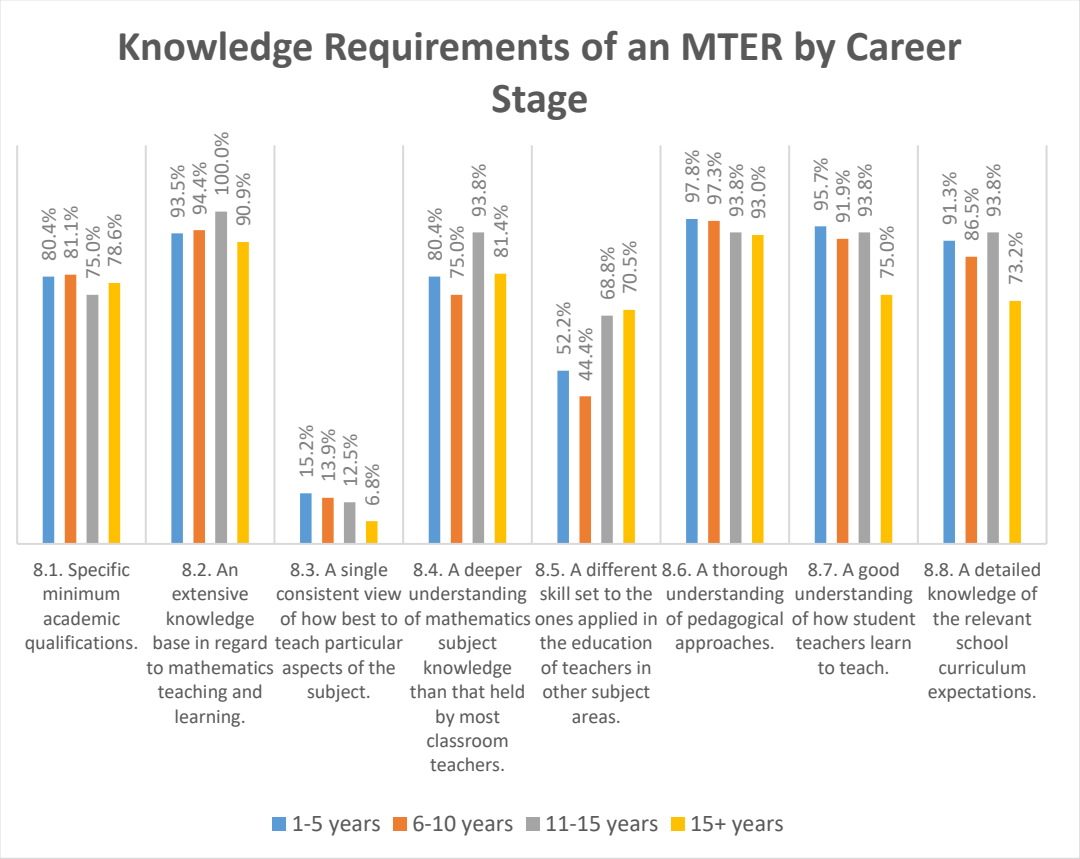


Chart E3: Agreement with Statements about Knowledge Requirements by Career Stage



Summary

MTERs almost uniformly agree that an extensive knowledge and skill base about teaching and learning is required in order to undertake the role. The open-ended responses showed this base to be diverse, covering mathematical content, how learners learn, knowledge of school curricula, empathy with learners, as well an ability to make connections. Knowledge of curricula are deemed less important by those with a later phase-focus, and by those with more experience in the role. Those in earlier phases consider it important to have a deeper understanding of mathematics subject knowledge than that held by classroom teachers. Those who have been in post longer tended to agree that the skill set required of MTERs is different from that required in other subject areas. Only a small minority consider that there was a single consistent view of how to teach the subject, and this reduces with age phase and somewhat with career stage. The open response items

confirmed the complexity of the knowledge and skill base, showing the diversity of knowledge and skills needed.

5.3.2 Questionnaire Section 9: Sources of Information Used by MTERs

This section asked MTERs about their sources of information. Almost every respondent (95%) agreed that their own experiences as a teacher and researcher was one of the most important sources (Chart F1). Percentage agreement varied by age-phase from 98% for EYS to 88% for FE (Chart F2), and by career stage: from 100% for those MTERs in role 10 years or less to 89% for those in role 15 years or more (Chart F3). This result is the only statistically significant result in this section (K-W: p= 0.024). ANOVA (p=0.006) too demonstrates significance but is invalid, since it fails Levene's homogeneity test.

This result can be abduced into a model in which the currency of personal classroom experience diminishes with time. In fact, all of those who said that they used personal experiences only infrequently had been MTERs for over 10 years. However, as the item mentions both teaching and research, this might be misleading, as this could also be explained in those cases by the research of some MTERs not being directly related to their own classroom practice. However, from personal experience, in many cases, MTER research activity focuses directly on teaching. This point might therefore be a useful focus of enquiry in the interviews which follow.

Other important sources of information were books and journals held in the library and personal books (both 89%). Resource books aimed at teachers were also used, but to a lesser extent (62%). In addition, 70% of respondents agreed that they also used information from conferences aimed at MTERs. None of these shows consistent variation between age-phases and career stages.

Chart F1: Respondents' Agreement with Statements about Sources of Information

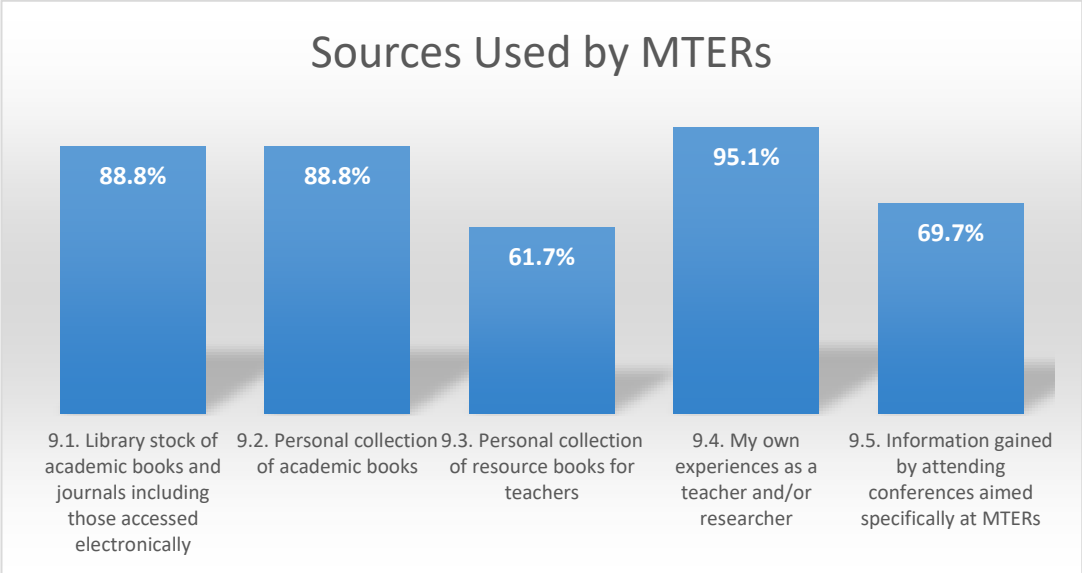


Chart F2: Agreement with Statements about Sources of Information by Age Phase

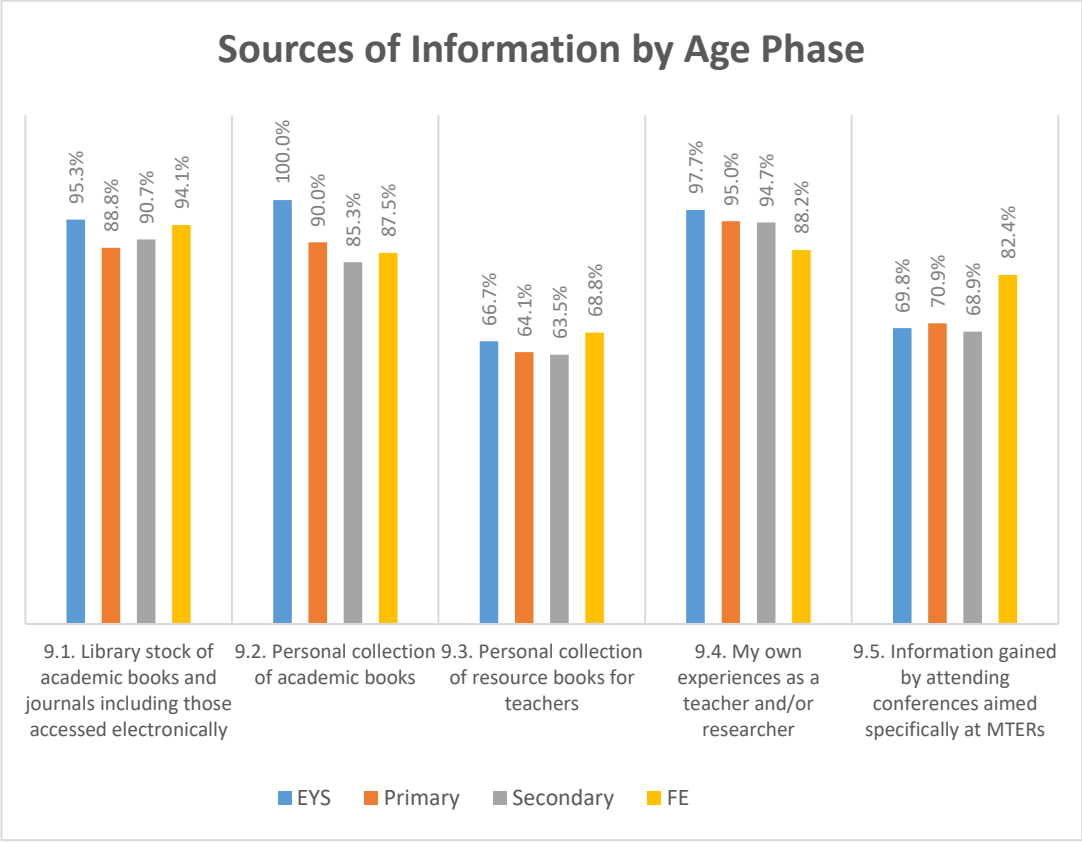
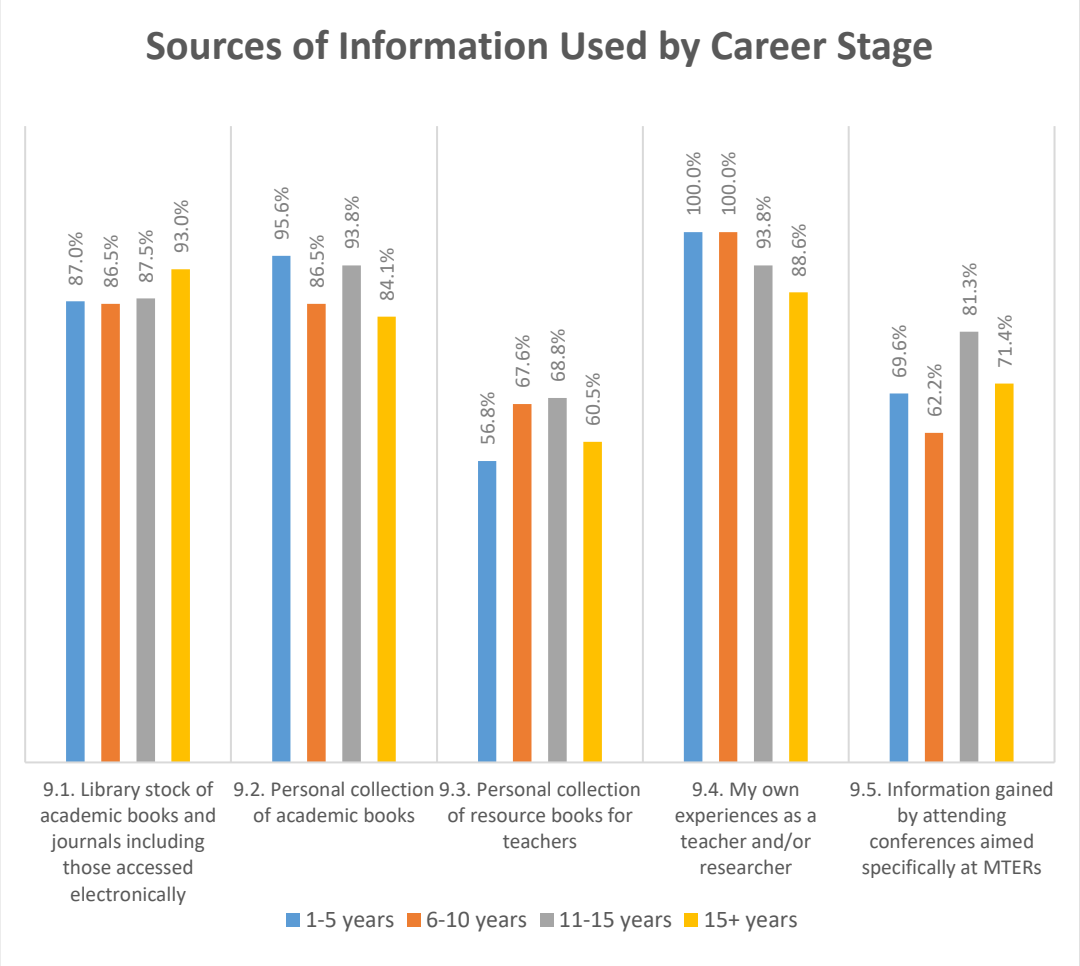


Chart F3: Agreement with Statements about Sources of Information by Career Stage



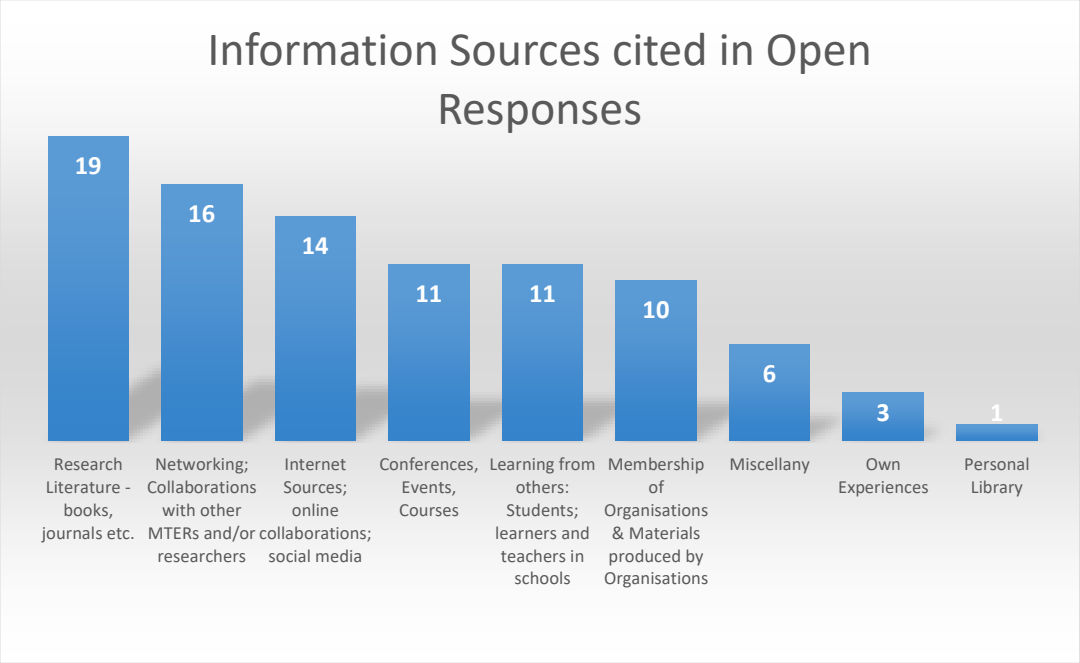
Open Response Items

Respondents were asked to cite other sources of information. Altogether 91 separate sources were gleaned from the 57 respondents who completed this section (Chart F4). 19 respondents (33%) cited the research literature and 11 respondents (19%) cited courses and conferences, even though these were option in QS9. Other sources cited, however had not been listed; these are:

- Networking with colleagues: (28%)
- Internet Sources, online collaborations: (25%)
- Learning from others: (19%).

In fact, these all tell a similar story – that of learning from peers. As one MTER put it, "[the]… Biggest resource is my fellow MTERs"; others mentioned "… "Knowledgeable colleagues", and "… information gained through networks". Some specifically included students and both teachers and children in these 'networks': "My learners are a rich source of information"; "Discussions with children and teachers", and from another MTER "As I work with practicing (sic) teachers, I build from their experiences too."

Chart F4: Information Resources cited in the Open Response Section.



Summary:

MTERs consider the most important sources of information to be their own experiences as teachers and researchers, but draw heavily on books and journals, both from their own personal stock, and the library. Other sources cited include the research literature and including attending conferences, networking with other MTERs, and internet sources. While these are broadly useful, they do not actually tell us what exactly MTERs are gleaning from these sources, nor how they are using this information. Almost all MTERs claim to draw on their personal experiences of teaching and research, but this seems to be somewhat less important for those longer in post, and it is unclear whether this is related to the currency of their teaching experience or the relevance of their research.

5.4 *Being* (Questionnaire Sections 10 & 11)

This block has two sections: one on the attributes of MTERs, the other on personal views on being an MTER.

5.4.1 Questionnaire Section 10: Attributes of MTERs

Chart G1 shows that three-quarters of the respondents (75%) agreed with QS10.3, that MTERs should have a well thought through philosophy of education. While this varied by age-phase (Chart G2) and by career stage (Chart G3), there is no overall pattern to these variations; nonetheless the differences by age-phase are statistically significant (ANOVA p=0.026; K-W p= 0.042).

70% of respondents agreed with QS10.2 -that specific skills and attributes are required, but only 44% agreed with QS10.1 – that a specific personality type was required. In neither case, is there systematic variation with career stage, but there is with age-phase: agreement with QS10.2 varies from 74% in EYS to 47% in FE, and agreement with item 10.1 varies from 56% in EYS to 29% in FE. However, none of these or effects is statistically significant.

In QS10.4 only 57% of respondents agreed that established MTERs should be making a significant contribution to research in their field. This is surprising, given the support for research noted earlier. However, there was no systematic variation with either phase or career stage, and neither was statistically significant. In looking at the open response items, one possible reason for the low figure of agreement may well be due to question phrasing.

One MTER suggested that in the context of the question *"Research' may be too broad"*; another noted that, *" 'Should' sounds like the pressure some colleagues feel in becoming a researcher."*, and yet another said, *"… not sure that I want to be so dogmatic about contributions to research- much depends on what is meant by 'significant'"*. These comments would tend to suggest that the 57% may not entirely represent respondents' actual views on the value of research, and the extent to which MTERs contribute to research in the field.

The other open responses in this section presented a wide diversity of different elements that MTERs clearly regarded as positively contributing to the role of a MTER. These included: empathy, a supportive nature, a positive attitude, a clear enthusiasm and passion for the subject, adaptivity, flexibility, a willingness to learn, an ability to listen, an open mind, tact, diplomacy and 'a thick skin'.

A flavour of the richness of responses can be obtained by considering the two pieces below written by MTERs themselves:

> "The responses above reflect my view of that to be a respected and effective MTER you need a particular personality, attributes and philosophy - but not that everyone's personality and attributes should be identical - it is important in a team that there are different facets but with a common shared philosophy. One could be a teacher educator with a very different philosophy to the one I believe is important, that could lead to people being good at 'teaching to the test', and so good for improving school GCSE results for example, but without being good at 'educating' pupils, making them think, making them appreciate the subject and generally empowering them for their future."

> "I think there would be lots of different qualities and attributes which may not all be present in one person but would contribute to being a good MTER - flexibility, open mindedness, willingness to learn, willingness to listen, proactive. I think that if you have lots of experience as an MTER it would be good to contribute to research in their field, but that would also depend on the person."

Chart G1: Respondents' Agreement with Statements about MTER Attributes

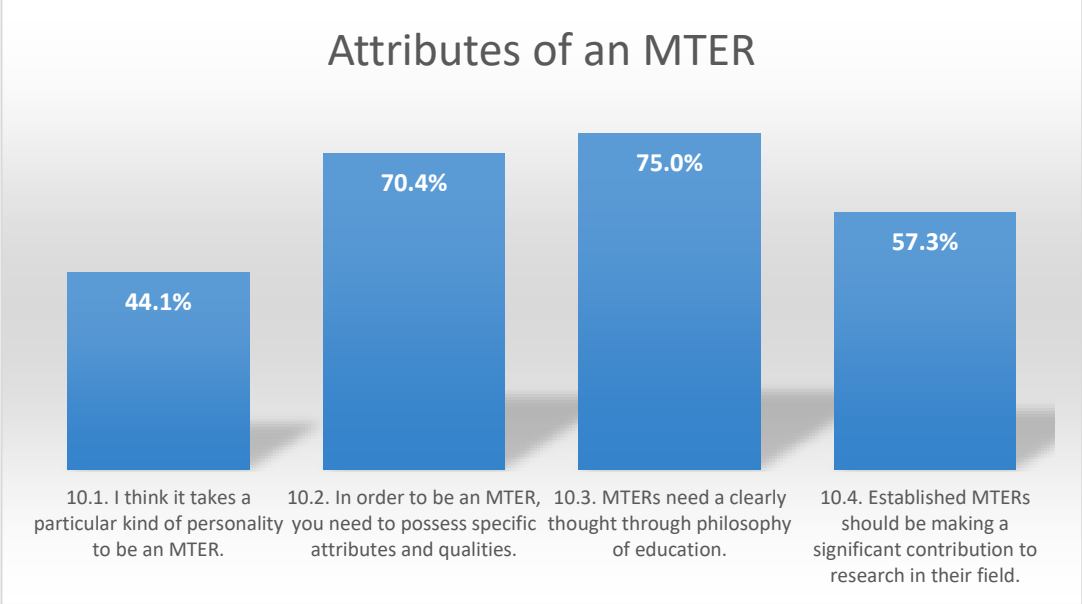


Chart G2: Respondents' Agreement with Statements about MTER Attributes by Age-Phase

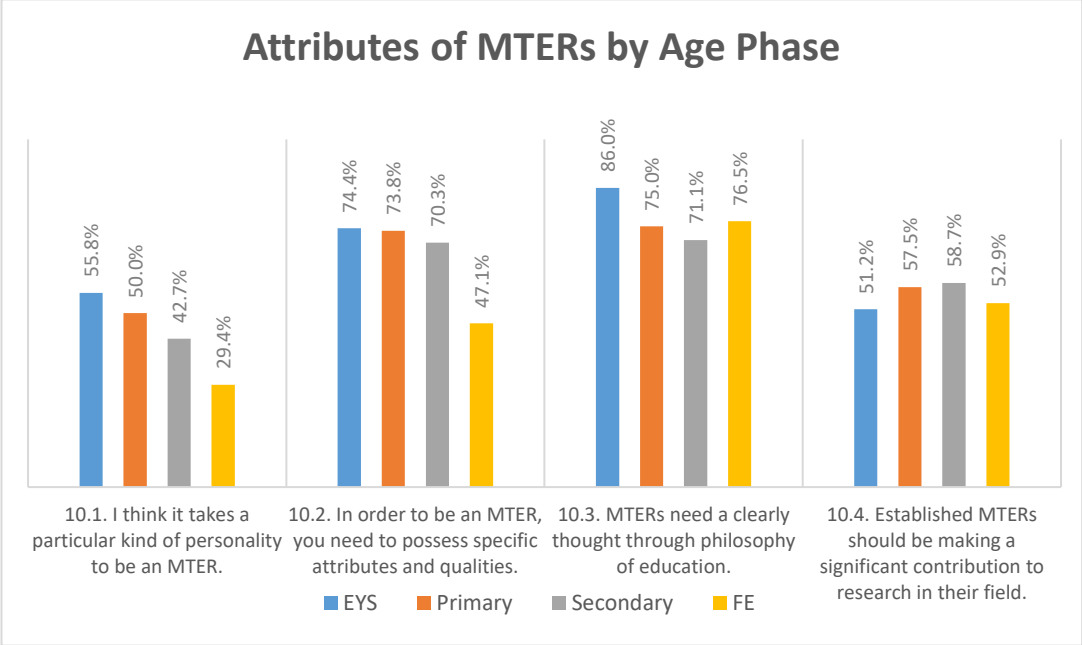
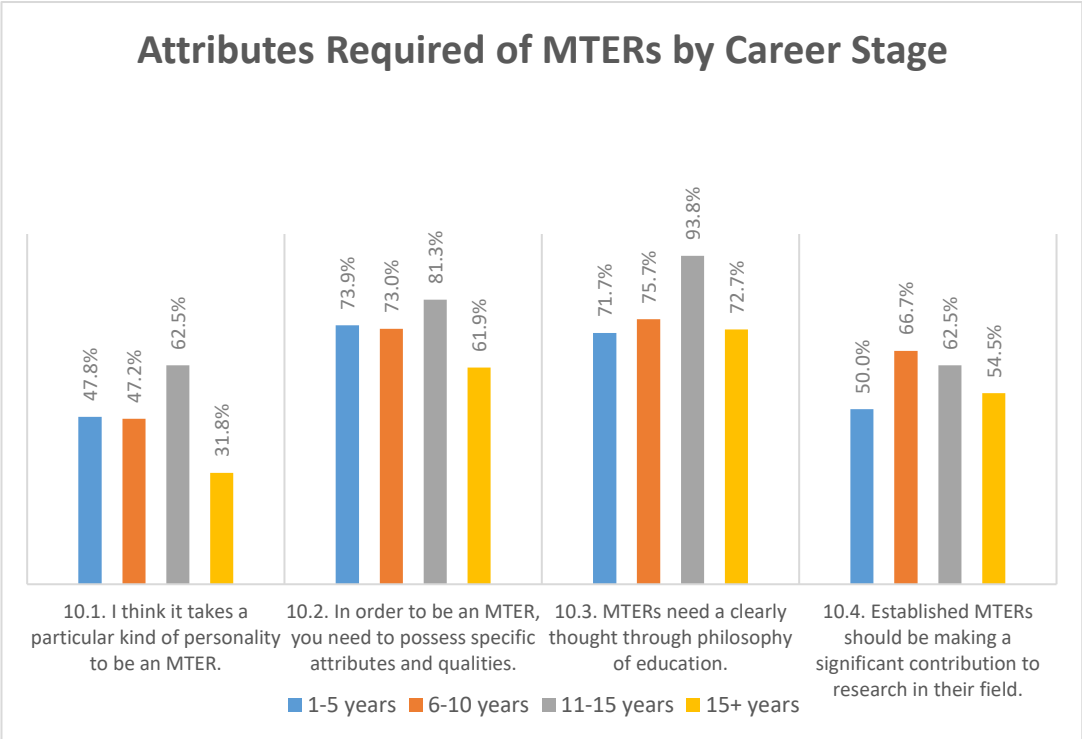


Chart G3: Respondents' Agreement with Statements about MTER Attributes by Career Stage.



Summary

The majority of respondents thought that MTERs should have a well thought through philosophy of education, and that being an MTER requires specific skills and attributes. In the open-response items attributes were cited such as: *empathy, a supportive nature, a positive attitude, a clear enthusiasm and passion for the subject, flexibility, a willingness to learn, an ability to listen and diplomacy*. Over half of the sample thought that well-established MTERs should be making a significant contribution to research in the field. It may be the value laden phrasing here precluded more respondents from agreeing with it.

5.4.2 Questionnaire Section 11: Personal Views and Experiences of MTERs

Chart H1 shows that the overwhelmingly, MTERs agreed that they derived great satisfaction from their role (93% agreement on QS11.1), but often find the role very challenging (87% agreement on QS11.5) though "challenge" might be interpreted both positively and negatively. There are some variations between age-phases (Chart H2) and between career stages (Chart H3), but none is systematic, nor statistically significant.

Around 70% of respondents (Chart H1) agreed that they have a clear understanding of the role (QS11.4), but that at times they felt anxious about it (QS11.2). For both these, there are discernible variations by age-phase and career stage (Charts H2 and H3). However, only the QS11.2 results for age-phase near statistical significance: slightly more MTERs in EYS and Primary expressed anxiety about the role (72-74%) than did those in Secondary and FE (65%-66%). Here, K-W ($p=0.006$) is significant, but ANOVA is not, and the data also fails the Levene's test for homogeneity, so this could be an artefact in sampling. This is the only statistically significant result for QS11.2 & QS11.4.

80% agreed with QS11.3, that MTERs uphold specific values within the profession; but only 17% with QS11.6, that these values are specifically Mathematics – related. No significant variations between age phase (Chart H2) or career stage (Chart H3) are noted here.

Chart H1: Personal Reflection on being an MTER

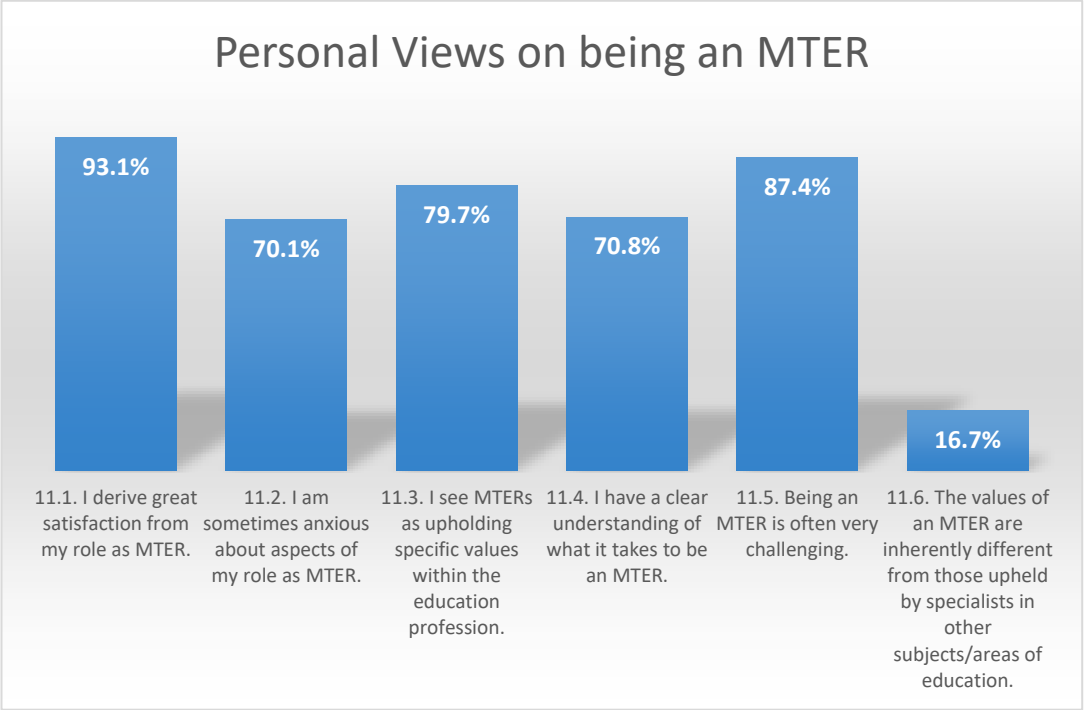


Chart H2: Personal Reflection on being an MTER by Age-Phase

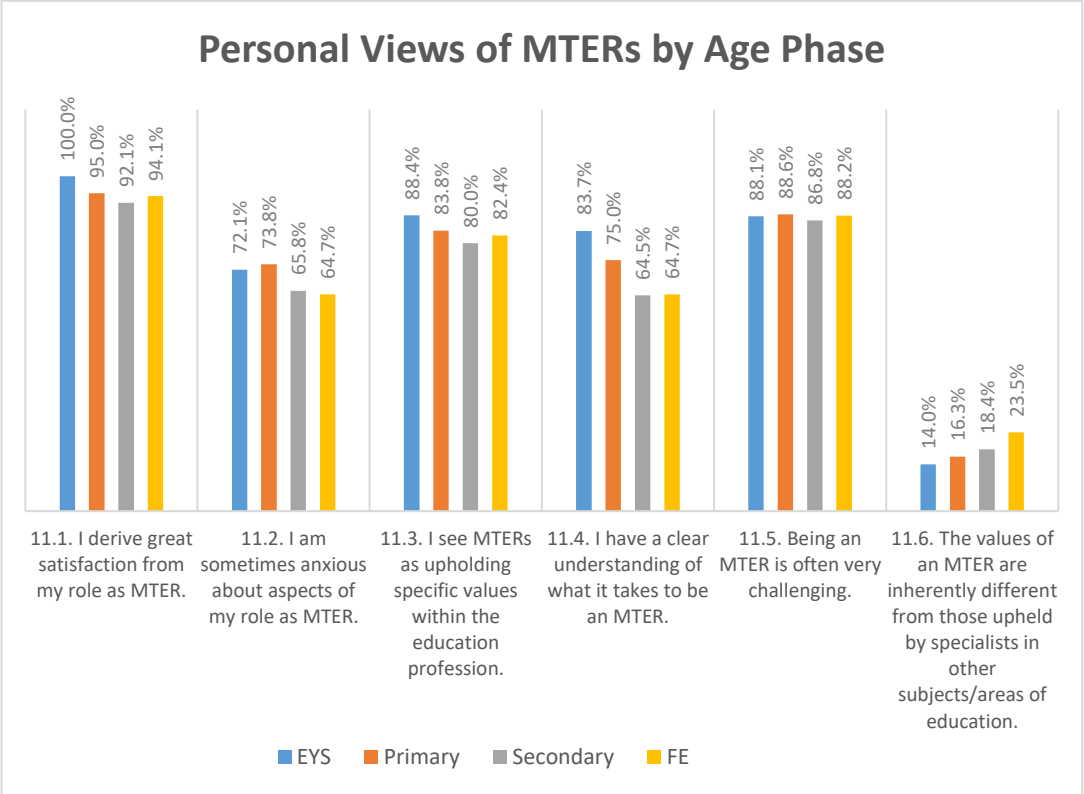
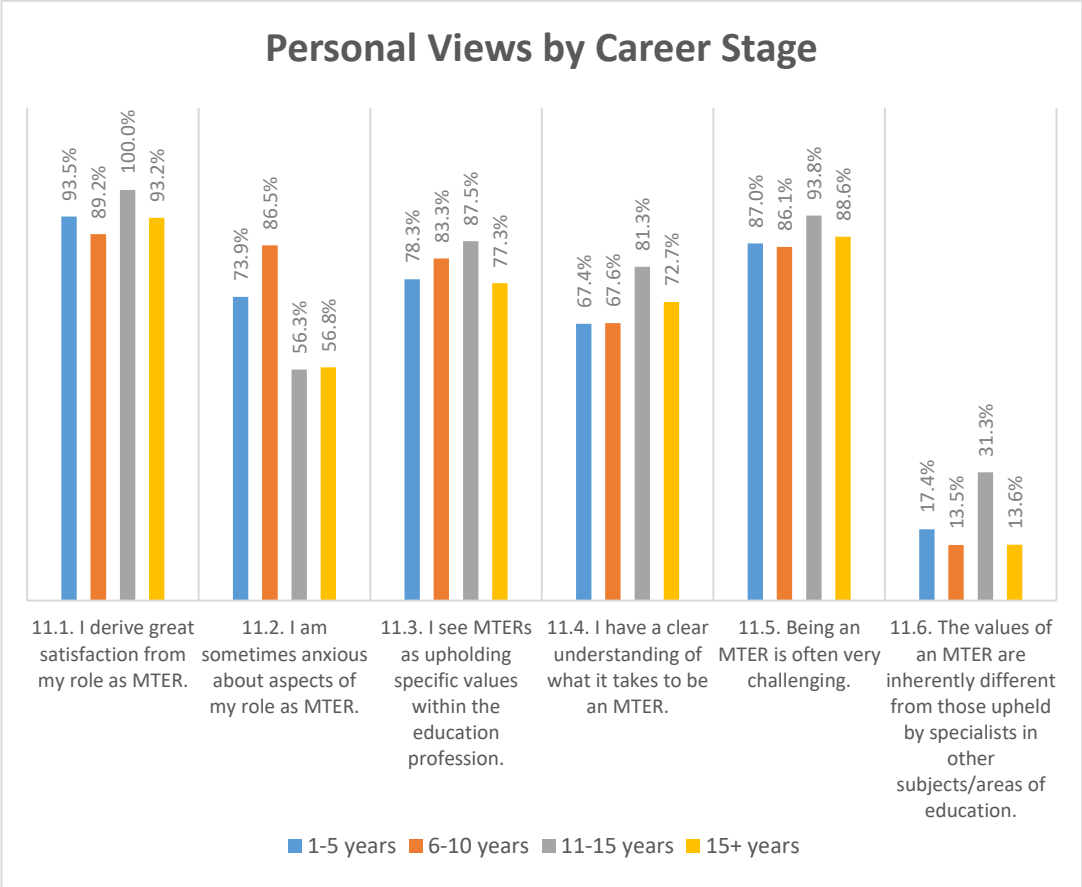


Chart H3: Personal Reflection on being an MTER by Career Stage



Open Response Items

The values identified were quite diverse, such as adopting ethical stances on particular issues, holding beliefs about mathematics, upholding social justice, respecting the views of others, demonstrating passion, commitment and enjoyment both to mathematics and to teaching. Some respondents thought that there were values and issues unique to mathematics, for example *"polarizing opinions … e.g. "traditional" v. "Progressive" … are more pertinent in mathematics education and can be challenging to navigate."* another expressed the view that they *"… do not see mathematics as inherently different from other subjects"*, with one MTER claiming that viewing mathematics as different is *"potentially antagonistic and elitist"*.

One MTER summed up the issues quite well:

> "The values needed at a professional level (supporting trainees who are having to face personal difficulties alongside their training, for example) are the same across all subjects, but the need to share how one can promote good mathematical thinking in students may well be different to that for other subjects - I believe mathematical thinking is different to the form of thinking needed by a student studying art, English or history for example."

Some MTERs also shared some of their anxieties alluded to above, discussing concerns about *"relative inexperience"*, others even sharing their feelings of guilt, for example about their *"lack of desire to engage in research",* or discussing their apprehensions of working with *" world-class academics who were renowned in their field of study",* describing this as *"daunting".* Several MTERs variously noted possible *"conflicts between pedagogy"* that can occur, between MTERs and *"teachers or school leaders",* and *"government/policy makers"* noting that "*The mathematics education student should not be the victim of the conflicts*."

The following provide a flavour of some of the responses:

> "I think that developing a healthy work ethic impacts on any job and role, but there needs to be a passion for the subject / career to be motivated to be any teacher. Commitment and dedication and wanting to make a positive impact on future learners (new teachers and children)"

> "…there are some values, inclusive teaching for example, which MTERs do (and should) uphold. It is the role of the MTERs to support their students in developing their own values within the education profession. "

> "The pressures of assessment driven education where children and schools are judged by results is impacting upon maths education for children and many schools are not teaching how I believe maths should be taught. Thus, our primary trainee teachers experience on placements is often contradictory to how I am educating them. The ability -based culture prevails across all subjects but in particular in maths."

Perhaps the best summary of this section was provided by the respondent who said:

> "I think MTERs have different values from each other and there are many ways to be a MTER."

Summary

There was overwhelming agreement that MTERs derived satisfaction from their role, but that it could be very challenging at times. The vast majority had a clear understanding of their role, but often felt anxious about aspects of it, especially those teaching in EYS and Primary, and those in the earlier stages of their career. The majority of respondents felt that MTERs are upholding specific values within the profession, but very few thought these were specifically mathematics-related values. Open response items highlighted a range of possible values, but these were diverse and fairly generalised, such as *adopting ethical stances*, *holding specific beliefs*, *upholding social justice*, *respecting the views of others* and *demonstrating passion, commitment and enjoyment.*

5.5 *Belonging* (Questionnaire items 12 & 13)

In this block, there are two sections related to the *belonging* lens of the Framework: status in the MTER community and collaboration with other MTERs.

5.5.1 Questionnaire Section 12: Relationships within the MTER Community

From Chart I1, 81% of MTERs agree that they have established good working relationships with others (QS12.1), 80% claim to benefit from membership of professional organisations (QS12.3), and 73% feel that they are part of a community of like-minded individuals (QS12.4). While there are some MTERs who work on their own, relatively few (30%) seem to report feeling isolated because of this (QS12.2). One each of these there are some differences between different groups, but no systematic differences by age-phase or by career stage (Charts I2 & I3).

The following explanations were provided by MTERs in the open response sections, and provide an explanation for these findings:

> I feel part of a professional community of mathematics and teacher educators but not in my place of work. I am in a different academic school from those working in ITE, which makes this difficult, and I am the only person working in mathematics in my academic school.
>
> In my paid work it is not uncommon to be a sole voice advocating a need for change. This can be very isolating and stressful. Networks and communities of practice are crucial in being able to maintain and develop a (non-pejorative) critical stance.

Only 30% of MTERs thought that their work was well-known and respected in the community of MTERs (QS12.5 Chart I1), with moderately large differences between age phases (Chart I2), with lower numbers of EYS (33%) and Primary (26%), compared with higher numbers of Secondary (43%) and FE (65%), these differences being statistically significant (ANOVA p= 0.020; K-W p= 0.013). There is similar variation by career stage (Chart I3): only 13% of those in the profession 1-5 years thought their work was well-known, compared to 24% (5-10 years), 56% (11-15 years) and 43% (15+ years). The result attains statistical significance (K-W: p = 0.004). ANOVA (p=0.003) is also significant, but invalid, failing the LH homogeneity test.

Perhaps here it is useful to compare the responses of someone who has been in the role 3-5 years, with someone who has been in the role for more than 15 years:

> "As a new MTER, with only a very small addition to research in the field, it is difficult to see myself as a 'valued' member; however, I do feel supported by the MTER community."

> "I am a National Teaching Fellow for my work in Primary Maths - working together and creating a 'home grown' field of expertise in local schools is very rewarding - I have my alumni of specialists supporting and mentoring current trainees - and work in partnership with several local authorities; Maths Hubs, and Alliances."

A wide variety of contexts are mentioned, including *working with colleagues within departments, school partnerships, Maths "Hubs", presenting at conferences, external examiner work, project work, Twitter, consultancy* and *editing of journals*, and *work in National and International fora*. In many cases these will overlap, with the same people being involved in multiple contexts. Rather than one single community, perhaps this is best described as a network of overlapping communities.

Summary

These results portray a large majority of MTERs as feeling that they are part of an MTER community, that they have good working relationships with other MTERs, that they are benefitting from membership of professional organisations, and feeling that they are part of a community of like-minded individuals. Most do not feel isolated, even if in their place of work they are the sole MTER. However, only a minority of MTERs feel that their work is known by other MTERs, especially those in EYS and Primary, and those who are in the first 10 years of their role.

Chart I1: MTERs' views on Relationships within the MTER Community

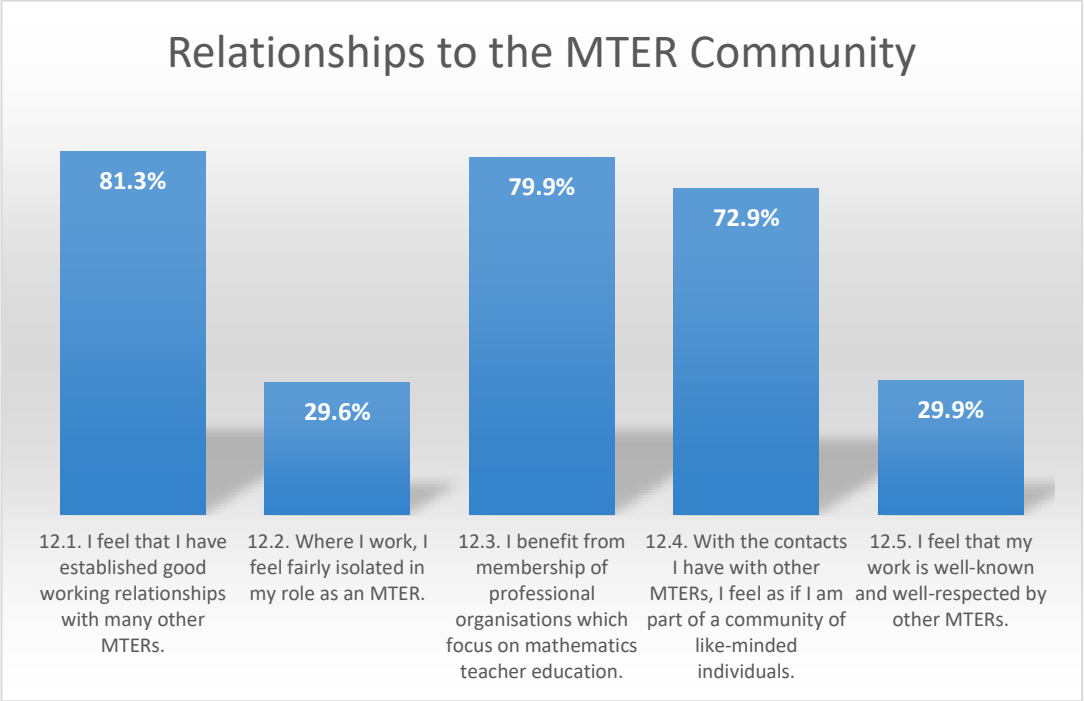


Chart I2: MTERs' views on Relationships within the MTER Community by Age-Phase

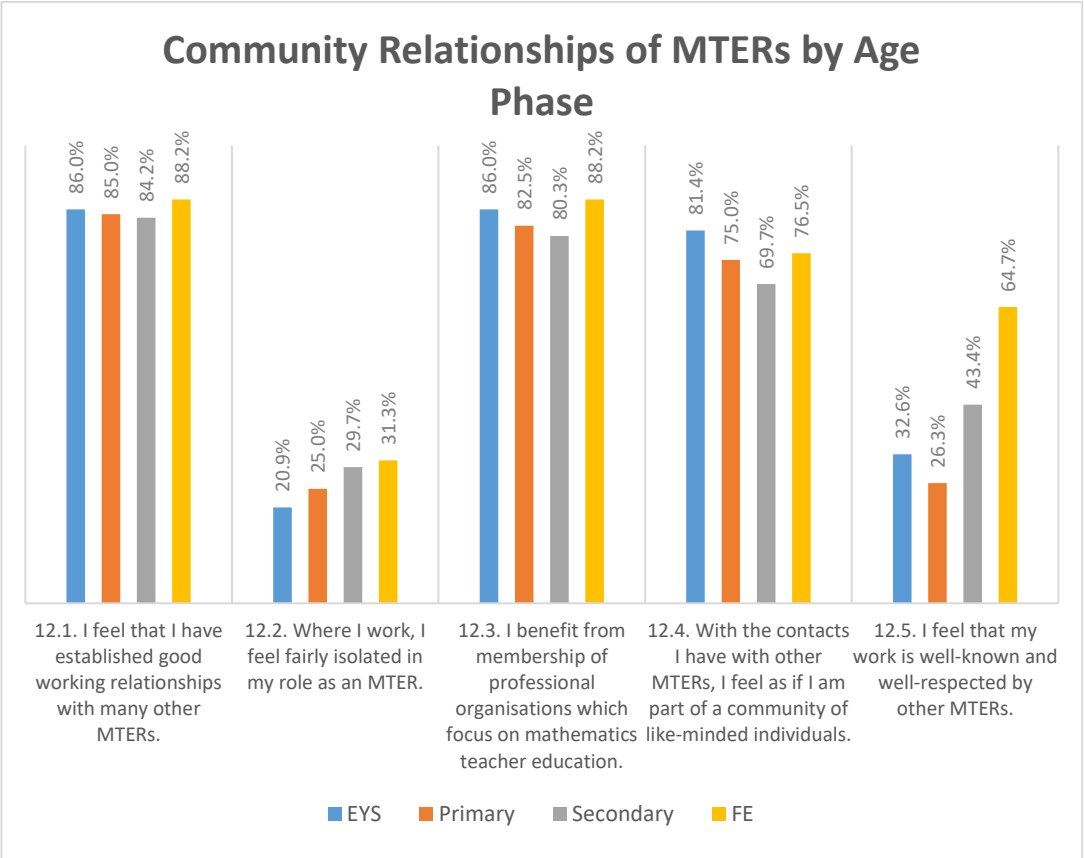
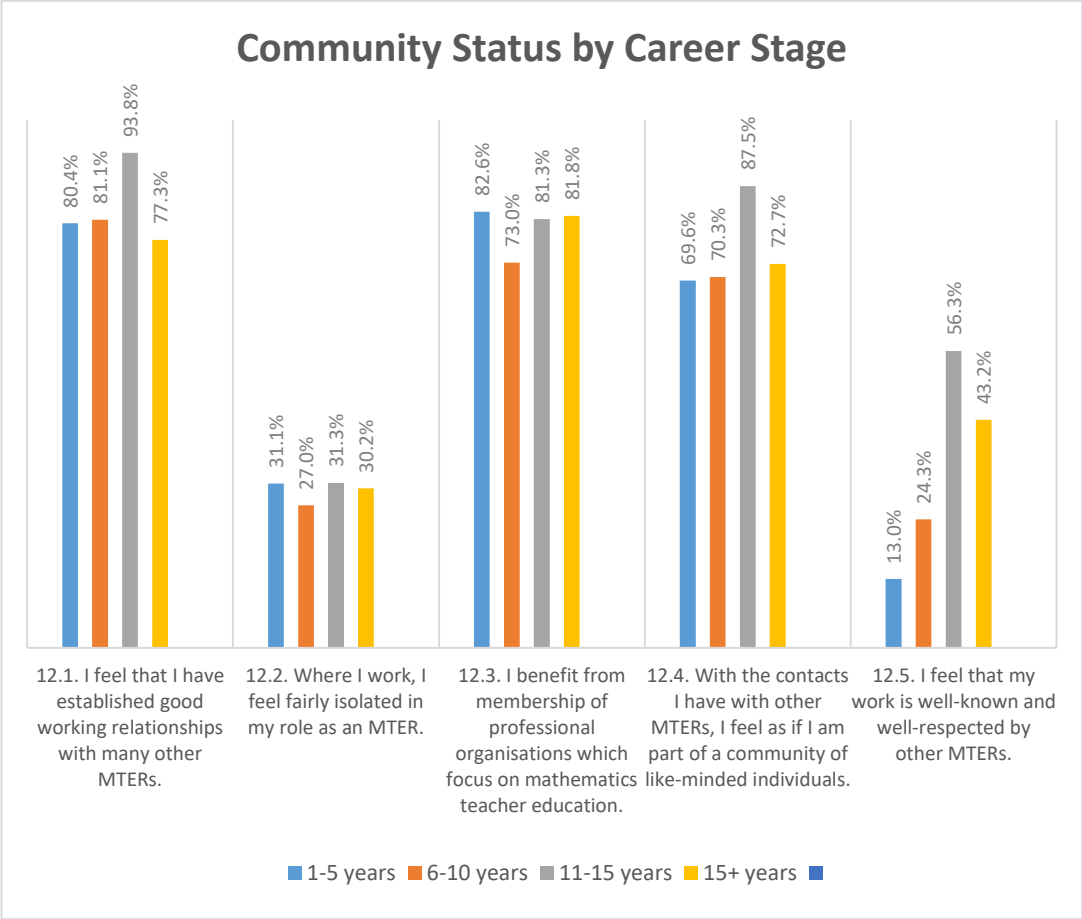


Chart I3: MTERs' views on Relationships within the MTER Community by Career Stage



5.5.2 Questionnaire Section 13: Collaborating with Other MTERs

In Chart J1, the level of agreement on all items ranges from around 40% (QS13.1 - online dialogues) to 63% (QS13.5 - views being challenged). Previously, the level of agreement with items relating to "mutual support" has been much higher, often around 70-80% (e.g. Chart I1). Note however, that while many respondents may find benefit from mutual support, individuals do so for different reasons; each reason will necessarily have lower agreement than the whole.

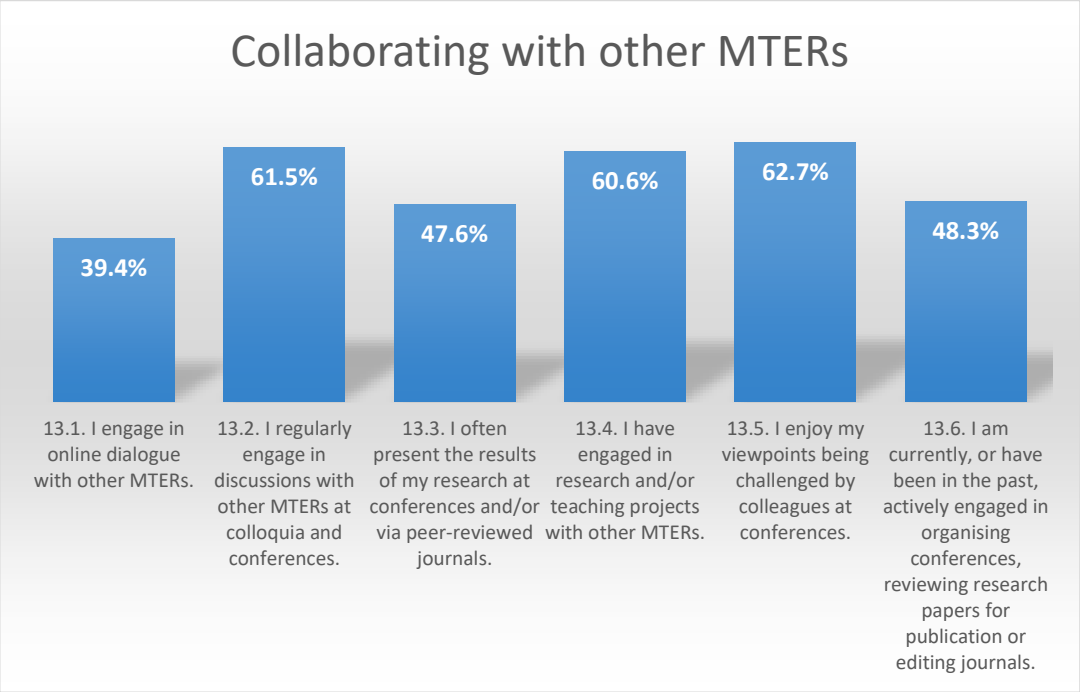
Three items prominent here are: discussions with colleagues at conferences (61.5%-QS13.2), engaging in joint research projects (60.6% - QS13.4), and the challenges to existing viewpoints (62.7% -QS13.5). These are all strongly supported in the open response items:

"[I] regularly meet with other MTER AMET committee members to discuss latest mathematical pedagogic developments."

"I am currently engaged in writing with other MTERs as contributions to books."

"I am happy to have my views challenged as it enables me to be more knowledgeable and open minded".

Chart J1: Collaboration and Communication with other MTERs



In Chart J2, there is concomitant variation of each items with age-phase, with the level of agreement for the FE phase being greater than all other phases, and on items QS13.1 (online collaboration), and QS13.3 (presentation at conferences) the scores (88% in both cases) are well over double that for EYS (40% and 37% respectively) and Primary (39% and 40% respectively). These are both statistically significant on the K-W test. For QS13, p =0.013; for QS13.3, p =0.000. In both cases, ANOVA is also significant (p=0.010 and p=0.000 respectively), but fails the Levene's test, so is not used.

Similarly, on QS13.5 (viewpoints being challenged), the levels for Primary and EYS (Chart J2) are at 56-63% compared to Secondary and FE at 74-82%. This is also statistically significant (AK-W p= 0.014) Once again ANOVA (p= 0.009) is significant but invalid.

There is possible variation with career stage on QS13.4 (engaging with other MTERs) and QS13.6 (organising conferences, reviewing & editing). While less clear these two items do achieve statistical significance: For QS13.4, K-W: p= 0.043), and for QS13. 6, ANOVA: p=0.001; K-W: p= 0.002.

There is enough here to claim an effect in relation to career stage – certainly between "beginning" and more experienced MTERs.

Chart J2: Collaboration and Communication with other MTERs by Age-Phase

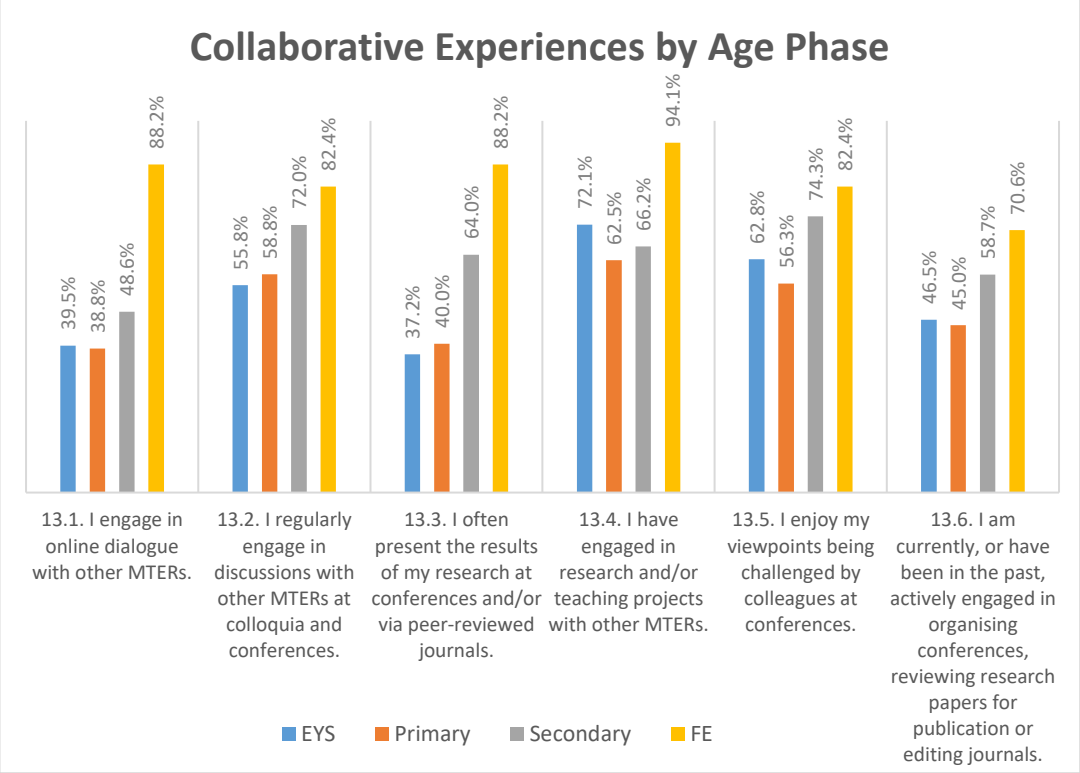
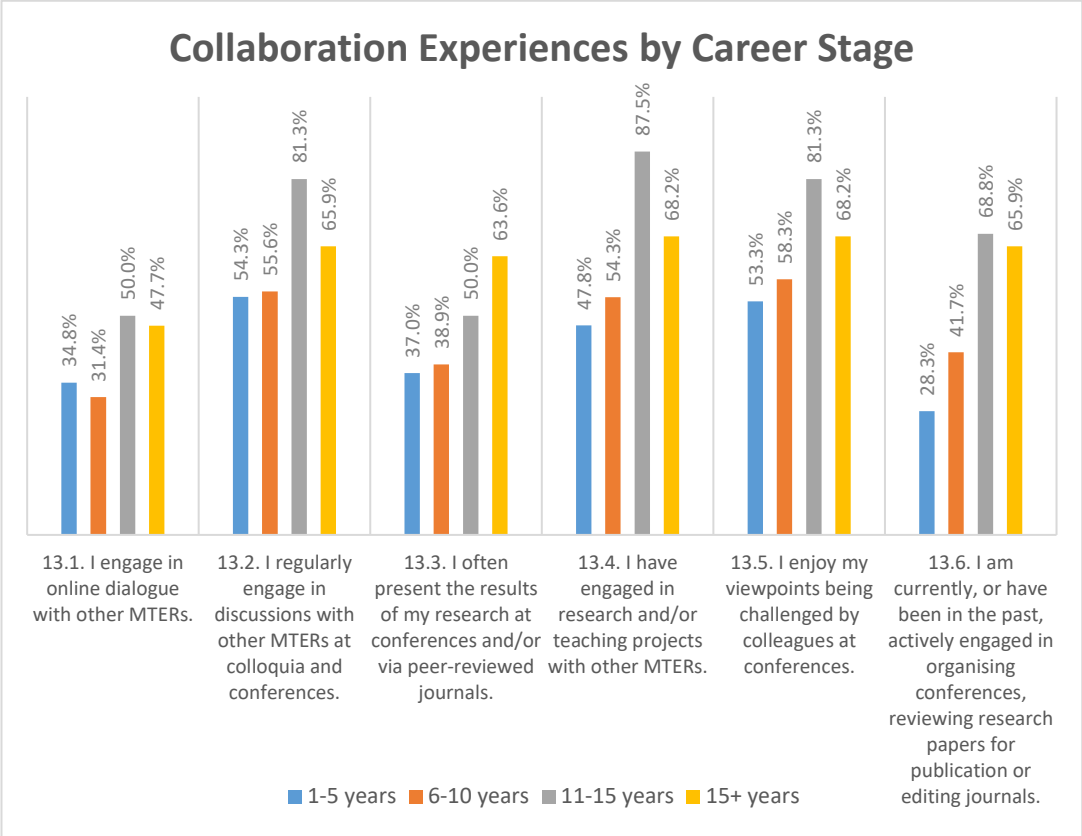


Chart J3: Collaboration and Communication with other MTERs by Career Stage.



Open Response Items

To get a flavour of the difference between the experiences of "beginning" MTERs, and those more experienced, both of these MTERs have been in role for less than 10 years:

> "I am just starting to do this so feel I can't comment. This is my 9th year as an MTER and I only now feel more confident in this!"
>
> "I have only presented the findings of my Master's dissertation at a conference, but found the experience to be challenging and rewarding. I also enjoy listening to the research of others at conferences, and being given the opportunity to discuss mathematics education."

These MTERS have been in the role considerably longer:

> "I review research papers but I haven't organised conferences or edited a journal."
>
> "In my youth I edited Mathematics Teaching for maybe 4/5 years when not working in a university. I am currently on IC of PME and on the IPC of PME42 Sweden. I am a Senior Editor on a Springer research journal. Currently waiting for whether a group of us from Mexico and England have been successful in a research bid."

Summary

Three main ways in which collaboration can occur have been highlighted: *discussions with colleagues at conferences*, *engaging in joint research projects*, and *receiving challenges to existing viewpoints*. These are all well-supported in both the items of QS13 and the open responses. These is stronger agreement for Secondary and FE than Primary and EYS, and greater agreement according to length of time in role.

5.6 Additional Section: *Being Valued*

QS15 is considered outside of the Davey framework.

5.6.1 Section 15: Perceived Attitudes to University MTERs

129 of the 144 MTERs who were University-based completed QS15. Chart K1 presents an "obvious" result in that 100% agree with QS15.1, that University MTERs have an important role to play. For QS15.2, 87% thought that students valued their contribution for QS15.3 80% thought that teachers welcomed the opportunity to engage with University MTERs. These contrasted with QS15.4: just under 50% agreed that University MTERs are well-regarded in a national context.

None of these results varies systematically by age phase or career stage (Charts K2 & K3), but QS15.3 (teachers are welcoming towards MTERs) achieves statistical significance in relation to career stage, with greater proportions of longer serving MTERs agreeing (ANOVA p=0.029; K-W p=0.024). Q15.4 just fails to achieve statistical significance in relation to career stage (ANOVA p= 0.05, K-W p= 0.072).

Open Response Items

In the open response section, many MTERs wrote extensively about the issues underpinning the value of the MTER role in a National Context, expressing strong opinions on these matters. Many spoke of the real benefits they felt that being part of a university culture brings to the role – the depth of expertise, and the research base, as well as the strong relationships that are formed both with students and the teachers in schools:

> "The university-based PGCE route into teaching mathematics in schools can provide opportunities for connecting practice to research and for establishing networks of collaboration that can be difficult to produce through other, school-based routes."

> "University MTERs are not all alike, but all represent at least an association with the body of knowledge and research into mathematics education, which should never be remote from policy and practice."

> "I think the University element is important because it links 'teaching on the ground' with a culture which values research and collaborative inquiry into mathematics education. I know that I am respected and the University's role is valued by colleagues in advisory roles and by those involved in CPD such as our Maths hub leaders."

> "Universities are established places of research and development, nationally and internationally, this needs to be retained, whereas school teachers, or groups of school teachers are isolated pockets of development trialling good practice for their own pedagogy. They do not have the time to research, write and share ethnographic findings."

However, while many saw their roles and the services they offer as extremely valuable, they also perceived being under threat from a national agenda which places the education of teachers in schools. Some saw this as undervaluing their contributions; others saw this in terms of reducing the education of educators to the training of teachers, yet others commented on the conflict it generated with schools sometimes being in competition with universities in the recruitment of students.

> "I feel both a pride in what I do as an MTER - feel valued and respected by students (feedback) and teachers when I do school supervision visits and we jointly observe … YET I also feel challenged in my role by national political agendas."

> "I am not sure that the UK government values the role of the university MTER as they seem to encourage routes that bypass university education input to teacher training."

> "My perspective - certainly in recent years the Govt (M Gove very explicitly) and NCTL have not respected the role of Univ ITT educators … Training in schools appears to be very much focused on how to teach the next lesson(s) and not about how to develop mathematical thinking … I have heard from stduents and applicants that they have been given blatently incorrect information/advice on PGCE course in favour of school based training routes." [typography/spelling uncorrected]

> "Other initiatives, e.g. SCITT or Teach First lack theoretical underpinning and quality assurance in terms of student teacher entitlement. Feedback from schools are that PGCE, or University courses continue to provide better quality (NQT) teacher"

> "It is vital the teacher education is linked to universities so that the theoretical aspects of teaching and learning and critical engagement with research play a part in teacher education. Unfortunately successive governments have undermined the role of universities in initial and continuous teacher education and teaching is increasingly positioned as a practical skill which is learnt from other practitioners."

One interesting comment was provided by an MTER who works in an International context:

> "I currently work in both England and [Country X]. In the former context the role of the university in general has been increasingly marginalised in relation to teacher education. In relation to the latter, and to many parts of continental Europe, subject didactics is a well-regarded research based academic sub-field in HE."

Chart K1: Perceived Attitudes to University MTERs

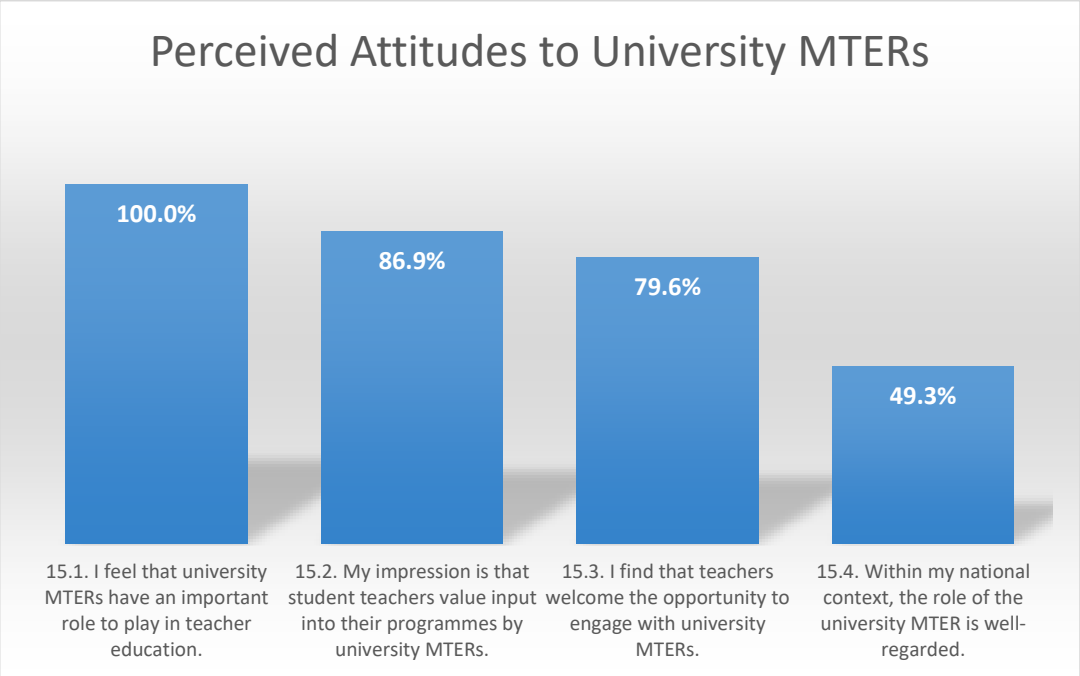


Chart K2: Perceived Attitudes to University MTERs by Age Phase

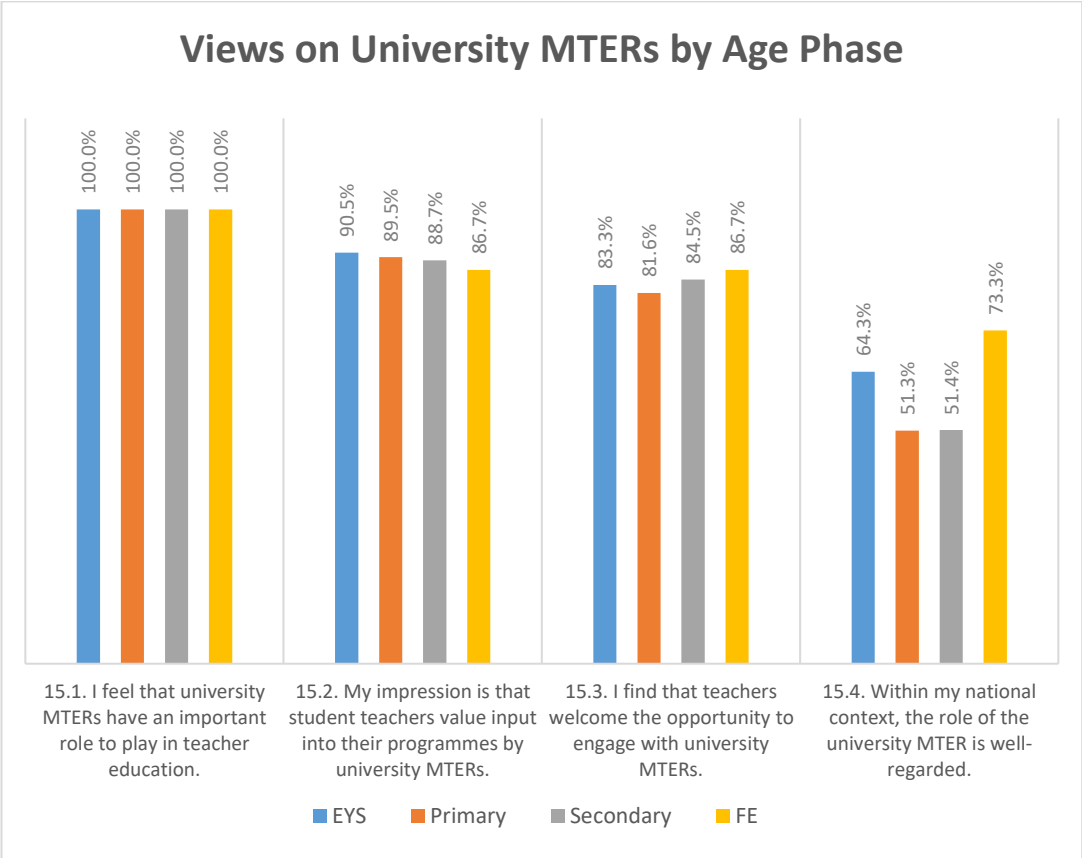
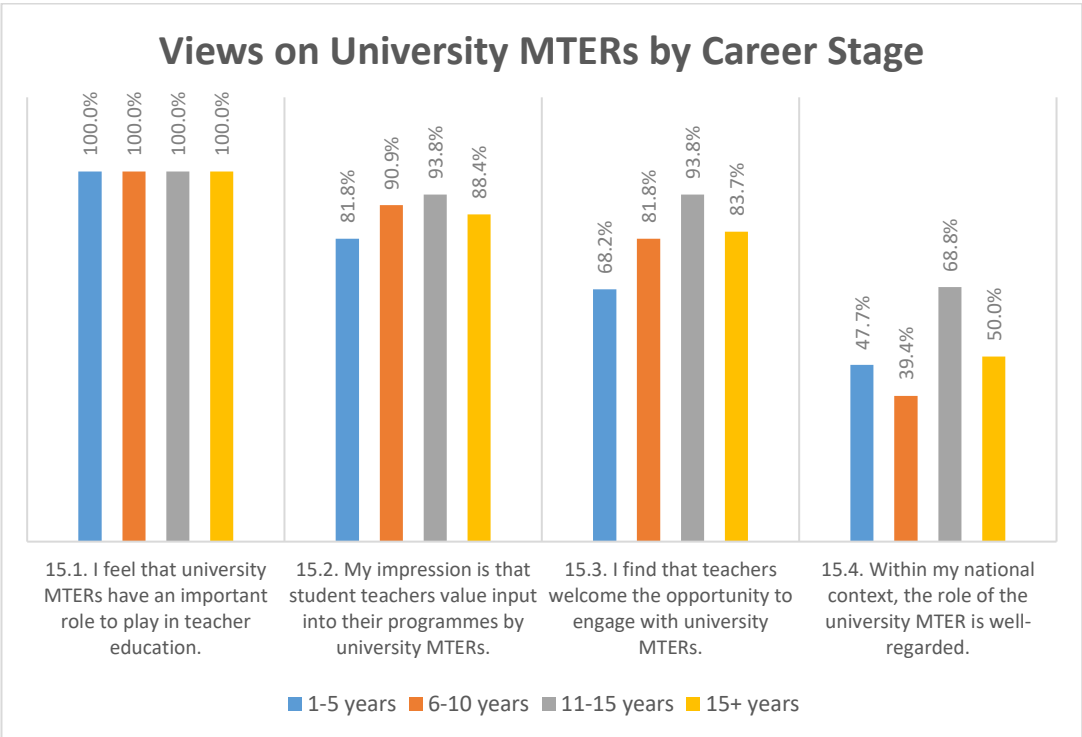


Chart K3: Perceived Attitudes to University MTERs by Career Phase



Summary

Two results stand out here: the majority of MTERs think that students value the contributions of University MTERs, and that teachers welcome the opportunity to engage with them. Only a minority thought that University MTERs were well-regarded in a National context. There is a suggestion from the data that these perceptions might well be different for MTERs at different career stages. From the open response items, it is clear that many MTERs feel undervalued in terms of a national agenda.

5.7 The generalizability of results

At this stage, it is important to reflect on the possible applicability of any of these results to the more general group of MTERs who work in universities and other training institutions. In the discussion in Section 4.8, I noted that the core group to which these results would be applicable would be those MTERs based in England, and while that remains true, there are some provisos which should be noted.

First of all, for all MTERs in the study, by the very nature of the work itself, and clearly from the answers provided, it is not possible to provide any more than cursory indications about differences between MTERs teaching in different age-phases. However, it has been entirely possible to discern differences between MTERs' actions, beliefs and attitudes in different stages of their career. Given that some of these differences are strong, and some statistically significant, the likelihood is that these results are robust enough to claim that they would be found by any attempt to replicate this study. In addition, where such results are also backed up with cogent descriptions and rationales from respondents in the open response items as a result of *respondent validation*, it might also be claimed that through triangulation, sufficient consonance has been demonstrated that the results are valid generalizations to all MTERs working in England. While this claim is true in principle, the reality may be more complex: a case study of one of the respondent validation exercises, for example is provided in Appendix E1.3, where it becomes clear that while the item may well reflect a strongly-held opinion amongst MTERs, making generalisations and inferences purely on the basis of a single item may present significant challenges.

With this proviso, it should be noted that there are few, if any, indications of any attitudinal or other differences between MTERs based in England with those in the UK, or the rest of the world. One such exception would be the finding in the previous section that MTERs feel undervalued in terms of recent government

agendas. While this does not mean that we can claim all the results are more widely generalizable, they would certainly constitute an interesting set of hypotheses which could form the basis of further study. We might hypothesise, for example that for many MTERs, the role is a career-long commitment, and during this career they become more deeply involved, taking on a range of roles within the profession, especially to do with research and dissemination of their own work.

5.8 An examination of the Framework Assumptions.

This whole study and specifically the questionnaire, is constructed on the basis of the Davey Framework, and items were designed specifically to address particular "lenses". The ontological assumption is that there is, for example, a lens such as *being*, and that by asking specific questions, some indication can be gained of a respondent's mental state in relation to this lens, where answers to one item within the *being* lens should be related to another item within the same lens, since they are derived from the same over mind-state concerning the same thing.

In order to test whether this assumption is accurate, it is possible to test for statistical association between the items within the lenses, via an examination of all 1485 correlations between the 55 Likert items. In this table the highest correlation was a value of 0.68 between QS13.3 (presentation at conferences) and QS13.6 (organising conferences), with the obvious connection illustrating how the approach works.

For a correlation to be significant with n=144, it should be at least 0.164 (5% level) or 0.215 (1% level) (Zaiontz, 2019). However, even though a correlation of 0.68 achieves extremely high levels of statistical significance, it should be noted that this still only means that $(0.68)^2$ = 46.2% of the variability of one item is explained by

variability of the other, and if 5% significance levels were used, then only $(0.164)^2$ = 2.7% of the variability in one item would be explained by variability in the other item (Johnson, 2011).

To determine relationships between the items in the questionnaire, two different approaches were used:

(1) Principal Components Analysis, using SPSS
(2) A detailed examination of the Table of Correlations.

All the larger tables in this section have been placed in Appendix C1 and C2.

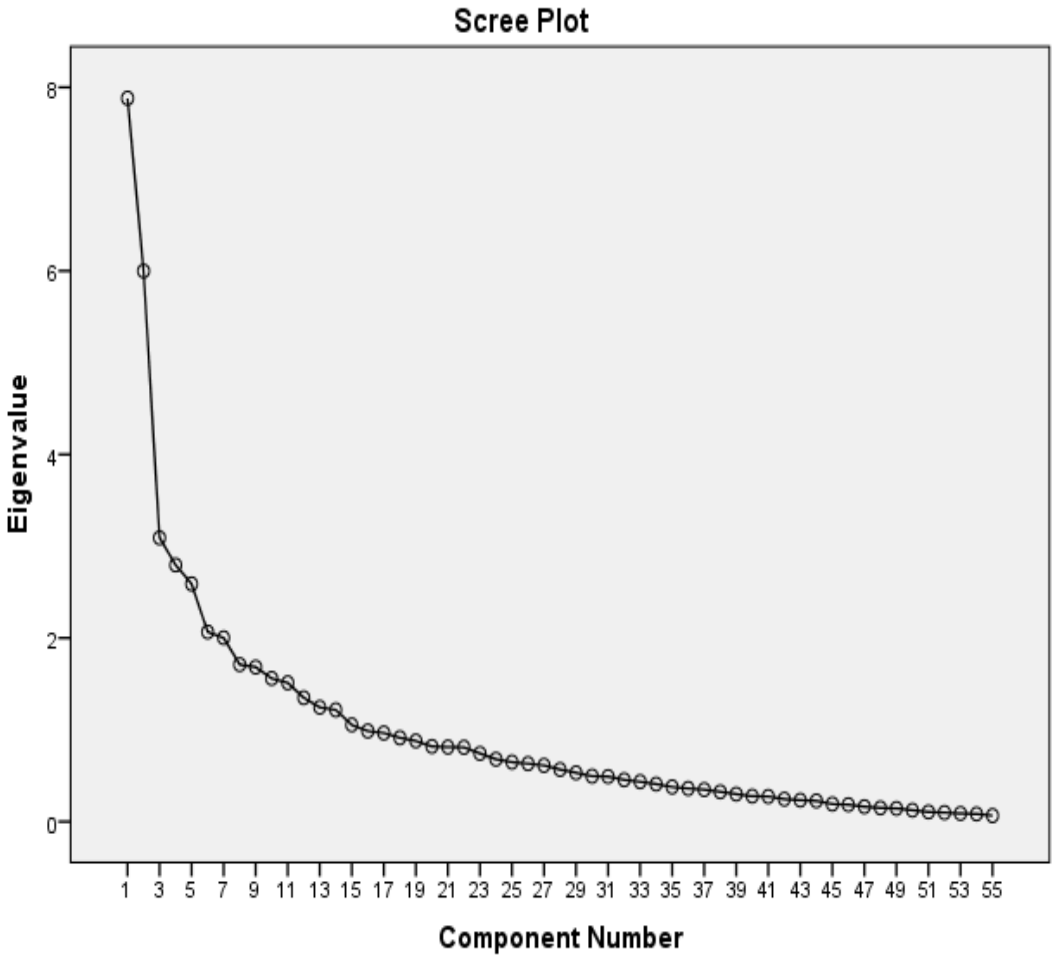
5.8.1 Principal Components Analysis

Principal Components analysis seeks to represent the entire 55 items as groups, producing a set of factors, each uncorrelated with the other factors, which can account for the variability in the data. It does this by projecting or loading the score on each item along a set of two or three axes called Principal Components.

This technique initially produced a list (Table L1, Appendix C1) of 15 components which had eigenvalues greater than 1 (i.e. a component which explained more variance than each of the 55 items individually) and which in total explained 68.6% of the entire sample variation, with the first two accounting for 25.2% of the variance, and the others accounting for between 1.9% and 5.6% each.

The scree plot in Chart L2 shows the relative contributions of each of the components.

Chart L2: Scree Plot showing the Eigenvalues of each of the Principal Components



There are several suggested criteria for how many components to retain. Kaiser's Rule involves retaining all values greater than 1 (Field, 2005). Others recommend either truncating at 70% of the variance, or at the "elbow" in the scree slope (DisplayR, 2017).

Following this latter recommendation gives an obvious truncation point after two components, just prior to where the scree curve flattens out. However, these components only account for just under one-quarter of the variance, well below the suggested 70%.

The PC analysis was re-run, extracting two components (Table L3), and rotating orthogonally to be displayed on pair of axes (Chart L4). This equalises the amount of variance explained by each factor.

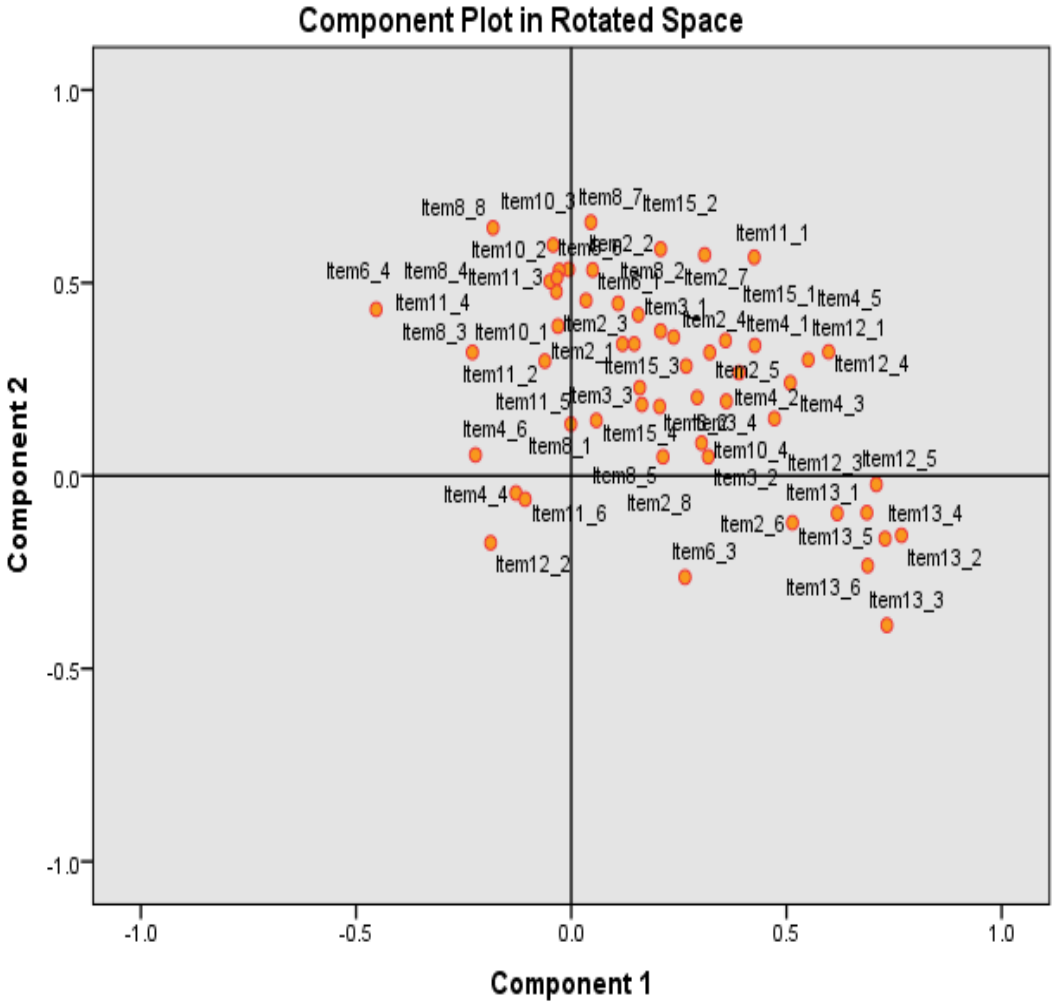
Table L3: Revised Principle Components: Two Factors, Rotated.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.881	14.329	14.329	7.881	14.329	14.329	7.066	12.847	12.847
2	5.999	10.907	25.236	5.999	10.907	25.236	6.814	12.388	25.236
3	3.092	5.621	30.857						
4	2.796	5.083	35.940						
5	2.590	4.708	40.648						
6	2.066	3.757	44.405						
7	2.002	3.640	48.045						
8	1.711	3.110	51.155						
9	1.684	3.061	54.217						
10	1.559	2.835	57.052						
11	1.512	2.749	59.801						
12	1.350	2.454	62.255						
13	1.245	2.263	64.518						
14	1.217	2.213	66.731						
15	1.054	1.916	68.647						

Each of the loadings of the 55 items onto each of the two Principal Components are shown in the chart below.

Chart L4: Component Plot for the first two factors.



The actual component loadings are shown in Table L5. (Appendix C1).

To determine what these components might actually mean, it is normally recommended that loadings of 0.7 or greater (equating to around 50% of the variance on that item) be examined, subject to having relatively low loadings on the other components. However, the table in Hair, Tatham, Anderson and Black (1998, p 12), suggests that for a sample of around 150, factor loadings as low as 0.45 can be used.

In Table L5, several Component 1 loadings equal or exceed the 0.7 figure (shown in red in tables L5 and L6). All of their loadings onto Component 2 are small and most are negative.

The content of these questions focuses on participating in a community, and collaborating with others.

Table L6: Content of Component 1

12.5. I feel that my work is well-known and well-respected by other MTERs.
13.1. I engage in online dialogue with other MTERs.
13.2. I regularly engage in discussions with other MTERs at colloquia and conferences.
13.3. I often present the results of my research at conferences and/or via peer-reviewed journals.
13.4. I have engaged in research and/or teaching projects with other MTERs.
13.6. I am currently, or have been in the past, actively engaged in organising conferences, reviewing research papers for publication or editing journals.

Component 2 presents slightly more challenges, since there are no weightings greater than 0.7, and only two (QS8.7, QS8.8) greater than 0.6. Relaxing the criterion to weightings greater than 0.5 (only 25% of the variance), brings in the set highlighted in blue in Tables L5 and L7.

Table L7: Content of Component 2

2.2 I wanted to share my understanding of mathematics teaching and learning with others.
8.6. A thorough understanding of pedagogical approaches.
8.7. A good understanding of how student teachers learn to teach.
8.8. A detailed knowledge of the relevant school curriculum expectations.
10.2. In order to be an MTER, you need to possess specific attributes and qualities.
10.3. MTERs need a clearly thought through philosophy of education.
11.1. I derive great satisfaction from my role as MTER.
11.3. I see MTERs as upholding specific values within the education profession.
11.4. I have a clear understanding of what it takes to be an MTER.
15.1. I feel that university MTERs have an important role to play in teacher education.
15.2. My impression is that student teachers value input into their programmes by university MTERs.

While these items are not totally consistently focused on the same areas, the general concentration of items here concerns the knowledge, understanding, values and stance of MTERs as professionals.

Principal Components Analysis has therefore yielded two factors which together explain 25% of the variance in the sample:

- Component 1- “Community and Collaboration”
- Component 2- “Knowledge Understanding and Values”

These do not entirely coincide with any of Davey’s five areas. While it might be argued that Component 1 is very nearly *belonging*, and Component 2 has elements of *knowing, doing* and *being*, there are clearly elements of each of these in both components, which together only explain around 25% of the variance across the entire sample.

This begs important questions. If Davey’s framework successfully models the experience of MTERs, and the questionnaire in the current study successfully captures the meaning of that modelling, then why are there not clearer divisions in the data between each of the lenses, and why is only a small amount of the variance explained?

There are three possible causes: (1) The questionnaire does not adequately capture the Framework, and the experiences of MTERs, or (2) Davey’s Framework is not an adequate tool to model the experience of MTERs, or (3) that there is considerable overlap of material that runs across all of the lenses within the framework, and that attempting to extract individual, non-correlated factors is extremely difficult.

Before concluding that any of these is correct, it is worth considering the extent to which the five areas of the questionnaire appear to be cohesive – i.e. the correlations between the items which comprise the five lenses of Davey's Framework.

5.8.2 Examining the Tables of Correlations

It is now pertinent to ask whether the questionnaire or the framework is actually useful in describing the experiences of MTERs in developing and experiencing an MTER identity.

The analysis in Appendix C2 examines the internal consistency of each section of the Questionnaire, as well as the coherence of each of the five "lenses" This shows that while the questionnaire sections are reasonably internally consistent, and for some of the lenses there is a consistent core of well correlated items telling a consistent narrative, the different sections within some of the lenses, particularly the *becoming* lens are less cohesive. This would suggest that the questionnaire construction has succeeded in teasing out the different aspects, but that the lenses themselves might not be totally coherent. Nonetheless, in terms of the questionnaire construction, *Becoming* and *belonging* have provided good insights into those aspects, as well as *knowing*, and to a lesser extent *being* and *doing*. One issue here however, is the value of the Likert-items. They have provided an overall "snapshot" of opinion, which has been useful in identifying broad themes, and pointing to statistical significance. However, the really significant detail has come through from the open-response items. That has allowed the themes to be abduced into an explanatory framework.

In this sense, the use of the Davey Framework as a basis for a questionnaire has been vindicated.

However, the overall sense coming from the questionnaire analysis is that one of the most important aspect of MTER identity is its sense of community, and this cuts across all aspects – not just *belonging*, but impinges on *becoming*, and *being* and probably on *knowing* and *doing* too. This is also borne out by the Factor Analysis, which yielded a factor related to- "Community and Collaboration", largely based on Sections 12 and 13.

The other main aspect coming from the questionnaires, is the generation and maintenance of Knowledge, Understandings and Values. While these form the core of the sections on "Doing, Being and Knowing", they also cut across all aspects of the Framework. Newly appointed MTERs do not arrive on day one of their role as blank slates; they will have been appointed because they already have considerable knowledge, skills and understandings, and they possess specific values which have persuaded an employer that they can function effectively. Again, this is also borne out by the Factor Analysis, which yielded a factor related to "Knowledge Understanding and Values", and based on QS8, 10 and 11, together with items from QS15.

5.8.3 Summary

The questionnaire, while not perfect, has demonstrated its overall usefulness in investigating MTER identity, but some of the items as indicated in 5.8.2 above would need to be revised if it were to be used again. In terms of the Davey Framework, while each lens has proved broadly useful in examining the different aspects, the research here has cast some doubt on the coherence and consonance of the items within some of the lenses, since they have not all been equally successful. *Belonging* and *becoming* for example are more successful than *doing*.

Furthermore, as demonstrated by the Factor Analysis, and supported by the Likert data, together with detailed testimony from the open response items, the two overarching themes "community and collaboration" and "knowledge understanding

and values" appear to cut across several lenses, and by simply looking at MTER identity through each of the lenses, we may miss how these themes run through and underpin the whole.

One conclusion therefore, is that while some of the questionnaire sections are reasonably well-focused, and provide a useful lens through which to view identity, in doing this, we may be missing a bigger picture obtained by comparing and combining the view through several lenses simultaneously. This conclusion is based primarily on two approaches, both statistical, and both ultimately using a similar methodology – that of examining correlations between items. Therefore, while it is possible to assess the reliability in the different sections, based on the internal correlations, this does not guarantee that such a conclusion is valid. However, if we turn to the open response items, in nearly all cases, respondents did appear to address largely similar concerns to the items themselves, and this is shown by the fact that except in a relatively few cases, the categories which emerged from the open response items, were highly pertinent to the focus of that particular lens. Where this occurred, it not only reinforced the claim that the individual lens was well-focused, at least on that aspect, but suggests also that the views through that lens is a valid representations of that particular aspect of MTER identity. The second part of the conclusion here, however, is that the lenses themselves do not provide unique views of particular aspects, and that for greatest benefit, several lenses need to be combined simultaneously. While that appears to be a reasonable hypothesis, as yet there is no evidence to support it. This contention is now explored via the interviews in Chapter 6.

A fuller discussion of the conclusions in this section, will be found in Appendix F1, and the discussion will be picked up again in Section 7.1.5.

Chapter 6. Research Findings: Analysis and Discussion

This chapter now looks more deeply into the Professional Identity of MTERs by using the results from Chapters 4 and 5, as a series of provisional hypotheses and interrogatives, by drawing on both the literature and findings from the interview stage of this exploratory study.

6.1 Introduction

In considering Professional Identity, the evidence so far has been gathered from a sample of 144 MTERs via their questionnaire responses. In this section I look at the interview responses of 27 of these MTERs, specifically selected because of their Primary age phase focus, who participated in semi-structured interviews. This group will subsequently be referred to as PMTERs.

6.1.1 The Sample of PMTERs

The research reported so far has uncovered a wide variety of themes and issues, far too many to examine in the time and space available here. Therefore judgment has been used to limit the extent of further investigations. Firstly, given the challenging nature of the "Age-Phase focus" data in the survey, and the issues surrounding its construct validity, I reasoned that it would be better it is better to concentrate only on differentiation by Career Stage, and to use a homogeneous group with a specific Age Phase focus.

Given the limited number of possible follow-up interviews, PMTER candidates for interview were selected as the completed questionnaires were submitted. The potential interviewees were contacted, and the interviews arranged. I hoped to conduct the interviews as soon as preliminary findings became available, so as to leave as short a time as possible between the survey completion and the interview.

This would potentially allow respondents the greatest likelihood of being able to remember and explain responses in any case where respondent validation was required.

An equally strong rationale for selecting this particular sample, is that for an in-depth study, this is the phase in which I have the most experience, and the one in which I can call on a deeper understanding of some of the issues, and therefore felt most able to explore PMTERs' concerns. It could be argued that this might lead to researcher bias, and issues of confirmability, but the agenda set by following the Davey framework, and the focus on the hypotheses generated by the questionnaire results ensured that such a bias would be minimised. Taking a large group of nearly 30 also ensures that there will be enough variety within the group to capture a good range of opinions and experiences from a specific subgroup of the 144.

Clearly this decision has the potential to limit the generalisability of findings as discussed in Section 4.8 above, specifically in those cases where we are looking to confirm or disconfirm results. However, what is crucial here is to recognise that while individuals may have a focus on the Primary Age-Phase, they, like others in this study, also contribute to other phases. Thus this decision may not be as limiting as first indicated. In addition, it is possible to reconsider the questionnaire responses of this group against the responses of the rest of the sample, and determine whether or not there appear to be differences. Such comparisons are made in Appendix H1, and are drawn on later in this chapter.

A detailed rationale for choosing this sample, together with some methodological considerations, and an analysis of the differences between the sample of 27 PMTERs and the full survey data can therefore be found in Appendix H1. There are some implications for the generalisability of the study's findings, but further

discussion of these issues will be picked up in Section 6.4, prior to reviewing the Research questions.

6.1.2 Interview Methodology and Focus

Following the summaries of the questionnaire data, five research hypotheses are identified. These, together with follow-up themes, constituted an agenda (found in Appendix D1) to guide the interviews, with the intention of focusing on one key aspect of each of the five lenses for deeper analysis and discussion. While this procedure might provide evidence for or against these hypotheses, there is no attempt definitively to "prove" or to "disprove" these hypotheses; merely to regard them as useful foci of investigation.

Accordingly, material from these interviews below is used to make further observations and to explore possible motivations or underlying rationales. Following the critical realist approach, different forms of retroduction suggested by Meyer and Lunnay (2013), notably case comparisons, thought experiments concerning counterfactuals, and counter-cases, are then used to explore the robustness of the hypotheses.

This chapter begins to depart from the strict use of the Davey (2013) Framework. In parts of Section 5.3, and more specifically in Section 5.4 it became clear that adhering strictly to the five lenses is not always possible, nor perhaps is it even desirable. In particular, whilst professional identity is associated with the individual it has to be contextualised in the sense of belonging to a particular profession or community (Jenkins, 2014) otherwise notions of common characteristics and shared philosophies carry no meaning. To become such a professional, a person acquires the shared values and commitments of that profession. For this reason, when addressing Davey's five lenses in the sections that follow, *becoming* and *belonging* are considered first, noting explicitly the clear overlap between the two, before

moving on to the discussion concerning *doing, knowing* and *being*, the latter now incorporating the items from Section 15 of the questionnaire, in line with the discussion in 5.6. This first section looks mainly, but not entirely, at MTERs as a collective, while the second draws mainly on the understandings of MTERs as individuals. The final section in this chapter looks at the composition of the sample of PMTERs, and whether there are any features if this sample, which might collectively pose threats to generalisability.

The methodology adopted here uses the coding principles adapted from **Bleiler (2015, p.237**), laid out previously in Section 3.5 and given a fuller treatment in Appendix E1.2. This methodology is not referred to in every section, but for the material on "Values" in Section 6.3.3 below, an example has been provided in Appendix E1.2.2 to illustrate how the coding principles have been applied in that particular case.

6.2 *Becoming* and *Belonging* as an MTER

6.2.1 Becoming

6.2.1.1 Summary of Becoming

Sections 4.5 and 5.1 of this thesis provide detailed information relating to the first of Davey's lenses, with a picture emerging of MTERs *becoming*. For most MTERs starting in role is based on opportunity rather than planning, perhaps even, a "leap of faith" as suggested by Davey (2013, p.49). Motivations include the desire to develop their own understandings of mathematics education, and to share those with others. This is encapsulated in a deep desire to develop professionally, to collaborate with others, to be part of the MTER community, and to contribute via research and through teaching, both to the community and for their own professional development. This process is certainly not limited to an initial *becoming* stage, nor does it appear to diminish with time; in fact, there is some evidence that this desire probably deepens over an MTER's career. An abduction here might be that no-one *becomes* an MTER, but that MTERs are constantly *becoming*: embedding more deeply into the role, and deepening their commitment to it. This is certainly true in my case, and true for a large number of my colleagues.

The data and analysis presented in Section 5.1 has helped lay out a wide range of features related to *becoming* an MTER. However, in doing this, a number of issues are still unresolved, such as why someone might be drawn to the role of MTER in the first place. Evidence has also emerged that induction and mentoring are not commonplace, but for a number who have experienced this, the results have been very positive; for others, less so. What is unclear from the questionnaire is what sorts of induction activities have taken place, and which are deemed beneficial and why; Murray and Male (2005) contend establishing new professional identities takes 2-3 years.

From this it is possible to conjecture:

Research Hypothesis 1: The process of "becoming" an MTER is not limited to the initial time in post, but is part of a career long commitment.

Other hypotheses generated here might have related to the incidence of mentoring having reduced in recent years, its possible benefits, as well as how some MTERs feel anxiety during the initial stages of their role, and how they cope with this. Other issues to explore might be related to the professional development aspect of *becoming* including time and organisational constraints which affect MTERs, and how they might have sublimated their main sources of professional development (Ping, Schellings and Beijaard, 2018) into research activities (Hill and Haigh, 2012), self-study and collaborative working (**Erbilgin, 2019**).

6.2.1.2 Coming to the Role – experience of the interview participants

Of the Primary MTERs (PMTERs) interviewed nine had agreed with the questionnaire item (2.8) that an MTER role had been part of their career plan. In the interview, four confirmed that they had consciously been working towards a career as an MTER for a few years by considering their mathematics teaching experiences and/or undertaking higher level degrees. A further one started to consider it through discussion with peers with whom she was undertaking an MA in mathematics education. Two were seeking posts in primary ITE though not necessarily in mathematics however both were pleased with the outcome. Two more had vaguely thought of the possibility but applied when they had been encouraged to do so by others. One of the interviewees (B2) had been recruited via this route, and in turn had use this route to recruit others.

> "…it's partly about making those connections with people and there are lots of opportunities for developing those." [B2]

In fact, a further ten only thought of the role as a possibility when they saw an advert for a post or were told about it by someone who thought it might suit them. One of these applied for the MTER post but was offered an English TE post, only later being able to apply and secure a maths position. A further participant [D1] applied for an English TE post and was subsequently offered mathematics which she took.

Once in post however, and irrespective of how they arrived, all expressed commitment to it. Many spoke passionately about their subject teaching and/or research. Those in other positions of responsibility with very little or no teaching responsibility continued to maintain a specific interest in mathematics education.

6.2.1.3 Making the Transition to MTER

One of the issues which many of the PMTERs discussed was the need to be able to transfer or modify skills learnt in a classroom context to teaching in Higher education, with its different sets of codes and expectations, and even procedures such as marking. For some, clearly, it was almost like facing a class for the first time:

> "I mean, I remember being absolutely so nervous I was shaking and felt physically sick, you know, before my first few lectures, definitely." [A10]

> "coming from primary school into that environment was a huge culture shock and all the language and the politics and all the things that go along with it" [B10]

This even caused self-doubt, which for some clearly continued well into their first year and beyond:

> "I did have a lot of anxiety about it because I didn't feel I had a really deep conceptual understanding of the connections, with maths, because of my previous understanding." [D1]

> "…after being able to teach children without really thinking about, you feel a little bit disempowered" [C4]

A powerful statement made by one respondent shows that even after many years in the job there were still elements of self-doubt:

> "… I just had this feeling of, "This isn't good enough, I could be better at what I do, and what can I do about it?" I would certainly say that as I became confident in higher education, and more familiar with the environment and the expectations, I thought, "No, I could be doing better." So, yes, there was that element of drive, for my own development and self-improvement. And, I knew it would have a positive impact on working with the students." [D1]

Respondent D1 is an interesting case, explored further below. Statements like the above are clear evidence to support Hypothesis 1; that the process of *becoming* is not limited to the initial time in post, but part of a longer term, ongoing development.

The transition from teacher to teacher educator clearly represents a crucial stage in the *becoming* process, a critical point made here:

> "Many universities today treat teacher education as a self-evident activity both for school and university-based teacher educators who mentor prospective teachers in clinical experiences and for the instructors and faculty who teach the courses in a teacher education program." (Zeichner, 2005, p.118)

Zeichner (2005) is rightly critical of the assumption that teachers who have proven themselves to be effective teachers of children will be equally well-equipped to support student teachers. The PMTERs in my sample made various comments which confirm this is an issue still today in the UK.

> "It can be quite daunting coming in and trying to teach adults because obviously they have a preconceived idea about what they want to learn, they have an ultimate goal in mind of being a teacher and you want to share, to really share your experience as best you can but also allow them to explore what sort of teacher they're going to become and which elements they might need more support with." [C1]

Whilst the situation varies between universities, there is still an issue to be addressed in regard to effective induction. Many of the PMTERs reported

university-wide induction and whilst useful almost all who discussed this noted its limitations. The successful mentoring experiences all involved working alongside an experience member of staff, planning alongside them, and in some cases being allowed time to observe sessions taught by others.

> "There was an induction programme in terms of being a lecturer but not in terms of the subject specific ones. I would say that I was quite lucky that X was the lead for primary mathematics year at that time and she was here for eighteen months and she did actually provide me with a lot of support, not necessarily induction but she was just there for me to help shape lectures, to tell me whether she thought it was work or not … she gave me a lot of freedom and then would have a look at what I'd done rather than say, you've got to do it my way, which was very helpful." [B8]

Around half of the respondents reported similar experiences, many of these informal. The most successful of these appeared to follow a pattern of first of all being asked to teach sessions planned by others, where the PMTER had been directly involved directly in the planning, then following this up sometime later by the 'novice' PMTER taking on the planning role, supervised by a more experienced member of staff.

> "So, in the first instance I was really delivering other people's content and then obviously as I gained confidence I would then adapt it and share ideas, share resources and so it was just that kind of evolutionary process rather than any formal induction or training, really. [A7]
> "I was able to be part of that kind of whole team discussion right from the very beginning … they'd designed the timetabling so that the first maybe 10 weeks I shadowed so there were multiple runs of the same session I would watch one of them teach the first session after having planned it together and then I'd go ahead and teach the rest so I felt really well supported with its content of the modules as well and it was great. It was a really nice way to get inducted in and it meant that I could hit the ground running and within 6 months I suppose I was up and running and taking the lead looking forward to leading modules, looking forward to making changes" [B10]

Interviewee B7 discusses how in the early stages of her career she craved the support and encouragement of a more experienced colleague.

> "…I knew how much I had to learn. And I wanted to listen and I wanted to talk to people and I wanted to be able to sit and work with people. But that only happens if people have got that time or understand that

> you need it. So, I did need nurturing. So, I did a lot of self-learning and from, you know, I over planned every session, really, was over planned just to make sure I really knew." (B7)

6.2.1.4 Early Career Stages

What the PMTERs raised as concerns in the early stages of their careers include:

- *understanding developing a pedagogy for working with student teachers;*
- *marking academic assignments;*
- *the tension between their knowledge of the practice of teaching versus their relative lack of knowledge of the theory underpinning it.*
- *completing next phase of qualifications, e.g. Master's or Doctorates and/or beginning research for publication;*
- *The need to keep "up to date".*

A key way in which PMTERs felt the first two of these concerns could be addressed was through observing or working alongside their more experienced colleagues. Five of the 27 were not able to do this in the early stages of their career. Three had been MTERs for over fifteen years however two were in their second year. One had spent some time as a consultant but recognised a different approach was needed with PSTs.

> "… really it was a kind of muddling along. […] I'd been a Consultant. I had written sessions before but obviously not to do with what we were doing here. […] I knew […] the kind of thing that I needed to do and, obviously did the same kind of thing that I would do as a teacher and try and put myself in the shoes of the students." [A1]

The third and fourth concerns manifest themselves in the tension between credibility and currency: the idea that while a novice MTER is likely to be regarded by their audience as having recently "walked the walk", they may not actually be equipped with sufficient theoretical depth to be able to "talk the talk". The need to keep "up to date" was expressed in one form or another by over a third of the PMTERs. In one sense this is related to the "currency" issue, in that there is a sense in which schools are constantly at the forefront of changes, and that MTERs need to be able to inform their students of current practice:

> "For me, my priorities are keeping up to date with what mathematics looks like in school, and how it should look, in terms of what we are doing at university. So, that there is a link there, between national picture, what's going on in the schools, and just keeping it current. [E4]

A discussion of the currency issue will be explored more fully in Section 6.3 below, and is related to the idea of Professional Development examined in 6.2.3. The concerns noted resonate with those identified by Murray and Male (2005) in their study of the *becoming* process of 28 Teacher Educators. My research suggests that certain challenges and tensions persist well beyond the first three years in role. New and different ones arise dependent often on external factors, individual and contextual circumstances, and some which may be more particular to MTERs than TERs focusing on other subject areas.

One of the surprising things, perhaps, is the amount of time it takes for PMTERs to begin to feel as if they "own" the role. Respondent C5 has been in post nearly five years:

> "I know that of the three of us, I probably still see myself as novice, and I'm quite happy with that. I'm very much enjoying learning. But, actually, I know that my opinions are valid, and valued. I know that actually, I probably have as much input as anybody else. It's just the way your feel sometimes, you feel people are more expert than yourself. … I think actually, I'm beginning to regard myself as more of an expert." [C5]

From the questionnaire, four MTERs presented a different perspective to the majority and did not view their professional development to be a crucial part of being an MTER. While none of these MTERs thought that the role was a stepping stone to other things, two of these had nonetheless moved on to other roles, and were not currently fully engaged in the role of MTER. Similarly, two of the four did not see being an MTER as the major focus of their career, but all thought they had gone as far as they could in developing the role. One of this group was interviewed, and serves as an interesting *counter-case* (D1).

Respondent D1, whilst outwardly seeming to do a very good job as an MTER for over ten years and reporting very good feedback from the students, as noted above was quite self-critical in the role. D1's history is interesting, in that from the start (s)he was appointed to a role with a different subject focus (mathematics) to the one for which (s)he had applied, and from the start felt under-qualified. Despite doing a good job for students evidenced by evaluations and more, (s)he never felt fully at ease in the role. D1 was proactive in seeking support via the maths team, courses and personal study.

> "…through an inquiry into my own practice, and looking at how we can empower students to be more autonomous and engaged in their own learning it actually made me realise that the way I was teaching maths, wasn't the most…It was successful, and the students were great, but it wasn't good enough for me, I think. So, it made me think about my practice as a mathematics educator. And, helped me see how maths could be taught in a different way, and in more of a collaborative way." [D1]

D1 has recently moved into a different ITE position, and doubts a return to the mathematics role. (S)he was the only one of the 27 interviewed to suggest that (s)he would be unlikely to maintain a continued specific, rather than general, interest in mathematics education.

6.2.1.5 Evaluating Research Hypothesis 1

In terms of Research Hypothesis 1, the issues explored here allow for a variety of reasons why *becoming* may not be limited simply to the initial time in post. In order to carry out the role effectively there may be pressures concerning credibility and currency which necessitate an MTER's involvement in an ever-widening range of activities simply in order to do the job. In particular in the beginning the transition from one identity to another necessitates involvement with many different colleagues, across several different environments: the university departments within schools and the wider institutional setting. It is possibly not the "commitment" so much as the practicalities of the role: to do the job fully requires that an MTER changes, develops and grows. For Hypothesis 1 not to be the case,

this would require an MTER already to possess a doctorate, possess the skills of teaching adults, and be familiar with Higher Education procedures, to be a member of mathematical organisations with a good range of contacts. This is certainly not the typical route by which MTERs enter into the profession in the UK. In other countries the situation is mixed but the majority of entrants do not appear to have both high levels of academic qualifications and teaching experience (Tatto et al., 2012**; Wu et al., 2017**).

In the survey, there were only five MTERs who were within the first five years of their role, and possessed doctorates in mathematics education. One of these was based in the US, and out of the UK ones, three were in secondary and were in their fourth or fifth year. One of these was in the second year of being a primary MTER, and was interviewed as respondent E2, and makes another interesting *counter-case*. E2 has in fact taught in Higher Education for several years previously, before taking on this role. Despite this, and despite having a doctorate, E2 expressed the view in the survey that (s)he was keen to develop the MTER role, to develop professionally, and did not consider that (s)he had gone as far as possible in developing it. E2 is an interesting case and is explored further in one of the sections below.

6.2.2 Belonging

6.2.2.1 Summary of Belonging

Section 5.5 established the existence of a network of overlapping communities to which each MTER may possibly belong. These operate at the local level within the same institution, within the local region, across universities, at a National or International level; they can be face to face, via textual sources or online. They can be formal or informal. Through each of these communities, MTERs communicate and collaborate, sharing information and providing mutual support, establishing

strong working relationships with others, and also benefiting from membership of professional organisations, attending conference both to hear of developments, and to present their research. Connecting to one or more of these networks can provide MTERs with a range of positive experiences, advice and support, and allow them to collaborate on projects and on research. There is evidence that these links and collaborative activities strengthen over time.

There is however, a small proportion of MTERs who do not have such relationships, and do not have such contacts, and who feel isolated, do not seem to derive benefit from professional organisations. An area of further research might be to tease out a better understanding in regard to the experiences of these individuals and look at specific cases to build up a picture.

While the open-response items have allowed us to establish a number of important ways in which MTERs communicate, collaborate and support each other, it would be useful to explore these further, firstly to ensure that all aspects of communication and collaboration have been captured, but to examine how these happen, and at what sorts of levels and with what frequency. In particular how do MTERs manage these communications and contacts? How do they find time in busy schedules to engage with others and nurture relationships, and what investment of time does it take to maintain relationships in each of these communities?

From all of the above, it is possible to conjecture:

Research Hypothesis 2: There is a deepening commitment to the MTER community over time.

6.2.2.2 The Nature of Belonging

The sense of community and collaboration coming from the PMTER interviews was reiterated repeatedly by respondents. 25 out of the 27 interviewees discussed their relationships with others, using language such "links", "connections" and "partners". Only three of the interviewees reported negative experiences in relation to this. These are returned to later. Many PMTERs claimed to draw strength, support and inspiration from colleagues across a wide variety of contexts. 18 of the interviewees mentioned relationships at the immediate level, within University departments:

> "The maths team have been amazing over the last five years – I've never worked in such a supportive environment as this and count myself really blessed to work with the individuals I do who I genuinely have a high regard for as friends as well as colleagues" [B6]

Almost all of these respondents spoke positively about the relationships (16/18); some explicitly used the language of *belonging* as a means to identify with their colleagues.

> "I've definitely got a sense of belonging where I am here. It's definitely a good primary team. Definitely got a sense of belonging" [B7]
> "…that was a very nice part of the job to be part of a strong community like that. And what I find is that the communities have changed – I always need to feel a part of the community" [A3]

Belonging does not mean uniformity, however:

> "…they're all different. The way that they work is different. We're not clones, we can't be clones we have to be who we are. But, I think it's something about always being open to learning and recognising that even when you think, I would want to be like that, but you can still learn from that." [A8]

6.2.2.3 The Communities to which MTERs belong

The communities with which MTERs identify are not limited to teams working within the same department or organisation; 11 respondents talked at length about

their links with local schools in terms of "community", with all but one of these being positive:

> "I feel quite rooted in the primary schools' community in our local area because that's where I spent my teaching career and that's where I spend a lot of my time supporting students and working with teachers so I do feel part of that community". [B10]

16 of the respondents also discussed their relationships to professional organisations such as the Association of Teachers of Mathematics (ATM) and the National Centre for Excellence in the Teaching of Mathematics (NCETM) in terms of the networks of contacts, and their relationships with other MTERs. Again, almost all (14/16) responded positively, and for a few respondents these relationships were quite strong:

> "for me ATM […], it's my professional home. It has always been, for me, where I feel – I resonate with the aims and guiding principles " [A8]

One of the strongest signals coming from the survey was the strength of commitment of most MTERs to "community" and the value placed on it. This situation seems well-corroborated in the interviews. One respondent states this explicitly, seeing the communities in terms of widening areas of influence, and noting that there are different sets of objectives, values and possibly even personas appropriate to the different levels:

> "I think that the importance is that you have communities at different levels. So, there is the community within the maths team, we all support each other laterally. Then you've got the communities of the people like the maths hubs and the NCTEM where you put on a different persona because that's a kind of space of, what can we do to improve more national outcomes? And you support each other at that level but working not just for local but more regional and national outcome." [B8]

> "There seems to be three different areas, there are researchers, there are the mathematical experts and consultants who are going in and supporting the maths education community and then there is the practitioners and there isn't always as much overlap as there should be and I think where it's really exciting is where there is that overlap." [B10]

There are clearly differences in the nature of these groups, their purposes and their membership. Some PMTERs perceive there being differences in focus and status between different mathematical organisations:

> "Yeah, I think there are differences. There is the BSRLM that's very much teacher education people who are in higher education go to that one. Then there's the ATM where it tends to be – you get some higher education people but you also get a lot of teachers attending that conference, as well. And a lot of secondary teachers. And there's – I think it's been nice that BSRLM are starting to recognise the need perhaps for a primary and early years [group, where] you can focus on maths research. So, I'm very excited about that." [B1]

If this perception is accurate then in fact it might be more appropriate to talk of MTERs identifying with different groups, and possibly therefore the identities of MTERs, in the plural. This idea is articulated by an experienced MTER who has been in the profession for over 15 years, giving these insights about the feeling of *belonging*, not just to one single community, but to many, and over the course of a career:

> "Yeah, I think it's incredibly important and incredibly powerful. And there have been times in my career where it has been particularly important. So, for me, it was an absolute revolution, for example, to become a numeracy consultant both because there was community within the early years – I worked within a team of four and five with two advisors and that opportunity to develop as part of a team all focused on maths education was just so exciting. … then of course there was the wider community of the National Strategy so we came together as consultants regularly and there was a real sense of working, you know, shared goals and shared understanding and support really wide development opportunities … Moving on through my career we had things like that maths community working with consultants … working as an NCETM associate and CPD provider again gave me really good opportunities."
>
> [B2]

As noted above, there were three respondents who voiced some negative concerns. However, what is interesting is that in each case, the person recognised the value of *belonging* to a community, and noted they were or had been a member of a particular community, but that a sense of *belonging* was absent in their current or specific context:

> "within the PGCE team I do feel a sense of belonging there. I don't feel that there is a wider sense really. Even within our school, the school of education. There are loads of people who, I've seen their faces over the last eight years and I don't even know their names, you know. There isn't that real sense that we're all in the same school and we're all colleagues." [A7]

> I do believe that I belong to the ITE community in the university but I don't really feel part of a community that's a research-based community even though I know that's a priority in our school. [B10]

> I don't feel a sense of belonging at [this university] I barely see my colleagues, […] because of the REF […] I can't rely on [this university] to build up the community, I have to do it outside of that. It's really, really, really important. In terms of research you know as you need people's input, their opinions to talk it through with other people. [B9]

There is also the issue of the extent of collegiality and collaboration between those teaching in different age-phases or curriculum groups. In this regard, one person warned of the danger of creating "silos":

> "I think probably people get stuck in the silos – I think people get pushed into the silos through the way in which the curriculum in teacher education can be delivered. Like, I'm a maths teacher specialist and people are thinking subject specifically. Whereas, I think if you could organise the curriculum in a different way where you were working as inter-disciplinary teams on cross subject issues …" [A3]

6.2.2.3 Induction into Communities

One important question is how individuals become "inducted" or enter into each of these different communities, and especially wider communities beyond the immediate departmental level.

> "I'm almost coming to terms with that, and growing confidence in that. […] the bigger, wider field of maths specialists, who go to maths conferences. Again, I think I'm still very much the novice. And, I go in with other colleagues, and go, "Oh that's so and so." […] "Wow." And, then you'll go back and say, "That's so and so, we quote them when we're talking about such and such. […] oh okay, all these people that I know I have books that they've written. So, I still kind of have that awe […] in the bigger, wider world of maths people. C5]

A number of respondents reported initial reservations about entering into these new environments, in particular attending conferences, and in particular presenting at conferences:

> "I only intended my first MA and ATM meeting a couple of weeks ago, actually, in London – it was the first one that I've been invited to but in future I'm going to try and get to as many as I can. What I found is just how supportive those colleagues were, whether it be consultants or people who are still teaching at schools or other maths educators, there was a feeling of collegiality that actually it wasn't about, you know, we're doing something better than you." [B6]

> "… when I first started going to them, I felt a little bit overwhelmed by them, sit at the back and stay quiet. But, now I'm beginning to enjoy them an awful lot more and get a lot more from them. In addition to that, I've undertaken my own research project, that I've now presented at conference. That, I think, almost helps you see things from a slightly different perspective. Rather than just talking about other people's work, you're then thinking, 'Actually, this is something that I'm contributing to, this is something that I'm moving forward with'." [C5]

> " I was telling [X] who I'm trying to get to come along. You know, the first time that I went I felt sick, you know, I don't know why, I just felt so anxious." [A10]

But some feel up for even greater challenges:

> "… the Congress of European Research in Maths Education. ... the first time I went was the most horrendous experience because you go in – so you have to write the full paper before going and so you – they don't call it a special interest group but, it's something else like maths groups. So, the idea is that you've read all of the papers for that group and you stick with that group and you go to all the sessions. So, the way that they do it is that for your slot there are three of you that are presenting but because the idea is that everyone's read your paper anyway you do a three-minute synopsis and then you go to different tables and anyone who wants to come and talk to you comes and talks to you. But, my interpretation of what happened was that I was interrogated. Now, reflecting back on it I perhaps wasn't but that's what it felt like at the time. And so, I didn't go to CERME again for a few years. It's only every three years anyway and then I made myself go and I think I've been to two more, maybe, since. And feel a little bit more confident but still don't feel massively confident in that area." [**C5]**

Some MTERs clearly go beyond ordinary membership to become Committee members, editors and organisers

> "… but, yeah, BSRLM I just think is the most lovely supportive inclusive environment to be in – I'm the [X] there now, so on the executive committee and I'm loving that. In fact, I've got to give that up in – well, I think the next [X] will be elected […] and I'm just thinking, I'm going to be so sad, because I'll tell you – we have to make decisions about things like who should be the editors and who should be voted for the Janet Duffin prize and things." [A10]

> "… now I'm part of the Maths Education Community nationally. When I go to things I know an awful lot of people there. And I follow that community quite strongly. I'm chair of [X]. I set up the [X] maths groups, I belong to the […] primary group. […] So, I'm working with [national groups]. And I was invited to be on [X] and [X] expert panels" [A5]

6.2.2.4 Falling away from Communities:

One important sense that comes through from the group of PMTERs who have been 15 or more years in role, is the transience of some of the "communities". People may come together on projects for a while then drift apart, but this allows relationships to form, which may then be maintained over a long period of time.

> "I've slipped away from some of those and I perhaps haven't followed all of those community opportunities so much as some other people have. Working within the university I am still collaborating with colleagues from other universities, actually. But those are largely connections that I've made at different points in my career so I do some cross-university work, I'm writing a book at the moment with two colleagues who are now in other universities. … to be honest the role in the university was so multifaceted that it was […] There were too many connections to keep up, in some ways it was quite difficult to have those very strong links and the time to actually have a developmental community… And there were again, a lot of opportunities to work with school communities so I did […] the research project was fantastic because it was a little community on its own for a two-year project, which was very developmental." [B2]

Some do "fall away", though.

> "I used to be a member of the MA and read their stuff. I don't think I ever went to any MA meetings. I used to be a member of BSRLM as well. And, so, I used to go to their meetings every three months. But, that kind of died off, it was always on Saturdays, and in different parts of the country, and I stopped doing that. When I finished my PhD and started the job, and after a while, I wasn't really doing much research either. It was nice, but it didn't necessarily feel that relevant any more. Because my job was 85% was planning, teaching and marking stuff. Not really research. Some hours to do research, mainly just to try and keep up to date with what I'm teaching." C7 [6-10 years]

6.2.2.5 Evaluating Research Hypothesis 2

Hypothesis 2 posits a "deepening commitment" to the MTER community over time, and while what we are seeing here can broadly be described as a "deepening commitment", this encompasses a whole range of other, more detailed effects, such as the widening sphere of influence as an MTER, the strengthening of identity and status, and even a greater sense of belonging, a "having found a home". Each of these processes also might involve multiple *becomings* - "*becoming a teacher of teachers*" (**Helliwell, 2017a and 2017b**), or *a researcher (***Haser, 2018***), a school community project leader (***Goodchild, 2014a***), a mentor of MTERs (*Tzur, 2001; Tzur, 2008*)*. In the wider teacher education literature also, some of these are explored (Boyd and Harris, 2010; Murphy and Pinnegar, 2011; Pinnegar and Murphy, 2011; Hartog, 2018).

Let us consider for one moment what it would take for Hypothesis 2 not to be the case – whether it is possible to be an MTER, yet not engage in discussions with others, not attend conferences, and not engage in research projects with other MTERs. In fact, five such MTERs are potentially identifiable from the survey. Two of these have now moved on from the role, but three remain in post. One of these Primary focused, and from the US; two were secondary focus, and from the UK. None of these was interviewed therefore as part of the sample.

One of these respondents was a very experienced MTER of some 30 years standing, who provided an extremely detailed and possibly very different account of "belonging" in the open response sections in the survey, stressing "being focused on the local community and also part of [the international] MTER communities", which the respondent felt "leaves me without a need to be part of a community of MTERs", and that, "Locally we are well-respected and valued … We are a community who work together."

The other UK respondent in the category has a Master's degree in Mathematics rather than Maths Education, and agrees to feeling isolated, and not having any strong relationships with other MTERs. (S)he is also somewhat ambiguous about deriving satisfaction from the role, and the responses display some sense of dissatisfaction, citing: "Lack of specific support within the university where I work". The respondent has a secondary focus and so was not part of the interview sample. No Primary MTER "counter-case" was evident.

Therefore, in terms of Hypothesis 2, while it might be admitted that it is possible for MTERs to become and remain MTERs without engaging in the wider MTER community, or collaborating with colleagues, such individuals will be in a very small minority. What has been seen from examination of the evidence above, as well as the counter-cases is why all of these things are important, and why, although not every MTER will engage with each element with the same intensity, some combination of these elements is a necessary feature of the identity of a successful MTER, who finds satisfaction in their role.

6.2.3 Developing

6.2.3.1 The MTER Workforce

The Questionnaire and the data in Section 4.1 has given us a broad snapshot of the MTER workforce, particularly those working in the UK.

Out of 132 UK respondents, 121 were University-based at the time. Only a minority of MTERs focus on a single age-phase; many focus on two or three phases, some on all phases. The data also shows that some MTERs stay in the profession over the length of a career, 15 years or more (31% of the sample fell into this category).

In terms of qualifications, around three-quarters of the MTERs have an A-level in Mathematics, with around the same number having a mathematics, or mathematics-education related degree. While neither of these seems to be a strict requirement for the role, the large number of MTERs possessing these qualifications indicates that either individual MTERs or the community of MTERs think that they add some value, if only to demonstrate that an MTER must have had an interest in or a personal commitment to mathematics or mathematics education stretching back even to their time in school.

About five-sixths of the sample have a Master's degree, and about three-quarters of these degrees are mathematics or mathematics-education related. Half of the MTERs have a doctorate, with over 85% being mathematics or maths-education related. However, it is clear from both the Survey and the subset of interviewees that possession of a relevant Master's degree or a doctorate is not universally seen as a prerequisite for the MTER role at least in the UK. Around two-thirds of MTERs in the survey possessed a relevant Master's degree, with only one in five of those in their first 5 years possessing a relevant doctorate. However, the number with

directly relevant i.e. mathematics education related doctorates rises steadily to around half of all MTERs in the 15+ group.

The UK system for recruiting MTERs into the profession contrasts with many systems overseas. For example, in the United States, it is expected that MTERs already possess doctorates in the field prior to applying for a post; this would suggest that there, an MTER career is specifically planned (**Masingila et al., 2012**), and though not necessarily mathematics specifically, the same appears to be the case in Canada (Kosnik, Cleovoulou, Fletcher, Harris, McGlynn-Stewart and Beck, 2011). In Europe, it would appear from the literature that there are specific courses available for those intending to make the transition from teacher to teacher educator (**Kynigos and Kalogeria, 2012**), and in China most MTERs have Master's degrees before they start their careers which again suggests that a post as an MTER was likely on their radar of those undertaking the degree (**Wu et al., 2017**).

6.2.3.2 Obtaining Further Qualifications.

There are clearly different requirements in operation at different institutions: several PMTERs had noted that their University had required them to undertake a Master's degree or a PG Certificate in Teaching and Learning in Higher Education, and in one case, both. No one reported either that a doctorate or that acquiring one in the future had been a requirement of the role. Nonetheless many PTMERs had either undertaken, were in the process of undertaking or intended to undertake a doctorate as the "next step". In only one case, did a respondent report on planned institutional support:

> "… the EdD programme at University X, at that time, ran once a fortnight […] and I was just released from any teaching […] I chose to do the EdD and not the PhD because although I'd done my master's it felt like quite a long time ago. So, I wanted to kind of refresher in research, both methodology and things. But also having a group of people around me, you know, I knew would be helpful and motivating."
>
> [A10]

Not all PMTERs had been so fortunate, with two of them reporting dropping out of their study for a higher degree, citing workload pressures as well as lack of support either from the University or from departmental managers. Even those who did complete talked of some pressures:

> "this is going back a while. But, in terms of research I wanted to do my PhD and there were no doctorates in the department, you know, there was two senior folk who had been there quite a long time – […] who were more into writing books and working with publishers and very lively people to work with, but they weren't researchers. And so, I struggled to find a supervisor – I wanted to do research, I wanted to register for my PhD but I struggled to get a supervisor because at the time, even in the wider school of education there were very few people who had that sort of experience. You know, they'd really come from classrooms and then into colleges of education and then it being subsumed into the university. So, yeah, it wasn't easy in those days." [A3]

Nonetheless, those who do complete, talk positively about how it caused them to reflect on their practice:

> "doing the MA, was the best thing because it really forced me to look at my practice" [A7]

> "But the second year was about doing the research project about your own teaching and learning, which I think is also what prompted me away from looking at primary children doing maths – because it had to be something about my own practice that I had to research. "[A10]

6.2.3.3 Research and the Deepening Commitment

Working towards a doctorate, and pursuing research are clearly important forms of professional development, which the overwhelming majority of the MTERs in 5.1 (Q S4) saw as a crucial part of being an MTER, with almost all claiming to have developed professionally during their time in post. From 5.1 (QS2), a majority of MTERs said that one of the reasons for joining the profession in the first place was the opportunity to pursue research.

For some, however, this interest in research activity is initiated by their master's or doctoral research which then continues beyond the point at which they are awarded their degree. For at least one, this was clearly the case:

> "I had thought, "Oh I'll just do any old master's to tick the box" then when I was researching and came up with the maths teacher education master, at [X], I thought, "Actually, this is going to be really useful for my job." … And, it absolutely was. Again, it's that kind of awareness of where you're at." [C4]

The discipline of studying for a higher degree seems to provide the structure, the impetus and the interest in research. About four or five respondents talked at length about how their research had changed their practice, and in some cases, their understandings:

> "I think a lot of the reading that I did, so to actually have the theory to back up what I kind of felt instinctively as a teacher, teaching mathematics myself... It all fell into place when I started reading around how children learn mathematics." [C6]

The results from QS13 reinforces the fact that for many MTERs, a commitment to research continues to develop over their career, and that those who remain in the role for ten years or more, have the deepest commitments to it, including attending conferences, and pursuing research or collaborative projects.

Evidence from the questionnaire also suggested that MTERs still continued to value the role and seek to understand it better, even those who had been in post for 15 years or longer; 25 of the 27 interviewees agreed. Of the interview sample all agreed that they had developed in the role over time.

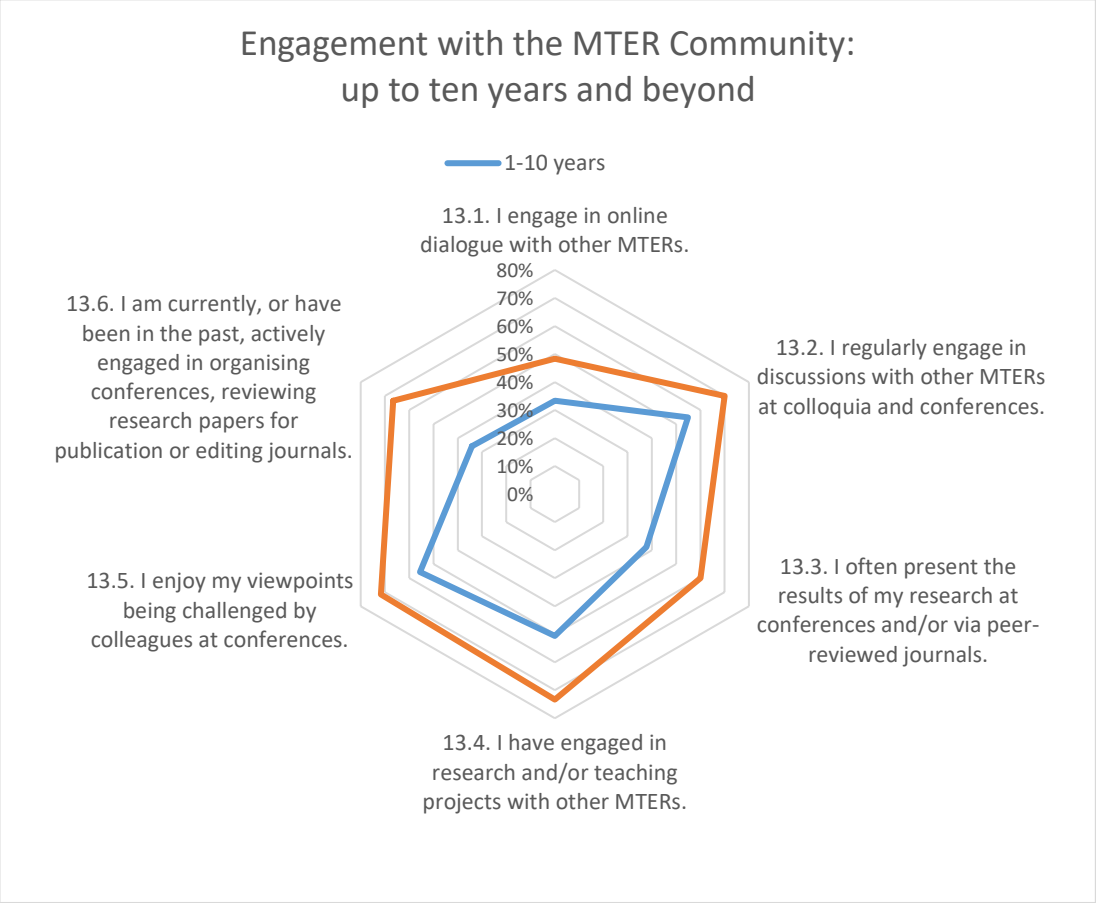
These other forms of development include collaborative projects with schools, often linked to research:

> "something that's been really useful for me and supportive for me getting into research in the last two years, is that I've been involved in a research project at University with more experienced Researchers, and it's been about mentoring Teachers in schools." [A4]

> I've done collaborative projects with nursery teachers, with my colleagues and other teachers – we had some Nuffield funded research on manipulatives, which also involves working with teachers but doing different sorts of research and now I'm doing some collaborative research with teachers developing awareness. [A5]

Chart 6.1 summarises the results from Section 13 of the questionnaire: each of the ways of interacting with others in the wider MTER community becomes stronger, with experience in the role.

Chart 6.1 Engagement with other MTERs career stage comparisons



This chart neatly summarises the two linked Research Hypotheses arising from the Survey phase of this research, that: (1) The process of "becoming" an MTER is part of a career long commitment, and (2) There is a deepening commitment to the MTER community over time.

This entire section has presented evidence from the interviews not just to support both of these hypotheses, but to explain how these occur. "Becoming an MTER" is certainly not something that happens when a former Primary School Teacher sets foot into a University and begins to teach prospective teachers for the first time. *becoming* is an extended process, and the MTER will clearly go through several stages, before even considering him or herself to be a full member of the profession.

Via the consideration of further evidence, it is suggested that there is an embedding into the role via a commitment to keep "up to date", to obtain further qualifications and to become a better MTER. Further "deepening" happens with ongoing commitments: to attending conferences; becoming involved in research and other projects; and possibly engaging in in committee work or at an organisation level.

To see how this "deepened commitment" can affect personal lives, this is the testimony of one MTER:

> ".. on a Saturday night, when you're relaxing, or [there's] nothing particular that you want to do. I could be seen, just going on the NCETM website, or looking on other websites that are linked to maths education. It's almost a pastime, not just a job, but it's almost like one of my main interests I suppose, it's almost my own social life, by myself sitting on a computer. It pervades my whole thinking, and when I've got a few minutes, it's like, I might side track into that sort of thing when I should be doing something else. Therefore, I'm perhaps not getting on with the marking I'm doing, because I need a break from it. Then, I get side tracked into, "Am I up to date with maths education? What's going on in the world? Is there anything I've missed? Any new documents that have been produced? What are OFSTED saying?" All that sort of thing."
>
> [E4]

6.3 Being an MTER: *Knowing* and *Doing*

6.3.1 *Doing*

6.3.1.1 Overview so far

The analysis of the questionnaire data paints a picture of MTERs as being relatively autonomous, setting their own agendas and priorities, with only a minority of MTERs having a formal job description. Indeed, most MTERs in the sample thought that it was not possible to encapsulate all professional activities within a job descriptor. There are some clear indications that while this picture is a good description of many MTERs with a Secondary and/or FE focus, that it applies to slightly fewer MTERs with an EYS or Primary focus. The picture also better describes the experiences of MTERs later, rather than earlier in their careers.

Whilst the literature tended not to address this type or level of detail, the TEDS-M data (Tatto et al., 2012, Appendix A4) confirmed that only in a minority of countries did those teaching mathematics content or pedagogy courses also teach general pedagogy (Chile, Germany, Malaysia, Philippines and Thailand). Generally, the picture, in the remaining countries in the sample, was that fewer than 3% taught across both areas. This in itself does not explain the wide range of professional activities being undertaken by MTERs but it does suggest that the roles may be more contained. This could be an artefact however of how the data was collected.

Separately in Wu's research in China, the research team clarify they are only reporting on the key aspects of the MTERs' roles, that is, teaching 'college' (higher level) mathematics, problem-solving; mathematics pedagogy, and observing mathematics being taught in school. He confirms that the MTERs also take on a number of other roles such as professional development for teachers and research activities. It appears that these may also be mathematics related however that is not certain **(Wu et al., 2017**).

6.3.1.2 Teaching, Supervision and other Commitments

The interview data provided more insight in relation to the questionnaire results and resonated with personal understanding based on experience of the PMTER role. Primary teacher educator roles are complex in any case and many PMTERs teach general professional studies as well as mathematics education courses. In school they may observe PSTs teaching a range of subjects and not just mathematics, or may focus on meeting mentors to review PST progress generally rather than specifically in relation to mathematics. Travelling to schools and administrative tasks also take time. What was evident from the interviews was that PMTERs undertake a wide variety of duties; where these were concerning teaching and school visit commitments they were largely viewed as complementary.

However, time was a significant constraint when balancing with concern for PST well-being both time-consuming and a priority for many.

> "I think the thing that does cause conflict for me personally really is just trying to keep up with everything because when you're on the road all the time and you've still got all the emails coming in and things like that, it's quite difficult just keeping up with all the admin and that side of things." [A7]

> "You know basically the whole kind of "there is not enough people to actually do the job properly" and I'm not somebody who is prepared to do half a job badly so if it comes to that point, I think that's where I see the tension possibly arising, if we ever get pushed to the position where budget is so tight that actually I'm not able to do a decent job of the things I've got on my plate, I'd rather not to any of it because I think it's counterproductive and stressful and we are not there yet but it's not a comfortable feeling where we work at the moment. I know this is confidential but I'm sure it's the same in a lot of places. I see the university's priorities very much a sort of conflict with my priorities really because my priority if I had free reign would be to have more contact with students rather than less." [B10]

> I don't think teaching adults is very much different to teaching children, in that sense. I think you've always got the assessment role and the teaching role but you've also got that pastoral role, as well, and we do have not just a duty of care but it is something that I enjoy doing. [A7]

> "So, my main role is a Programme Leader with a huge amount of pastoral care to keep our students on the programme and the maths is my exciting bit in lots of ways. It's the bit that I feel the most creative about when I can get the opportunity to do so." [C2]

> "But, myself and the programme leader, do get drawn upon a lot for advice, "What do we do about this situation? What do we do about that?" Within my role, it's kind of like the pastoral role. I do have a big box of tissues in my office that gets used quite a lot by trainees." [E3]

Where PMTERs had other responsibilities or managerial posts, conflicts were sometimes present particularly where these were imposed.

> I'd say probably there are more conflicts than there are complements. So, another role that takes a lot of my time is the timetabling role, which is nothing to do with what I do as mathematics person it just happened to fall into my lap. [B6]

> I've been thinking about that [future career] a lot recently because for eight years I ran the PGCE programme at UNIVERSITY and it just killed me. I just think until anybody's done that kind of job, you know, people that work in universities don't understand how running a PCGE or any teacher education programme are different to other degree courses, because of the whole OFSTED. [B10]

In conducting the interviews, a point arose in regard to career progression for PMTERs. The issue was captured in the narrative of one MTER [C8] in particular who had been in post between 11-15 years.

> "I think, in terms of perception, leading a subject in a primary ITE department always seems slightly lower in the pecking order […] within universities there is this unwritten hierarchy of course lead, or programme lead, then head of department and so on […] managing people has a higher status than managing the subject well." [C8]

In C8's case, determination combined with contextual circumstances had resulted in promotion to principal lecturer status whilst combining the MTER lead role with a wider area of responsibility – the latter being the area linked with the higher status. C8's case was highly unusual. For many there appears to be a ceiling beyond which MTERs are likely to substantially reduce, or lose completely, the MTER aspects of

the role which is potentially problematic for those wishing to retain interest and commitment in this area, and in terms of their expertise being lost.

6.3.1.3 Teaching v. Researching

The dual aspects of the role, teaching and researching, provide another interesting window through which to view the role, and to see how MTERs both combine its demands and manage their personal interests, as well as the various ways in which the MTER role is played out in different institutions. Around half of MTERs said that their main focus was on mathematical education, with only a minority claiming that their main focus was research. Again here, what comes through from the sample is that those MTERs whose main focus is on research, tend to have been in the role longer. This section posed some challenges, since the questionnaire items were few in number and limited in scope it provided only a narrow perspective on a quite a complex topic. While this was a useful starting point, the interview data is rich and can add further insight. Arising from the questionnaire analysis, the following Research Hypothesis provides a way to further probe:

Research Hypothesis 3: For many MTERs there is a tension in the role between the day to day demands of educating teachers and pursuing research.

The PMTERs clearly value research and almost all would be research-engaged if not for the constraints of their busy roles.

> "…the one challenge that I have at the moment is time to do the research that might improve my understanding of how people learn maths." [B1]

Another said research was something that (s)he definitely did not want to do; this explicitly concerned the writing up stage rather than reading or even engaging in some of the more practical aspects of researching. There were different levels of commitment evident and this was reflected in their comments regarding the university contexts in which they work and the priorities, expectations and support

available within them. B9's story of self-determination to pursue a research path was illuminative.

> "I basically did my Ed D in my holidays and on the weekends even though I was supposedly had 10% of my workload for research, it didn't…I never got it because they loaded you up so much. It wasn't just that, my line manager wouldn't even talk about my Ed D of my research; it was like "it's not your day job, not interested. […] I guess that was partly was prompted me to leave because I knew once I finished the Ed D if I stayed there the chances of me having time to do much research or the only way to do it would be to go part time and do it in my own time and that's what some of my colleagues did." [B9 discussing first university]

> "Whereas at THIS UNIVERSITY it's totally different, I think it's usual because you know I basically am the same as any other lecturer at THIS UNIVERSITY", [B9 in second university]

Participant E2 has much less experience in the role but is already having similar frustrations to those expressed by B9. E2's university is perceived to be more focused on the teaching aspects and despite having a doctorate, E2 feels unable to access research time and worse perceives research not to be valued particularly either by her managers or students. However, there are clearly other institutions where E2 would feel more valued and perceive a more shared philosophy and sense of values.

Another point arising concerns what to research. B1 above has interest in the PSTs and her role in better supporting their mathematics understanding. Other MTERs see research in school as the way forward. There are many examples of communities of practice or inquiry set up by MTERs in collaboration with teachers (for example, **Hunter, 2010**; **Sztajn et al., 2014; Goodchild, 2014a**), and similarly this was discussed by the PMTERs in the sample.

An obstacle besides time is that of learning how to become a researcher (**Haser, 2018**; **Liljedahl, 2018**). For many the way in is through master's and doctoral level

study and research which can be challenging in that it is useful to discuss ideas in order for them to better solidify. There are many MTER papers relating to self-study but its advocates (LaBoskey, 2004; Loughran, 2005) are mindful that there should be reflection with others. What appears very powerful are those examples where two or more MTERs collaborate in research with teachers **(**for example, **Erbilgin, 2019**).

6.3.1.4 Evaluation of Research Hypothesis 3

The issue here is clearly complex. While there is evidence that Hypothesis 3 is largely correct for many MTERs, it is context-dependent and for some MTERs whose University values their research, conflicts are minimised. The tensions, where they exist, are not between the research and the teaching per se, but on their competing demands for time and priorities.

One respondent articulates clearly the importance of research as the fundamental underpinning of the role of MTERs:

> "… it is my job to think about maths education. And, actually, I'm beginning to see the university's role. It's our job to find out what is the best practice, what does current research say, and disseminate that." [C5]

6.3.2 Knowing

6.3.2.1 Overview so far

Section 5.3 has provided us with a fairly extensive description of the categories of knowledge and skills which MTERs see as important, and a fairly comprehensive account of the sources of information used, and the relative importance of each.

The open-ended items have gone some way into illustrating what is the content of these categories, however we do not see the detail, for example, what is meant by a "*depth of understanding", "how learners learn", "an ability to make connections*", and whether there is agreement between MTERs on these. It would also be useful to explore what it is that MTERs "know", the different types of knowledge and skills and how MTERs develop this "knowing", and how knowledge acquired from research activities affects their classroom practices.

The study was set up as largely exploratory and what additional depth could be gleaned through single event, multi-lens interviews was inevitably going to be limited. It was clear that there was concordance in regard to the overarching types of knowledge that MTERs considered important with reference to Shulman's knowledge types as was noted in the literature (Shulman, 1986 and 1987; **Chauvot, 2008; Chauvot, 2009**; **Chick and Beswick, 2018**)). However, what arose as a hypothesis, both from the survey data, and in the early stages of the interviews was investigated explicitly in later ones.

Research Hypothesis 4: MTERs tend to supplant the currency of their classroom experience with more recent project or research-related experiences as their career progresses.

6.3.2.2 The Currency of Classroom Experience

I have noted above how MTERs new in post might experience some transition issues, but a strength of novice MTERs is that they can talk with PSTs concerning classroom issues on the basis of immediacy. This 'currency' provides then with a validity in the basis of their continuing identities as primary teachers (Murray and Male, 2005). The relevance of this was summed up by B10, who was approaching a fifth year in post.

> "I know it's an issue because when I went for my interview I was asked what I thought was the strongest element of my experience and I said "my current knowledge of practice, my recent relevant experience" and I think it is a really big issue and it's not just an issue for the student teachers, it's an issue for the class teachers and the school partners that we work with because if they perceive that the people who are teaching on the ITE courses are distanced from real life and don't understand what it's like to have their feet on the ground then you know their attitude towards the quality of training changes as well.[…] in the first few years, I definitely traded on my "I've been in the classroom, I know what this is like." [B10]

What was particularly interesting to explore was how MTERs longer-in-post thought about the issue, and how this affected them.

> "So, it's kind of twelve years since I've had a real front-line classroom role, which just saying that actually shocks me quite a lot, you know. So, I think you can get quite deskilled. But, I think, obviously, as you go on in the role you do learn more and because you're dealing with the more academic side of things I think that obviously strengthens, you know,[the] theoretical side. I do think a lot of teachers sometimes teach things either because they're told to teach things in a particular way or because it's the way that they've always done it and I think that one of the good things about my role, I feel that even though I've been out of the classroom for twelve years I would actually be a much better teacher now […] generally than I ever was when I was in the classroom, just because of being forced to evaluate other people's teaching and also to inform your teaching a lot more. I think that's the sort of thing that teachers don't tend to have a lot of time to do when they're in the classroom. It's just so full on. And so, I think, being able to step back and really think about what makes good teaching and learning. I think that's something over time you accrue more of that kind of knowledge and understanding. [A7]

Several MTERs did make the point that research had a place in maintaining currency.

> "There are different ways of staying current and I think – perhaps I hadn't explored all of them through my career as much as I could have done, so I have been involved in research because that's one way – is to actually make your research very practice based and collaborative and I think there are avenues for that and where you can kind of streamline, you know, the research that you're involved in, then that works extremely well."
>
> [B2, 15+ years in post]

However, research was not actually the only way in which "currency" is addressed: for some the day-to-day job provided space and opportunity to reflect more deeply, something clearly essential to enhancing knowledge, and by default, maintaining currency. Typical of such responses was E2 who was very clear about this point when asked whether 'currency' was of concern:

> "No, […], the main reason is I don't know anyone who spends more time in the classroom unpicking what I'm seeing than people who are in my role. Today I've been in two different lessons, one in Year 4 and one in Year 1. Two different schools, one using a scheme, one not. I'm seeing maths in practice in as wide a breadth as you can imagine, and I have issues when I hear people saying things like, "we need to bridge the gap between those maths educators in university and those teachers in schools", and I actually see that is my role. " [C2]

6.3.2.3 Evaluation of Hypothesis 4

Here it seems the Hypothesis was not fully correct; while there is a currency issue, the counter-case above and many others suggest that MTERs maintain their currency by many ways: research, working with teachers, and by school-based supervisory and moderating activities. It is difficult to capture here in a short section the depth of knowledge that an experienced MTER can bring to the role, and their commitment to both staying current in regard to practices, the latest being the mastery agenda, for example, as well as acquiring over time, a sense of the history of mathematics education having seen various incarnations of curriculum, and having had the time to reflect and undertake research contributing to the MTER knowledge-base.

6.3.3 *Being*

6.3.3.1 Overview so far

While the items within this block (Section 5.4) have established some important baselines, here again detail is lacking. MTERs think that those undertaking the roles should possess a philosophy of education, together with specific skills and attributes, and espouse specific values. However, it is neither clear what these are, nor whether MTERs are all in agreement as to whether any of these are fundamental requirements for the role. Section 15 on the perceived value of MTERs, was included within this lens, missing from Davey's framework, but one which I was keen to explore utilising both research tools. Here the questionnaire analysis indicated that there may be differences in the perceptions of those new to the role and long-established MTERs. This led to the final hypothesis.

Research Hypothesis 5: The values of MTERs, and their perceived sense of being valued by others, differ between newer and more well-established MTERs.

6.3.3.2 The Values of MTERs

In 5.4, it was noted that 79.7% agreed that they saw MTERs upholding specific values within the education profession. This key part of professional identity is given further insight in the open-ended question responses (Q11a and 12a) discussed in Section 5.4, and during the interviews the PMTERs were specifically asked about their values.

This topic was explored through the iterative coding and analysis of the transcripts following the four-stage procedure suggested by (**Bleiler, 2015**), as described in Section 3.5, and more fully in Appendix E1.2.

As a result of this exploration, 12 main themes emerged which, on subsequent reflection, were recombined resulting in four key areas, with a number of number of references within the interview texts:

- Affective matters (99)
- Cognitive concerns (48)
- Professional matters (6)
- Social Justice (6)

The topic of "*Values*" has been used as a case study in Appendix E1.2.2 to illustrate how the four-stage process has been applied. There can be seen how the different levels emerged, and how the various sub-themes contributed to the four key areas In the list above.

This list is not offered either as mutually exclusive or exhaustive; nor is it claimed that these areas would necessarily be representative of all MTERs. However, one MTER specifically said,

> "I don't think there is anybody I work with in primary ITE that I don't think shares my kind of values. We might disagree sometimes on the best way to implement those values, and best way to structure programmes and modules and that kind of stuff. But, generally, one of the best things about my job is working with really passionate people." (C7)

The final two items in the list are briefly considered before looking at the first two in more depth. Although raised as a value by PMTERs, notions of *social justice*, *equity* and *inclusion* only three papers in the *100 set* literature addressed this. Respondents' comments emphasised a recognition of the importance of a broad curriculum not overly biased towards English and Mathematics; attracting PSTs from backgrounds which might be considered non-traditional, a broader view of inclusion; and drawing on wider cultural experiences which impact our thinking and world views. The evidence here suggests that the concerns for equity that **Vomvoridi-Ivanovic and McLeman (2015)** noted in a specifically-targeted group of MTERs, are more widely held.

In the list above, 'professional matters' included such matters as building resilience in PSTs, professionalism & leadership, and valuing and supporting colleagues.

Affective matters

Over a third of the comments related to MTERs' concerns to address anxiety in their PSTs. This concern is not a new phenomenon; the mathematics anxiety of PSTs has been widely acknowledged for decades. The Cockcroft Report, for example, spoke of how mathematics *"could induce feelings of anxiety and helplessness"* (Cockcroft, 1982, 2:20), and Haylock (2018) in his book for PSTs discusses their mathematical insecurities in the first chapter.

Based on my own experiences with Primary PSTs this was not surprising, though it is disappointing after years of national policies aimed at improving children's mathematical learning, new generations of PSTs are still exhibiting the same anxieties that their forebears did nearly 40 years ago. It is worth reflecting on the fact that the majority of current undergraduate ITE and PGCE students will have experienced the both the National Curriculum and National Numeracy Strategy (DfEE, 1999) and the years during their primary education years.

As has already been noted, mathematics anxiety is certainly not unique to the UK; Stoehr's research in the US focused on female elementary teachers' anxieties in the subject (**Stoehr, 2017**), and in Canada, **McGlynn-Stewart (2010)** and **Nicol et al. (2010)** consider the same concerns, adapting and reflecting on their MTER practices in response.

The PMTERs in this study demonstrated a clear sense of responsibility to address students' mathematics anxieties, in so far as is possible within the time constraints of mathematics ITE courses. Three PMTERs suggested the issue is quite wide-scale.

> "I can guarantee that more than 50% say that Maths is the subject that they need to work on and I think […] that's probably the only difference between us [the primary subject teams] is that we seem to have a bigger hill to climb just to make sure that […] they are confident when they go into school." [A1]

> "… it came through in our work in [X University] that, you know, a lot of teachers have lived through that sort of experience of being undermined in terms of their own ability to do maths." [A3]

Another PMTER expressed this responsibility not simply as a duty to the student teachers but also …

> "I need to encourage that value [positive attitude to mathematics] into my students so that they can then go out and share that with all of these primary children so that we get people coming through the education system that aren't afraid of maths. I think that's what we've got at the moment." [B1]

B7 linked student teachers' mathematics anxiety to matters of student mental health and well-being, a topic of significant concern currently across the university sector (Brown, 2016). B7 emphasised points reinforced by others that as former primary teachers, many PMTERs have a natural tendency to a strong pastoral sense of duty towards their PSTs, presenting challenges, given the numbers with whom they work. These PMTERs clearly showed empathy for the challenges faced by PSTs as well as a recognition of the impact they will have on learners in the classroom.

Cognitive Concerns

Concerns here were: *Academic underpinning and research; Nature of mathematics; Knowing your stuff; Mathematics for understanding; Cross curricular issues*.

Concerns about the nature of mathematics related narrative tended to be those of longer-serving PMTERs. A rich commentary here was provided by a PMTER in post for more than five years:

> "We have a knowledge based curriculum which is ill-defined and focuses upon reinforcing factual knowledge which actually diminishes, […] and reduces maths to something else, it's not mathematics, it's a form of authoritarianism and fundamentalism, which is about remembering things." [A3]

However, similar concerns were also voiced by two newer MTERs. Clearly MTERs have very different views of the nature of mathematics than many of their PSTs, having a wider and richer view. C5 explained: "I've always been intrigued by the history of maths. I love finding out about how different things came about." This view resonated with me personally, and the research of **Jankvist et al. (2019**) has already been cited in this regard.

A related issue, repeatedly referred to by MTERs in this group concerned PSTs' beliefs about mathematics and their tendency to simply want 'the right answer'.

> "I don't want them to think that things are fixed. One of the things that I try to get across to them, straight away, is that maths isn't about answering things. They often come in and think it's about a right or wrong answer. It's about doing something a certain way. It's not, maths is all about patterns." [C7]

Whereas, E2, for example, commented:

> "…mathematics is about understanding the world around us, and as it is, and that's going to constantly shift." [E2]

This perception of mathematics combined with pervasive negative attitudes referred to above presents a challenge for MTERs not least because of the difficulties of shifting others' (or one's own) beliefs. The work of **Conner and Gomez (2019)** is relevant here, demonstrating how PSTs can superficially appear to fully embrace belief-changing ideas, whilst selectively retaining those beliefs.

The values and beliefs discussed by the PMTERs resonate with the four shared beliefs identified by **Lovin et al. (2012)** whilst also incorporating many others. In their study they explore the challenges of applying beliefs in practice; this sense of challenge is also exemplified in the narratives of the PMTERs in this sample.

> "…it's all acknowledged in the research literature – it's much easier to teach procedurally or instrumentally. So, I suppose, a value that I hold dear is that it's not about getting children through the SATs questions or getting them to complete a certain number of problems. It's about having that deep understanding." [A10]

> "[…] children need to understand why they're doing things, rather than 'procedural understanding' – I guess that's a real push for me, that

> ‘conceptual understanding’. I have a real passion about children and adults not being afraid of mathematics, and not being afraid to fail. So, you know, positive atmospheres, that ‘everyone can do this’ […] I think it’s when it clashes with my values as well, because they sometimes just want you to – ‘oh tell us what to do’ – you know, ‘just give us a list of what we have to do and we’ll do it’. Whereas I want them to have a deeper understanding, for them to develop the ideas themselves, so I don’t want my sessions to be, you know, a load of ‘do these activities in school and it will be fine’. I want to look at the deeper theory and get them to be able to create it, which is harder work for them. So, I think that’s when the clashes particularly happen, when their view of what they should be getting, clashes with my view of what they need. You know, and I guess in some way, they, you know, they’ve not been out teaching it, to know what they really need. […] they’re looking very short term, I guess.” [A4]

> “Well, I suppose, the main [value] at the moment is children have an entitlement to learn maths. And they shouldn’t be prevented by peoples’ prejudices about maths being a narrow subject. And they should be able to learn maths in an unpressurised and enjoyable way and to see it as, you know, an interesting and, indeed, humorous subject which adults don’t perceive.” [A5]

Being valued

Through the dialogue with the PMTERs it was evident that their roles are important to them but moreover that they have a deep sense of responsibility.

> “…it’s having that will to go over and above and the extra mile to ensure that the trainees that we are sending out into their first post, as NQTs, are as good as they can possibly be. Because we recognise that the impact if they’re not is massively damaging for hundreds of children in the future. So, having that awareness of our responsibility, I think is something that we all carry quite close to us – that what we do will impact much more widely than maybe first glance it would appear.” [B6]

The import to the role suggested by B6 echoes the sentiment of Livingston (2014) referred to in the Introduction. However, whilst it should surely be agreed that the MTER role is important (Livingston, 2014), the research here suggests that it does not necessarily follow that MTERs feel valued at every level. A sense of self-worth is viewed by some as an important aspect of identity.

There was an overwhelming sense in which the efforts of the PMTERs were very much valued by the PSTs. 26 positive references were made to this matter during the interviews.

> "I feel valued by the students and I don't think I'm really that different from anybody else that works in teacher education – because we've all been teachers in school we are quite passionate about making sure that they're well supported and, you know, feel confident to teach and the rest of it."
> [A10]

However, it was also clear from many points made by the PMTERs that there are challenges, several of which have been considered above. There is significant resonance with the literature both in terms of PST attitudes to mathematics (**McGlynn-Stewart, 2010; Stoehr, 2017**), adopting a caring ethos whilst attempting to develop a sense of inquiry (**Nicol et al., 2010**), and the difficulties involved in changing beliefs (**Lovin et al., 2012**).

The sense of being valued by other PMTERs in teams was largely very strong. One exception was the disconnect a PMTER experienced when first in post, between herself and the subject lead. Reflecting on the experience, B7 wished (s)he had adopted a more honest approach; being keen to be seen as confident and able, (s)he realised the subject lead had over-estimated the level of knowledge held, leading to frustrations on both parts. This is a crucial reminder not only for those mentoring new MTERs into the role, but also for the inductees themselves. The work of **Nicol et al. (2010)** also resonates here.

What was perhaps disappointing was that only two PMTERs reported having substantial interaction with secondary MTERs (SMTERs) or mathematicians, as literature suggests there are advantages to building these relationships (**Bleiler, 2015**).

> "I did a lot of self-learning and from, you know, I over planned every session, really, was over planned just to make sure I really knew. I remember talking

> to a secondary person […]. And sometimes I'd go over some of the higher level subject knowledge with him." [B7]

> "And, also, as colleagues, we have quite often, conversations about how do you teach this, because I'm struggling, because they don't come from a teaching background. So, we will have discussions around strategies that we might use. […] Or, how we might drive university policy forward around mathematics as well, so we'll all come together as a group, because it's a bigger force then."
> [C8 referring to interactions with SMTERs and 'mathematicians']

PMTERs also referred to the wider university community. It has been noted earlier that teacher education has struggled to defend its position in the university sector and some of this sentiment clearly still pervades. The following narrative brings together many points that have already been considered.

> "I don't think the rest of the university really understands what teacher education is all about, because we would put our students absolutely first, you know. Especially, probably, because they are going into schools and they're affecting lots of other lives. So, I would definitely put my students before anything else and that's probably why my research profile isn't very good and I know I'm going to get bashed about that, because if I've got a deadline for a research paper but then a student has a crisis, everything else is dropped for the student." [A10]

The sense of being valued through larger communities of MTERs is alluded to in 6.2 above, and there are a variety of associations captured in the questionnaires. Responses here reiterate a *sense of belonging* and *shared values*, including a sense of valuing each other's contributions.

The final question to PMTERs was whether they had a sense of feeling valued, collectively, at a Governmental level. The survey data revealed that a third of this group believed themselves not to be valued; including the "unsures" (who were comprised entirely of PMTERs in their first five years) took this to over one half. All but two of those feeling unvalued at the national level had been in post six or more years.

There was a definite sense of frustration and even 'hurt' in regard to PMTERs' perceptions of the lack of perceived value at this level. The rhetoric for many years has revolved around a "school-led" model for initial teacher education (Brown et al., 2016). However, at a meeting of the Teacher Training Agency I attended in the early stages of its inception, the speaker was asked for a definition of what the term meant. The response was to put this back to the audience of university teacher educators to come up with possible definitions. The report by Brown et al. (2016) on the School-led initiative agrees with this experience, "*There was much confusion however about what in practice, a school-led model meant*" (p.20).

The narratives below capture some of the thoughts of the PMTERs.

> "they're not valued, are they? I mean, even [names two internationally renowned MTERs] have written about their involvement [in 'expert/advisory' panels] […] she's written about her frustrations about that [views being ignored]. Politicians seem to think they know best, don't they?" [A10]

> "…when I started it was about the time that Michael Gove started, wasn't it. And the 'infamous blob' and that sort of stuff. Seeing the defamation of the profession over the last couple of years, both in terms of morale, in terms of numbers teaching, in term of people who are becoming teachers.
>
> You look at the side-lining effect of HEI's in teacher training, and now they're trying to push through an apprenticeship model for teacher training as well, virtually everything is going to be on the job. But, then, you look at what the evidence suggests worldwide, how the best jurisdictions have got the most highly trained teachers. But that's not the bit is it, to cherry pick from Singapore or Finland, they don't pick the fact that they're all educated to a master's level, or the fact that they've got all these skills. No, they cherry pick the bit about them working […] from a text book." [C7]

Brown et al. (2016) concur here:

> "In England, teacher education has been wrested from its traditional home within the academy … universities play a support role to what has become 'school-led' training … government funds for teacher education have been diverted to schools."
>
> (Brown et al., 2016 p.11)

6.3.3.4 Evaluation of Research Hypothesis 5

Hypothesis 5 seems therefore to have yielded two different aspects: the values of MTERs themselves seem remarkably similar between those in post longer and newer MTERs. However, this section has provided evidence that longer serving MTERs appear to have different perspectives than more recent recruits. This can be explained by their having experienced changes to the profession first hand.

6.4 Analysis of the PMTER sample

In concluding this chapter, it is now important to look at the sample of 27 PMTERs on which this section of the research was based. Below I discuss the nature and composition of this sample, and highlight some of the reliability and validity issues which are relevant prior to considering whether any of the results from this sample can be generalised to the wider survey group, and more widely, to other groups of MTERs. This material is a brief summary of a more extensive treatment to be found in appendix H1, to which I make multiple references.

Section H1.2 examines the Demographic details of the sample, comparing it to the data for whole survey; Sections H1.3-8 examine the profiles of agreement on the Likert-scaled items, comparing the PMTER sample with the whole survey data. The details of this are quite lengthy, and so a brief summary is provided here.

The analysis in Appended H1 shows that except in two regards, the sample of 27 PMTERs in terms of both the Demographic data, and the Likert-scaled items, are as representative a subset of the whole survey data as could have been expected if the sample had been chosen randomly. The 27 PMTERs were employed within 20 different universities, and cover the full range of career stages. Therefore, in terms of respondent validation, and the aims of providing deeper, richer material to illuminate findings, and to test hypotheses, this sample can be treated as if it had been chosen randomly.

The two ways in which the sample has unique features, were that:
(a) All of the people in the sample had a Primary focus, and
(b) the individuals in the sample seemed to exhibit an "enhanced commitment" to the MTER role.

In terms of the first point, the focus on Primary is to be expected, since this was precisely why I had selected these respondents in the first place, and in this specific regard in relation to age-phase profile, the sample is significantly different from the profile for the whole survey. [Chi-squared = 23.72, with 4df, p=0.0001]. However, while all of the group had a focus on Primary, there were 17 people in the group who declared a focus on EYS as well, and a handful who also declared a focus on Secondary and FE. Given my knowledge of the sector, it would be extremely difficult to decouple Primary from EYS, so this group probably represents the best that can be achieved in terms of a sample with a specific Primary focus. A concomitant finding here, which is entirely in line with the survey results, is that a smaller proportion of the PMTER group had studied 'A' level mathematics at school than is the case for the whole survey. This is entirely consistent with a result from 4.5.1 which showed that MTERs with a focus on Primary and EYS are less likely to have studied 'A' Level mathematics.

In terms of the second point, I have taken pains throughout Sections H1.3-8 to examine and analyse the profiles of agreement on the Likert-scaled items, and overall there are no areas where the sample group's responses deviate significantly from those of the whole survey. There are of course minor variations, but none of these is significant.

However, as noted in Section H1.9, where it is explored in detail, there is a small, but systematic effect, in that MTER respondents generally appear to exhibit greater levels of agreement with items providing a "positive" view of the role, for example a commitment to research, attendance at conferences, and lower levels of agreement on "negative" features such as feeling isolated. In the survey analysis in Chapter 5, none of the relevant sections appeared to show an association between age-phase and overall commitment levels. Therefore, I have been forced to conclude that this was sample bias, and that I had inadvertently introduced this into the sample via my selection methods, as described in Section 6.1.1.

As explained in Section 6.1.1, the recruitment procedure targeted the responses as they came in, looking for likely PMTER interviewees. This procedure, on reflection sought out those who responded early, and who, in retrospect may have been more interested in this type of study, or who tend readily to respond to requests from other MTERs. Such respondents are likely also to be more committed to the role, and be more likely to engage with other MTERs. It is hard to determine whether or not this is the case, but if it is, it serves as an object lesson: I undertook this analysis of the sample, in an attempt to determine whether the choice of Primary MTERs might potentially bias the results: it has turned out that there are few, if any differences between those with a specifically Primary focus, and the results from the overall survey. However, the prioritising of early responders may have skewed the sample slightly - in the direction of MTERs who are more research-oriented, more interested in the role, and therefore more committed to it. Thus, the subtle bias inadvertently introduced may have manifested itself as a subgroup of PMTERs who seem to have greater commitment to the role, and to research.

In fact, the differences noted are relatively small. In the majority of cases they amount to no more than a few percentage points, and even in the largest case, the difference is 25%, which in terms of numbers of MTERs represents a deviation of 7 or so, on an expected figure of 13 or 14, just within the borderlines of significance, given the low numbers involved. In no case therefore do any of these differences amount to statistical significance, and so technically any deviation on any particular issue is within what would be a normal sampling error. It is only when global issues such as a “deepening commitment”, where several items are considered together, would this have any effect.

Just to be clear: it is only on this latter point that sample bias would prevent me from drawing conclusions about all PMTERs on the basis of this sample. As indicated above, it affects neither the respondent validation issues, nor the validity of the “thick” data provided earlier in this chapter. Furthermore, this does not

prevent me from using the PMTER sample to draw out issues which might not have arisen in the survey itself, and explore these emergent issues in some detail. All I can say about such issues is that they are of particular concern to PMTERs, and might be of concern to others to a greater or lesser degree. Any conclusion which seeks to generalise about the level of concern for, or the strength of feeling about, particular issues would be of questionable validity, especially if these referred to topics related to "commitment", such as engagement with peers, participation in research or collaboration on projects. While "lived experience" descriptions about such things can clearly be regarded as valid testimony, attempting to claim that a specific level of engagement with the MTER community is representative of all PMTERs would not be a valid conclusion. However, there does not seem to be any structural differences in the sample which would affect internal comparisons, say by career phase, or any other differences which might suggest that interview data related to "level of commitment" or "engagement with the community of MTERs" could not be used in conjunction with survey data to come to an overall understanding.

Chapter 7 Reflections on the Study

This chapter begins by summarising the more important findings that have been established so far. The discussion then moves onto a consideration of the three Research Questions originally posed in Section 3.2.3, and what has been learnt in regard to these. The final part of the chapter considers what this research has contributed to the literature about MTERs and their identity, and ends with an outline of proposals for disseminating the results of the study.

7.1 A Summary of the Key Findings

The material below itemises findings from the four main chapters within this study: the Literature Review (Chapter 2); the demographics of the 144 MTERs who participated in the survey (Chapter 4); the survey responses (Chapter 5); and, the semi-structured interviews (Chapter 6. The final part of this section is a consideration of findings in relation to the Davey Framework, and how it has been used in this study.

7.1.1 Findings arising from the Literature Review:

The Literature Review systematically examined a core of 100 sources, together with other relevant material through five lenses. The summaries below represent the key issues:

7.1.1.1 Through the *becoming* lens:

- studies which might provide insights on motivations for *becoming* an MTER or the career plans of MTERs appear to be largely absent.
- a small number of quantitative surveys offer limited insights about MTERs' characteristics in different countries; however, the overall picture is of MTER qualifications and backgrounds is varied and often not at all clear.

- Davey (2013) proposed teacher-educators were in a state of constant *becoming;* this was clearly evidenced in the literature. In particular, two transitions were noted:
    - an early stage of 'transition' from school teacher to university lecturer
    - a different, possibly later, 'transition' from teacher to researcher

  Several authors note the importance of collaborative working in relation to both of these.

- In contrast to the lack of material about the early stages, there is a large amount of material concerned with professional development, and this covers a huge range of topics. Studies approach this using a range of methodologies, such as autoethnography, interview data, document analysis, and quantitative surveys.

7.1.1.2 Through the *doing* lens:

- The *doing* aspect of MTER identity was characterised by Davey (2013) as *doing* teacher education; *undertaking tasks and functions*; and*, perceptions of what the job entails and what elements take priority* - all of which are implicitly addressed in the literature.

- However, the only study to explicitly look at the role of an MTER, and examine the range of activities undertaken is that by **Wu et al. (2017),** but this yields only limited information.

- A large proportion of the papers in this section consist of self-study, in which MTERs analyse aspects of their own or other MTERs' roles. From these it is possible to obtain an overview of the types of activities undertaken by MTERs, at least those that they think important enough to study.

- Core to the *doing* lens has also been groups of studies concerning the practicum, which involves MTERs with their PSTs in school-based activity, and the University-based sessions, where MTERs engage PSTs in activities and discussions.

7.1.1.3 Through the *knowing* lens:

- In the literature are a wide variety of models laying out the knowledge requirements of MTERs. The detail and the complexity of these models attests to the sheer range of knowledge an MTER needs to possess Many of the models presented rest on the work of Shulman (1986, 1987), whose characterisations of different types of knowledge required by teacher education is to be seen across many sectors.

- The literature does not simply document what needs to be known, but the processes whereby MTERs acquire knowledge, and how they use it. There are a significant number of papers on the application of knowledge in the form of pedagogical practice, for example in relation to the Knowledge Quartet (**Rowland et al., 2014)** and on Task Design (**Zazkis and Mamola, 2018; Coles and Brown, 2016).**

- Several studies address the tensions between knowledge arising from research or theory, and practice. **Lin et al. (2018)** note that making connections between research and practice is a knowledge domain in the same vein as knowledge about research, and knowledge about practice. Goodchild (2008), suggests that as an MTER becomes more greatly involved in research, this transition helps MTERs inform their practice. 2

7.1.1.4 Through the *being* lens:

- Very little of Davey's description of *being* as the lens through which we might view "*professional identity as the personal in the professional",* is apparent in the literature.

- However, many of the papers contribute significantly to knowledge and understandings about the more emotive side of *being* an MTER, for example the studies of **Lovin et al. (2012)** and **Vomvoridi-Ivanovic and McLeman, (2015)**. These studies provide good insights into a range of MTER beliefs and values, and the potential conflicts that MTERs encounter as they consider their practice

- The literature also includes studies covering a range of value-related topics, such as social justice, equity and power balance, as well as some of the ethical issues faced by MTERs in interacting with PSTs who are anxious about teaching mathematics or even doing it themselves.

7.1.1.5 Through the *belonging* lens:

- evidence is present throughout the literature of MTERs engaging in collaborative activity and having a sense of *belonging* and appreciation of the benefits this brings. These practices are clearly of significance to MTERs, but the literature also documents a range of challenges, noting tensions around *belonging.*

- The more formal types of activity are based on collaborations between groups, such as the setting up of Communities of Inquiry between MTERs and Teachers. This is where tensions can sometimes emerge because of boundary Issues, and Power Balances.

- The types of collaborative activity are wide and varied, not just the more formal, but sometimes informal. Many studies which appear in earlier lenses involve collaborations between MTERs, or between MTERs and teachers, or MTERs and others, attest to the sheer amount of collaborative activity which is undertaken.

7.1.2 Findings arising from the Demographic Data:

The following points summarise the most important findings from demographic material in Chapter 4:

- Being an MTER is a long-term commitment for many. Around a third of MTERs in the sample had been in the role for over 15 years.
- Most MTERs focus on several age-phases. In particular there is considerable overlap between EYS and Primary: 98% of those who declared a focus for EYS also covered Primary as well.
- At least three-quarters of the sample had an 'A' level in mathematics. For secondary this was 92%, but for EYS it was just over half.
- Almost two-thirds of the MTERs' first degrees contained significant mathematics or mathematics education content.
- Just over 70% of MTERs had a PGCE qualification or equivalent
- 83% had a Master's degree, and 47% a Doctorate.
- Around three-quarters of MTERs had a higher degree in either Maths or Maths Education.
- While in post, many MTERs add to their qualifications, gaining either a Master's degree or doctorates. However, around 20% of MTERs who have been in the profession for over 15 years who have no higher degree.

7.1.3 Findings arising from the Survey Responses

The sections below collate related findings together under thematic headings. These do not follow precisely the Davey lenses, but all are taken from the end of section summaries in Chapter 5.

7.1.3.1 On Becoming and Developing as an MTER:

- For the vast majority, becoming an MTER was not a conscious part of a career plan. Motivations for taking on the role were varied, and included *a deep interest in maths teaching and learning, the desire to make a*

difference, wanting to share understandings, to pursue research or *join a community of "like-minded" others*.

- Previous experience and knowledge are almost uniformly (96%) seen as crucial.
- MTERs reported a relatively low incidence (41%) of formal induction processes into the role, but in the early stages cited working alongside other, more experienced MTERs, as an important factor.
- Almost all MTERs are driven towards professional development, and the overwhelming majority (97%) claim that they have developed as professionals during their time in post.
- Respondents cited as significant contributing factors for professional development: *collaborative working with others; courses and conferences; research activity*, and *self-study*.
- Barriers to professional development cited were *time and organisational constraints*, with many MTERs citing *workload-related pressures*.

7.1.3.2 How do MTERs see their role?

- The vast majority (71%) had a clear understanding of their role, but often felt anxious about aspects of it (70%), especially those with an EYS (72%) or Primary (74%) focus, and those in the earlier stages of their career (as high as 87%).
- Most MTERs (81%) appear to be relatively autonomous, setting their own agendas and priorities; only a minority appeared to have a formal job description, and most MTERs (73%) thought that it was not even possible to encapsulate the role in that manner.
- Around one-third of MTERs said that their main focus was on mathematical education of Teachers and PSTs with only a minority (7%) focusing on research. The majority (60%) had roles which combined both teaching and research. The research-focused MTERs tended to have been in the role longer.
- Over half of the sample (57%) thought that well-established MTERs should be making a significant contribution to research in the field. It may be the

value laden phrasing here precluded more respondents from agreeing with it.

- However, there are some indications that while this picture applies to many MTERs with a Secondary and/or FE focus, that it applies to fewer MTERs with an EYS or Primary focus. The picture also better describes the experiences of MTERs later, rather than earlier in their careers.
- There was overwhelming agreement (93%) that MTERs derived satisfaction from their role, but that it could be very challenging at times (87%).

7.1.3.3 What do MTERs need to know, and how do they acquire knowledge?

- MTERs almost uniformly agree (93%) that an extensive knowledge and skill base about teaching and learning is required in order to undertake the role and the skill base for the role is diverse and complex, covering *mathematical content, how learners learn, knowledge of school curricula, empathy with learners*, as well as *an ability to make connections*.
- Almost all MTERs (95.1%) claim to draw on their personal experiences of teaching and research, but this seems to be somewhat less important for those longer in post. In addition to these personal experiences, MTERs draw heavily on *books and journals, the research literature, material from conferences, networking with other MTERs*, and *internet sources*.

7.1.3.4 What values, beliefs and understandings are held by MTERs?

- Only a small minority (12%) consider that there was a single consistent view of how to teach the subject.
- The majority of respondents (75%) thought MTERs should have a well thought through philosophy of education, with 70% agreeing that being an MTER requires specific skills and attributes, including: *empathy, a supportive nature, a positive attitude, a clear enthusiasm and passion for the subject, flexibility, a willingness to learn, an ability to listen* and *diplomacy*.
- The majority of respondents (80%) see MTERs as upholding specific values within the profession, but very few (17%) thought these were specifically mathematics-related values. Among the values cited were those of:

adopting ethical stances, holding specific beliefs, upholding social justice, respecting the views of others and *demonstrating passion, commitment and enjoyment*.

- The majority of MTERs (87%) think that students value the contributions of University MTERs, and that teachers welcome the opportunity to engage with them (80%). However, only a minority however, (49%) thought that University MTERs were well-regarded in a National context.

7.1.3.5 How do MTERs view working with others?

- These results portray a large majority of MTERs (73%) as feeling that they are part of an MTER community, that they have good working relationships with other MTERs (81%), that they are benefiting from membership of professional organisations (80%), and feeling that they are part of a community of like-minded individuals (73%).
- Most do not feel isolated (70%), even if in their place of work they are the sole MTER.
- However, only a minority of MTERs feel that their work is known by other MTERs (30%), especially those in EYS and Primary, and those who are in the first 10 years of their role.
- Three main ways in which collaboration can occur were highlighted by respondents as being of particular importance: *discussions with colleagues at conferences* (62%), *engaging in joint research projects* (61%), and *receiving challenges to existing viewpoints* (63%), these are also well-supported in the open responses.

7.1.4 Findings arising from the Interviews

The interviews used as focusing mechanism, five research hypotheses, arising from the survey data. Below is summarised the evidence for or against each of these hypotheses as a result of the interview data and the discussions in Chapter 6.

7.1.4.1 Hypothesis 1: The process of "becoming" an MTER is not limited to the initial time in post, but is part of a career long commitment.

Interview data revealed that this claim is valid:

- In order to carry out the role effectively there are pressures concerning credibility and currency which necessitate an MTER's involvement in an ever-widening range of activities simply in order to do the job. To do the job fully therefore requires that an MTER changes, develops and grows.
- While it is possible for this not to be the case, it would require an aspiring MTER already to possess a doctorate, to have the skills of teaching adults, to be familiar with Higher Education procedures and to be a member of mathematical organisations with a good range of contacts.

7.1.4.2 Hypothesis 2: There is a deepening commitment to the MTER community over time.

Interview data revealed that the claim is generally valid, but the language may be misleading:

- For most MTERs, this appears somewhat accurate. However, the term "deepening commitment" perhaps does not capture well the constellation of other, more detailed effects uncovered by the research, such as the widening sphere of influence as an MTER, the strengthening of identity and status, and even a greater sense of belonging, a "having found a home". Each of these processes also might involve multiple *becomings.*
- While it might be admitted that it is certainly possible for MTERs to become and remain an MTERs without engaging in the wider MTER community, or collaborating with colleagues, such individuals will be in a very small minority.
- The research revealed and illustrated why, for most MTERs, these things are important, and why, although not every MTER will engage with each element with the same intensity, some combination of these elements is a

necessary feature of the identity of a successful MTER, who finds satisfaction in their role.

7.1.4.3 Hypothesis 3: For many MTERs there is a tension in the role between the day to day demands of educating teachers and pursuing research.

Interview data revealed that this is partially true, but the picture s complex:

- While there is evidence that this is largely correct for many MTERs, it is context-dependent and for some MTERs whose University values their research, any conflicts are minimised.
- The tensions where they exist, are not between the research and the teaching per se, but on their competing demands for time and priorities.

7.1.4.4 Hypothesis 4: MTERs tend to supplant the currency of their classroom experience with more recent project or research-related experiences as their career progresses.

Interview data revealed that this is not entirely correct:

- While there is certainly a "currency" issue, MTERs can maintain their currency in many ways: research, working with teachers, and by school-based supervisory and moderating activities.
- Furthermore, over time as an MTER becomes more experienced, they bring a depth of knowledge to the role as well as a strong commitment to staying current in regard to classroom practices.
- An experienced MTER will acquire over time, a sense of the history of mathematics education having seen various incarnations of curriculum, and having had the time to reflect and undertake research contributing to the MTER knowledge-base.

7.1.4.5 Hypothesis 5: The values of MTERs, and their perceived sense of being valued by others, differ between newer and more well-established MTERs.

Interview data revealed that this is not correct:

- In fact, the values of MTERs themselves seem remarkably similar between newer MTERs and those having been in post a long time.
- However, interview data revealed that longer serving MTERs appear to have somewhat different *perspectives* than more recent recruits.
- This might be explained by their having experienced changes to the profession first hand.

7.1.4.6 Other findings arising from the interviews:

Two issues clearly emerged:

Firstly, on the issue of induction into the role, Teacher-Educators at a university do seem not fit into the "induction into the role" patterns established for other academics. Almost all arrive with excellent teaching skills – probably "expert teachers in their subject", but not necessarily with skills of teaching adults. In addition, many in the UK are appointed without a doctorate, and some without a Master's. What is required for these novice MTERs to make the transition is very different from what is required of say, a History post-doctoral student appointed as lecturer, who already has a PhD, and may have done some university-level teaching while studying for their doctorate.

Secondly, many MTERs feel undervalued by successive governments and their agencies. This is in direct contrast to the way that they perceive they are valued by PSTs and teachers. Changes to the Education system, and the increasing demands of the role both to retain currency and credibility mean that MTERs are constantly having to balance competing demands of teaching and mentoring with their professional development and research.

7.1.5 Findings related to the use of Davey Framework in this study

From the discussion in Ch5.8.3, the following three points emerged about the framework:

7.1.5.1 Point 1: While most lenses were well focused, some were not.

While each of Davey's lenses overall were successful in allowing the examination of different aspects, the research revealed that in some cases the lenses lacked focus, because the different aspects within each lens – which formed the basis of the questionnaire items - were not sufficiently consonant or coherent. Thus, all the lenses were not all equally successful: particular aspects of *belonging* and *becoming* were reasonably well focused, *doing* was less so.

The criticism might be levelled, however that this was due to the implementation, rather than the framework. However, both the Factor and Correlational analyses in Section 5.8 and Appendix C1 shows that while the items within individual lenses were often well correlated, there was a good deal of overlap between different lenses, with the result that they cannot be regarded as different independent "dimensions" of identity.

Clearly, Davey understood this, and it was not her intention to produce five different and independent lenses of identity, merely that these were merely different ways of looking at the same things.

As a way forward in the study, when analysing the interview data in Chapter 6, I adapted a result from the Factor Analysis in 5.7, supported by the detailed testimony from the open response items, to create the two overarching themes of "community and collaboration" and "knowledge understanding and values". These themes group together several cognate lenses, and while retaining the same

aspects, they allowed more of the subject matter to be viewed simultaneously. By looking at MTER identity through each individual lens, one at a time, it may be that the big picture goes unseen. In grouping the lenses, it became possible to see how themes cut across different topics, and how the whole enmeshes together.

7.1.5.2 Point 2: Some elements were either missing or were downplayed.

I had noted while conducting the literature review, that some elements of identity did not appear to have sufficient prominence. For example, in Section 3.3.5, "*valuing*" is listed as an intrinsic aspect of *being*; however, the aspect of "*feeling valued*" was less evident in the framework, although "*sense of worth*" emerged in Davey's discussions with participants.

Items related to value and being valued (QS15.2 and QS11.3) had formed part of the important core of items of Component 2: "Knowledge Understanding and Values", arising from the Factor Analysis reported on in Section 5.8, and specified in Table L5 in Appendix C1.

Separately, within the lens of *becoming*, there had emerged a sense of "*constant becoming*", and this included the idea of professional development, meaning that *developing* as a discrete lens was missing. When this was explicitly addressed in Chapter 6, it yielded high quality data, and helped to clarify Research Hypothesis 1.

7.1.5.3 Point 3: The lenses seem to fall into two natural groups

The two groups first emerged in the Principal Components Analysis in Section 5.8, but was reinforced by other considerations, as noted in Section 6.1. This led to the following two groups of items:

Group A: Becoming and Belonging, echoing the ongoing personal and professional development and the "embedding" of MTERs into different communities at different stages of their careers

Group B: Being, Knowing and Doing, echoing the maturing knowledge, practices, values and personal philosophies of MTERs.

These two groups then formed a modified basis for the analysis of the material in Chapter 6.

Group A describes not only the processes leading up to, and the induction into the role, and in taking on the identity of MTER, but also describes what happens as an MTER takes on further challenges within the role itself, and encounters new communities of MTERs or begins to change focus to take on the identity of researcher, rather than of teacher or learner, eventually *becoming* an expert in the field. To do this requires a commitment to the role – a feeling of *belonging* and a large investment in terms of personal and professional development. From the literature review, and from the empirical research in this study, much of this could be described in terms of interactions between MTERs and their peers, and the communities with whom MTERs engage. These communities are diverse, and extend well beyond just the community of other MTERs; they include for example, communities of teachers, learners, and colleagues at other institutions. These are not just different "Communities of Practice" (Wenger, 2001), but are also "Communities of Inquiry" (Jaworski, 2003; **Goodchild, 2014b**). Such issues were highlighted in the Literature Review, Sections 2.7.1-2, and arose again when considering the different ways in which collaborations between MTERs can occur in Section 5.5.

In fact, *becoming* and *developing* are actually part of the same process, with over four-fifths of respondents expressing the view that professional development is fundamental to being an MTER, that they have developed during their time in post, and wish to go on doing this in the future (QS4, Chart C1). *Becoming*, therefore is not limited to an initial period, but is part of a career-long commitment. This claim is neatly summarised in Chart 6.1 (Section 6.2.3), which shows the differences in engagement with the MTER community between those with less than 10 years in the profession, and those with more. This claim also formed the basis of Research Hypothesis 1, which was tested in Section 6.2.1 against the interview data. For most of the respondents, *becoming* is therefore not just the period at the start of

their career, but marks the transition to different stages in the life-cycle of an MTER: they might have "*become*", and "*developed*" as a Teacher Educator, but then decide to deepen their commitment by *becoming* and *developing* as a researcher or as a mentor to new MTERs. Interestingly, the counter-cases examined in Section 6.2.1, who seemed not to exhibit this behaviour, had either moved onto other roles, or had left the profession.

Group B encapsulates the role itself, together with all its knowledge, beliefs, skills and values, and much of this knowledge base will remain, for many MTERs as a core to be drawn on throughout their careers. In this study, it has become apparent that many of the elements within the lenses described by Davey are processes rather than single events or static entities, and are often transitory rather than fixed. *Belonging*, for example as seen above is clearly a process, which is manifested not just in terms of the induction into the profession, but in the commitment to professional development which inevitably follows. In terms of the *knowing* lens, this transience was exemplified by Research Hypothesis 4 (Section 6.3.2), which proposed that MTERs tend to supplant currency of classroom experience with research-related material over time; while this claim turned out not to be fully correct, what was clear is that initial currency and experience does get supplanted by other forms of currency: research, working with teachers, school-based supervision and moderation activities.

Thus, *being*, *doing* and *knowing*, can be seen as potentially changing and developing throughout an MTER's career, even to the extent that what MTERs "do", or need to "know", may be different in different contexts.

In addition to this, in Section 6.3.3, "valuing" and the sense of "being valued", the latter not being explicit within the Davey Framework, were both explored within the lens of *doing*, where four key areas were identified. As noted above, "valuing", then

arose as an important correlate of component 2 from the Factor Analysis in Section 5.8. Here the term *valuing* should be understood, not just in terms of the values held by MTERs, but also the way that others value the work of MTERs –learners, teachers, educational leaders, education ministers and secretaries of state, and reciprocally, the way that MTERs perceive this sense of feeling valued by them. The evidence from this study suggests that *valuing* in this sense should sit alongside the other three lenses of *being*, *doing* and *knowing*.

Despite the criticisms levelled above, it must be stressed that the Framework has been of real value in this research, and the way forward would be to modify the framework, rather than reject it. Those modifications are detailed in Appendix F1, but are discussed below in Section 7.2.2.

7.2 A Review of the Research Questions

This section now refers back to the questions motivating this research, laid out in Section 3.2.3 and pulls together the material presented so far in this chapter in an attempt to answer these questions and draw some conclusions.

7.2.1 Research Question 1

What can we learn about the different aspects of MTER professional identity and the community of MTERs through each of Davey's five lenses?

Research Question 1 is the main focus of this study, examining the different aspects of MTER professional identity through each of the lenses. This has provided a huge amount of both statistical and narrative data.

In particular, the study has provided detailed information on the educational backgrounds of MTERs, especially those in the UK, their motivations for becoming MTERs in the first place, and why they chose to do this. For many there has been a lifelong interest in mathematics, evidenced by the high proportion of MTERs with Maths A-level and Mathematics or Mathematics Education degrees. For very few was there ever a long-term career goal of becoming an MTER, but their entry into the profession is mainly the result of choices made: becoming involved in projects; attending courses; joining associations; and above all, the actions of serendipity. Many MTERs enter the profession with the idea of "making a difference", feeling they have something to offer, and feeling that they can help improve the way that mathematics is taught and learnt. This feeling is echoed by the values shared by many, the care and concern not only for their students, but for the subject and the way it is taught.

The study has viewed MTERs through five lenses, and shown that *becoming* an MTER is neither straightforward, nor time-constrained. The transition from *being* a teacher to *being* an MTER can create tensions. Some may have resolved these tensions by already *being* MTERs by the time they are appointed, because they have been *doing* aspects of the job for a while, as school mentors, or by their involvement in research projects or even teaching as associate lecturers on teacher education programmes or CPD. For others, the transition from *being* a school-based "expert" in mathematics, to a novice, relatively inexperienced lecturer in a department of far more experienced others, can be extremely stressful and can even cause what one MTER termed as "culture shock" not dissimilar to Davey's 'identity shock" term (Davey, 2013).

The ever-present tension in the background is the one of "currency" and "credibility", and this tension seems to underpin many of the different aspects of MTER identity.

Most MTERs initially enter the profession with a high-currency "street-cred" identity as an "expert" teacher of the subject, but unless an MTER is maintaining a teaching role in school, that credibility can quickly wane as with their currency of knowledge and experience as a school teacher, and MTERs feel the need to attend courses and maintain their contacts with schools just in order to "keep up to date". At the same time, the newly-in post MTER has to grapple with their credibility in the new context of an academic setting, and associated ways of working that come with that: teaching adults (PSTs); being knowledgeable about underpinning theories; understanding university structures. As new MTERs meet other MTERs and other colleagues, compare notes, talk about their courses, their teaching, what works and what does not, they begin to understand different pedagogical approaches for the adult classroom, frameworks and theories, and expand their knowledge of teaching and learning.

An important part of *becoming* an MTER for many is the realisation they are supposed to be an "expert", not just in teaching children mathematics, but in teaching PSTs and teachers how to teach mathematics more effectively, and in the latter regard, that they belong to a community where others are far more "expert" than themselves. This is a wider community with shared knowledge, shared values, and shared expectations, and a whole set of skills and understandings some of which they have probably never even considered. And if they wish to *belong* to this community, to participate in *being* an MTER, this is what they must *become*.

Different MTERs will experience this in different ways, but those working in Primary and EYS, are more likely as novice MTERs to feel "daunted" by their new role. Some "becoming MTERs" are fortunate, and the path to *becoming* is helped by formal or informal structures, whereby a novice MTER can plan and teach alongside more experienced colleagues, so as to learn the craft over the first year or so, before they are required to undertake the role completely on their own. Others are less

fortunate, and there are examples in the research of novice MTERs being "thrown in at the deep end".

However, care must be taken, because as the research has shown, not all MTERs are alike, and treating MTERs as "blank slates" would clearly be inappropriate. They often bring a wealth of experience with them. As noted in 5.1, one respondent wrote: "*I do not think treating new MTERs as 'novices' makes a lot of sense. MTERs are already experienced professionals …"*

Through the lens of *being*, the research has revealed that the role of an MTER involves far more than simply educating the next generation of teachers. It involves a whole set of values about what is important and what is not, and a deepening of the knowledge and skill sets, both in terms of classroom pedagogy, but also the pedagogy of educating prospective teachers. Also, MTERs are sensitised to "being valued", in the immediate context by their PSTs, in the local schools' community, by their peers and in the wider National context, by government agencies.

In a very real sense, this underpins the drive towards becoming a better MTER, and the pursuit of research – either through collaborative projects, or by acquiring further qualifications or both. For many this is the start of a lifelong commitment to researching mathematics education, deepening their knowledge base, to acquire a better understanding of the subject, and through working with teachers in schools, attempting to use that knowledge and the influence to actually change mathematics education for the better.

The research has shown clear examples of how this is achieved through critical self-reflection on both these matters – that early in their careers, MTERs begin to ask themselves why they taught children in a particular way, feeling that they need a depth of research evidence to justify these things; later on they ask themselves the

very same questions about their own pedagogy with students: “why does this work, and this not?” In the interviews this consideration came out very strongly; for many this seems to be one of the most crucial aspects of *being* an MTER. For PMTERs, the added concern of attitudes to mathematics is significant. They experience tensions in challenging their PSTs into inquiry modes whilst simultaneously being sensitive to underlying anxieties which for some PSTs have pervaded their whole educational experience.

These considerations lead MTERs into carrying out their own research, either individually or as part of a research project, or for a substantial proportion of MTERs, part of the desire for enhanced qualifications. Obtaining higher degrees, presenting at conference and being published not only increases the academic credibility of MTERs, but the fact that MTERs are constantly involved in school based-research, working with teachers, often with PSTs also maintains their currency. However, this seemingly crucial aspect of the role then creates another tension, because pursuing research is time-consuming, and unless the organisational structures and constraints allow time and space for this, research can get marginalised or squeezed out altogether by the volume of teaching, with its associated planning and marking, with deleterious effects on both currency and credibility, as well as the MTER’s perceptions of their self-worth and their value to others.

Professional development, of which research is a crucial part, is, for the majority of MTERs therefore, a long-term commitment, which for some might even be career-long, and for a few almost all-consuming.

Clearly, the above description does not match the experiences of every MTER. A few, for example never complete a higher degree, and some are more interested in maintaining school-based links, working with classroom teachers than they are in

collaborating with other MTERs on research to develop new theory. However, the research indicates that around a third of those who enter the profession as new MTERs, are still there fifteen years later, just more qualified, more experienced, considering themselves better able to carry out the MTER role.

7.2.2 Research Question 2

How useful is Davey's framework in trying to capture the notion of MTER identity?

It was recognised at the start that in applying the Davey lenses, the same phenomena were being viewed through different lenses. However, what turned out to be particularly challenging was to keep a particular lens focused while examining a paper or interpreting comments. For example, when considering Professional Development, it was clearly a contribution to *becoming* for many MTERs, but the most valued, and possibly the most valuable forms of Professional Development were those where MTERs worked together, or collaborated – part of *belonging*. Further, a consideration of MTERs working with PSTs and teachers, is ostensibly *doing,* but in the analysis became entangled with issues about values and content – related to *being* and *knowing*.

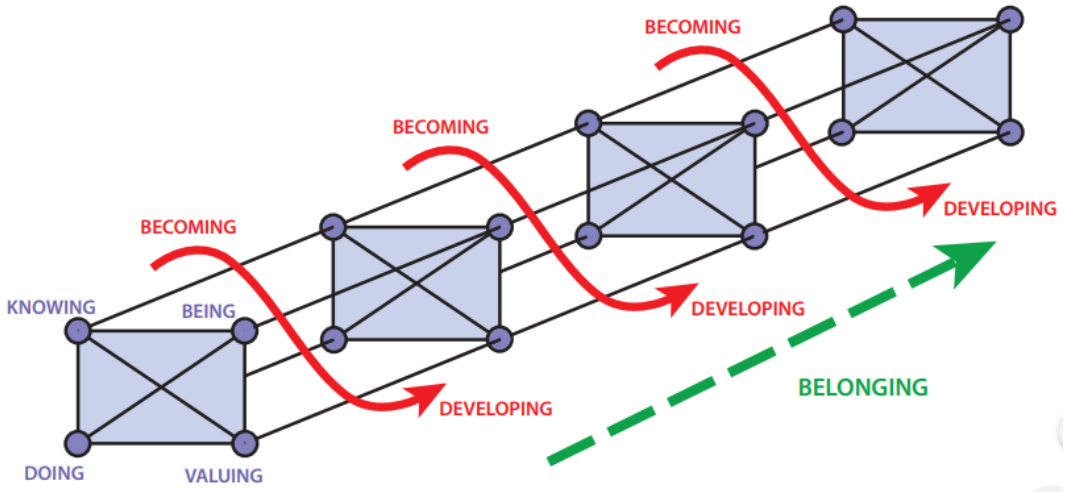
This overlap between lenses appeared at every stage of the research, from the literature review, questionnaire construction, and was even reiterated in the statistics of the Principal Components analysis in Section 5.8.1.

In the later stages of the study in Chapter 6, it has been possible to collapse the lenses in to two groups – one concerning the overall processes of ongoing development and embedding into different "communities" – "*becoming and belonging*", and another to do with the knowledge, practices, values and personal stances of MTERs – the "*being and doing*". Perhaps here, a key difference between the two are timescales – the first can only be studied over months, possibly years,

maybe even entire careers and on a large scale, while the second is something that can be studied as snapshots, and on small scales. In order to understand MTERs, we need both. The first contextualises the second, that is, the contribution of this research, in that it has provided such a context.

Appendix F1 discusses how the framework might be adapted for future use. One of the issues is that the framework as laid out by Davey, is descriptive, rather than explanatory. In Appendix F1.2, I argue for a more "dynamic" version of the framework, which more nearly represents an MTER's journey through their career. This version would seek to more nearly "model" the elements and processes involved in the acquisition of identity.

Fig. 7.1: A Revised Model of the Davey Framework



A full rationale and further details of this model are provided in Appendix F1.2 and F1.3, but here it is sufficient to note that the model in Figure 7.1 consists of two central components:

(1) The interrelated core elements of an MTER's knowledge, beliefs, skills, practices and values, that they possess at any point in their career.

(2) The processes by which these elements change over the course of an MTER's career: these are sequences of *becoming* and *developing*, as the MTER passes into various phases of their career, deepening their sense of *belonging*.

The two components can be seen to have emerged from the Principal Components Analysis in Section 5.8, which were then used to modify the Davey Framework in order to analyse the interview material in Chapter 6. What can also be seen is the explicit incorporation of *valuing* as one of the core aspects. This is not to say that values were omitted from Davey's discussions, but that in her framework it is merely one of a number of elements within *being*. Here it is expanded, and incorporates different elements itself, including "being valued", the perceived value of MTERs by others. For full details of the rationale underpinning this model, and how the different aspects of each of the lenses have been integrated into the aspects and processes, see the detailed treatment in Appendix F1.2 and F1.3.

The model can clearly point to new research. Some core elements of *knowing, being, doing* and *valuing* might be fixed, but others might change over time. For example, as noted in Section 6.3.2, recent school experience informs practice for a beginning MTER, but this is augmented by other experiences during their career. However, some core values and principles, together with some understandings and beliefs, might be relatively stable over the course of a career. The model offers the possibility of change over time, but does not preclude stability. Using this model to determine what types of an MTER's beliefs, practices, knowledge and values change, and which remain stable over the course of a career, could form the basis of an interesting research study. Other potential research questions generated by the model can be found in Appendix F1.4.

In summary, while the framework has been a very useful way of structuring this research, I would have some reservations about its further use in its original form. Elements were missing, some appear in the wrong place, but above all, the study

has revealed that possibly the identity of MTERs is not one thing. Because of the different communities to which MTERs belong, the different "hats" that they wear, an MTER may have several "identities" over the course of a career, experiencing a series of *becomings* and *belongings*. However, there is a core, an "essence" of being an MTER which has been summed up by one respondent as "*to teach [mathematics] more effectively and to do what's best for the children*"

7.2.3 Research Question 3

In what ways can a study of MTER identity contribute to improving the education of teachers?

The research has revealed that the vast majority of MTERs are recruited as well-qualified with a strong mathematics background particularly as secondary MTERs. In primary, the mathematics backgrounds are varied: from degree level mathematics to GCSE equivalent as the highest mathematics subject qualification. One of the findings to emerge was that lower numbers of those with a Primary or EYS focus possess an 'A' level in the subject. However, 'A'-level mathematics is not necessarily helpful in understanding the deep, connected nature of mathematics for primary level (Askew et al., 1997). PMTERs continue to develop this understanding as part of their roles, and despite not having pursued the subject to 'A' level, many MTERs will have had a lifelong interest in Mathematics.

Typically, MTERs are recruited as expert teachers, not as lecturers, therefore there is a steep learning curve, and transition from teacher to MTER can be challenging. There are ways to ease this, though these are not always recognised by an institution geared up, through most academic departments, to a model of "PhD first, with some lecturing, then do a PGCTLHE". For academics in other disciplines coming through this traditional route, institutional induction procedures might be appropriate. However, for MTERs new to the role many might benefit from a more structured and gradual introduction, along the lines of the models of good practice described above by participants.

There also needs to be a recognition that the knowledge base of MTERs is constantly moving, and that it is easy to become quickly out of date. It is also easy to lose credibility with PSTs and teachers, and the way to resolve this is to allow time for professional development – which might include a variety of activities which require close links with schools, especially working with teachers, and the nurturing of research linked to these activities. Such professional development ensures a currency of both knowledge and experience, and enhances academic status and credibility. However, many timetables are overloaded, and often teaching of PSTs takes priority over research.

In recent years, there has been a shift from a model of teacher education largely based in universities to a diversity of routes into teaching. This, in some cases has led to a significantly lessening of the university's teaching role, and replaced this with an onus on universities to manage and accredit teacher education within school partnerships. To do this, universities must be the repositories for expertise and pedagogical knowledge, as well as providing a sound basis for research carried out, whether by academics or school teachers themselves. This means that the focus on teaching and the focus on research have to be seen as of equal value, and that they are linked, and that timetables and workloads need to reflect this reality.

Just as being a good mathematician does not necessarily make one a good teacher, so being a good teacher of mathematics, does not necessarily make someone a good teacher educator. That takes time, and it also needs space for the person to develop and grow. It also needs a recognition by universities that there is far more to the role of Mathematics Teacher Educator/Researcher than simply knowing your material, and preparing and delivering courses, and producing research papers.

7.3 What are the Contributions of this Research?

This research is a large and complex study, with many different features. The following provides a list of the different aspects of the research which have either produced summary findings of value to other researchers, to those interested in the methodology adopted in this study, and to the MTER community itself.

1. A systematic review of the literature in the field, complete with tables and summaries of the type of literature, research approach and a critical review of findings.
2. A description of a large group of MTERs in the UK, in terms of their academic backgrounds, their qualifications, teaching focus, their information sources and their day to day activities.
3. Attitudinal and other data gathered from a large group of MTERs in the UK, which examines various aspects of MTER identity, including amongst other things, their motivations, aspirations, views on self and others, knowledge base, day to day activities, values and relationships to others and the wider community of MTERs.
4. Analyses and summary data arising from an extensive set of written material, provided by MTERs elaborating their views within "open response" items in the survey. This material offers, in many cases, detailed personal testimony both interesting to, and of value to others.
5. A set of interviews carried out with a group of Primary MTERs, revealing details of their professional life, their attitudes and aspects of identity formation. This is a rich seam of data, which the current study has only mined selectively.
6. The derivation and investigation of a set of research hypotheses which were derived from survey material, then challenged against interview data in order to test their robustness. Various "critical realist" methods were used to do this, including different forms of retroduction such as case comparisons, thought experiments concerning counterfactuals, and counter-cases.

7. A set of conclusions from the research about the role of MTERs with some implications for policy makers.
8. An attempt to apply and test a framework proposed in the literature, which described aspects of Teacher Educator identity. This framework was applied within a systematic review of the literature to categorise and evaluate research papers, and formed the underlying basis for an extensive questionnaire, as well as the focusing structure for a series of in-depth interviews. The framework was evaluated by a range of methods, including factor analysis and the internal coherence of the items, and the analysis of responses provided by participants both in the interviews and the survey.
9. An overall understanding of what constitutes the core of MTER identity, and the processes by which identity is acquired. This understanding is encapsulated within a revised model for the Davey Framework, and offers "ways of seeing" which suggest possible future research questions.
10. An attempt to apply the principles of critical realism within an Educational Research setting,

7.4 Proposals for Dissemination of Findings

Appendix I2 contains a list of potential papers which might be derived from the research and a two-year timetable for dissemination, including conference papers and journal publications. Below are given a brief summary of the possible papers and the modes of dissemination which can be done immediately:

7.4.1. Possible Papers and Presentations

A conference presentation outlining the demographics of MTERs.

This would describe the survey, and present the results in Chapter 4. The conference paper would present the key findings, and would allow feedback from peers on which parts other MTERs feel are important. This would be followed up by a detailed research paper, describing the methodology, and presenting a demographic description of a sample of the MTER workforce in the UK.

Two or more conference presentations on results from the survey.

This would primarily involve summaries of the Likert Findings, but there is enough material in the open response sections to produce a presentation on this alone. After feedback, these two will be combined into a single paper which references the demographic description and the methodology.

Several conference presentations based on the semi-structured interviews.

One of these would address the hypotheses derived earlier in the study, and others would draw on the interview data, to produce papers on different themes. There is clearly the opportunity for further publications here, but those are more speculative at this stage.

Appendix I2.2 describes several other possible papers including a paper on the Davey Framework, how it was used in the study, and its suggested modifications.

7.4.2 Timetable for Dissemination

The list below gives an indication of intended presentations and publications, with some potential timescales. My strategy will be to use local dissemination to colleagues first, and then present an amended version of the paper at a conference. This will provide critical feedback which will inform me about future dissemination plans. A fuller timetable and a potential list of journal articles can be found in Appendix I2.3.

Table 7.2 Dissemination plans for the next 18 months

Audience/Target	**Summary of Material Covered**	**Timescale**
University Colleagues (3 different locations)	**3 Presentations**: In each case, the core will draw on the research providing an overview of Professional Identity, but specifically including material targeted for each location: (1) Professional Identity of teacher educators and key findings re MTERs. (2) The features of Professional Identity, considering parallels across professions and implications for developing a professional centre. (3) Key features of Professional Identity, and the implications for colleagues who work on professional programmes.	**~3 months**
SRHE Conference (Society for Research in Higher Education)	**Presentation:** Brief presentation providing an overview of the research undertaken, and a summary of some of the finding in relation to the attitudinal and other data.	~ 6 months

AMET Conferences	**A sequence of presentations**: (1) Demographics of MTERs – who are we? (2) What was learnt from the Literature Review on MTER Professional Identity? (3) Attitudinal data responses - motivations, aspirations, views on self and others, knowledge base, day to day activities, values and relationships to others and the wider community of MTERs	~ 6-18 months

As can be seen from the brief list above, and the more extensive plans in Appendix I2.3, the strategy is to first of all offer my home university an opportunity to think about the implications of the research, not only for MTER colleagues, but also for other TERs, and wider professionals. Feedback from these varied groups will then provide me with an indication as to how much my conclusions resonate with others in a wider context. I then hope to widen this out over the next 12 months or so to other fora, with a view to writing journal articles drawing on the study, as laid out in Section 7.4.1 above, and Appendix I2.2. Feedback from peers will allow me to judge which of these elements are important, and which are less crucial, in order to guide publication priorities.

7.5 Moving Forward

This chapter has drawn together many of the findings of the study and has evaluated the material obtained in response to the three core Research Questions. It is crucial however, at this point to pause, and reflect on what has been achieved, what could have been achieved if the research had been approached differently, and what might be achieved using what has been learnt from this research. Those topics will be addressed in the final chapter.

Chapter 8. Conclusions

As J.R.R. Tolkien remarked in the foreword to Lord of the Rings, *"The tale grew in the telling"* (Tolkien, 1954). My initial plan was to have a modest study of about 30 completed small-scale questionnaires, and around 8-10 interviews. Somehow, with a much greater than anticipated response rate and willingness to participate in interviews, it developed into a study of 144 MTERs and 27 interviews lasting an hour or so, and a systematic and very extensive review of the literature. This enlargement substantially magnified the project, resulting in masses of data but has provided me with the opportunity to go beyond the thesis stage, with the very real potential of producing a series of publications focused on specific areas.

8.1 Limitations of the Study

The study has been constrained by a number of factors all of which have been mitigated in so far as it has been possible.

Firstly, in hindsight, I now know how the questionnaires could be significantly improved. Although steps were taken by having multi-stage piloting, some questions, possibly even entire sections need revision. For example, the issue with the age phase focus data lost one potential way of analysing the data, and even though I found ways of dealing with this, it is possible that interesting connections may have gone unrecorded. In response to the age phase issue, I decided to concentrate on a single age phase, which would hopefully yield new data about that specific phase. However, in recruiting early responders, I inadvertently introduced an element of bias into the sample which meant that any generalisations about the level of commitment of PMTERs would be of questionable validity.

Secondly, interviews were largely conducted by Skype or telephone rather than in person, as time did not permit the luxury of face to face meetings in the diverse

locations. One possible challenge to the research is researcher bias - that interviewing former and current colleagues, and even acquaintances could lead interviewees to say what they think the researcher wants to hear, especially considering the potential power imbalance given my role within the Faculty at the time. However, there are several counters to this: interviews were all conducted in the form of a professional dialogue, and some insider knowledge was valuable in understanding the context, with interviewees being aware that I possessed such knowledge. Further, in analysing the data, there were no discernible differences between the responses of the small group of interviewees whom I knew personally, and the others I did not. Additionally, the results from the open response categories of people who were unknown to me provided remarkably similar testimony to that of the interviewees.

Thirdly, I hesitated about attempting to adopt a critical realist stance, since even the advocates explain that this approach is largely undefined, and the methodology is still being explored (O'Mahoney and Vincent, 2014, p. 22). However, its principles proved extremely useful in ensuring that when interpreting statistics, I treated inferences not as results to be reported but conjectures to be validated or rejected – specifically looking at why the data might be as it is, and what can be said about cases which buck the trend. Looking for cases which "falsify" a hypothesis actually tells a lot about why, for many, the hypothesis might be true, providing viable explanations for results, and in which contexts they do, and do not apply.

8.2 What was achieved?

This study has therefore achieved:

- A comprehensive description of different aspects of MTER identity at the collective level, describing their qualifications, age focus, length of service, together with a range of attitudinal data, which examines their views, working practices and beliefs. While this data primarily focuses on MTERs from England, it provides some indications that particular results may be more widely generalizable both to the UK, and possibly beyond.

- A range of understandings about how and in what respects MTERs differ. In particular, the study has revealed how MTERs might develop over the course of their careers, presenting these as a series of hypotheses with evidence as to why – for most MTERs - these might be correct, and examining specific individual cases where they might not. These results are presented as hypotheses which might generally apply to all MTERs in the UK, but were only tested on a subset of English MTERs who have a focus on the Primary age-phase. However, despite this fact, there are strong arguments that the conclusions might apply more widely. First of all, the research has revealed that almost all MTERs focus on multiple age-phases, and so any group under consideration would necessarily involve several phases. Secondly, the sample of PMTERs used to test the hypotheses did not exhibit any significant differences to the full study in regard to their profiles of agreement within each of the survey sections. Finally, for each of items used to derive the hypotheses, there were virtually no significant differences detectable between the different age-phases. This means the surviving hypotheses in their amended forms could reasonably be expected to apply to all MTERs in the UK, and some even more widely.
- A "testing" of Davey's (2013) framework in a new environment and under a different methodology. This has yielded the result that while the framework has some issues, and this study has offered a possible reformulation to address these (see Appendix F1), overall the framework has proven itself to be a useful and interesting approach. While the framework may need to be amended to incorporate "perceived value", and possibly a sixth lens of *developing*, detached from *becoming*, and the lenses probably need to be grouped together to view individual and community aspects of identity, the overarching 'lens' structure of the framework has come through largely intact. This research has therefore validated the framework as a research tool, both in terms of its organising capability for providing a systematic approach to the literature, and providing lenses through which to view a complex subject. While not all items within the questionnaire itself have

proven equally useful, there is a sufficient core of questions within each lens which are well correlated, providing statistical reliability for the framework as a whole. Both the open-response items and the interview data have confirmed findings arising from the statistical summaries; thus the framework appears to be a valid way of viewing the identity of MTERs.

- Some understandings about what might improve the transition of new MTERs from the classroom to University, as well as some implications for policy makers in universities about the need to see differences between tutors employed on teacher education courses and those in other disciplines, particularly in terms of support provided. This was not initially a focus of the research, but arose out of the statistical summaries of the Likert-scaled items, and underscored by powerful testimonies in the open response items, and in some interviews. The 'transition' issue may well be a UK phenomenon. There is some evidence both from the Literature Review and from the survey itself, that other countries handle the transition in a different manner. This is an important topic, however, and would bear further research, both to examine the extent of the issue and to seek possible solutions which might be translated into policy.

In one sense, this study can be regarded as being complementary to that of Davey's, since Davey researched in New Zealand, and to a very large extent, this study has concentrated its focus on the UK. Davey researched a much smaller group of teacher educators (not mathematics) over a longer period of time. In regarding this study as "exploratory", it has provided the opportunity to falsify Davey's work – at least for the population of UK MTERs, which are potentially different to teacher educators in New Zealand. In fact, this has not turned out to be the case. By and large, what Davey found in a quite different kind of study, was very much replicated here. However, this study is not merely a replication of Davey's work, since it uses the lenses of the framework in a different manner to Davey, and is significantly larger in scope. The fact that we see similar images through the lenses, means that the images are not mere research artefacts of the lenses themselves, but that the

lenses are revealing an objective reality, one which appears to be remarkably similar both in New Zealand and the UK.

Therefore, while the results outlined above are clearly applicable to MTERs in England, almost all of these results can be conjectured to be more widely generalizable. There are few cases where any substantive differences were detected between MTERs working in England, and those working elsewhere in the UK or the world. The fact that Davey's framework was itself derived from a study in New Zealand, and has been shown to be applicable to Teacher Educators in the UK attests to the fact that the framework is addressing far more than local concerns.

Thus, this study can now form a benchmark with which to compare findings in subsequent research, possibly in the UK, but also in other countries. It can also act as a pointer to investigate in more detail key aspects of professional identity both by myself but more importantly by other interested colleagues.

8.3 Suggestions for further research into MTER professional identity

There are many points of this study which could springboard further research. I have selected a few avenues which I think might lead to fruitful outcomes for other MTERs and possibly policy makers:

- Detailed research into the various "transitions" noted in the research: from being a teacher to becoming a teacher educator; from being a teacher educator to becoming a teacher educator researcher, and from being a teacher educator researcher to being regarded as an authority on the mathematical education of teachers.
- Research into the different types of communities, projects, research groups and organisations that occur at all levels: how these operate – what is their membership, and by what process are MTERs "inducted" into these?
- Research into what I have termed the "currency" and "credibility" issue, looking at how it is that some MTERs retain a good balance between the two, and despite being out of the classroom for a long time, still maintain

their status with prospective teachers as credible ‘classroom teachers’ as well as becoming well-respected researchers and experts in their fields – developing policy recommendations for team leaders and Faculty heads.

References

Note: Sources in the *100-set* are noted at the end of the reference. The full *100-set* is listed separately in Appendix A2.2.

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Wenger-Trayner, E. and Wenger-Trayner, B. (2015) Learning in a Landscape of Practice. In: Wenger-Traynor, E., Fenton O'Creevy, M., Hutchinson, S., Kubiak, C. and Wenger-Traynor, B. (Eds.) *Learning in Landscapes of Practice: Boundaries, identity and knowledgeability in practice-based learning*, pp. 13-30. Abingdon, Oxon: Routledge.

Willemse, M., Lunenberg, M. and Korthagen, F. (2005) Values in education: a challenge for teacher educators. *Teaching and Teacher Education* 21: pp. 205-217.

Williams, J. and Ritter, J.K. (2010) Constructing new professional identities through self-study: from teacher to teacher-educator. *Professional Development in Education* 36 (1-2): pp. 77-92.

Wilson, S. M. (2006) Finding a Canon and Core: Meditations on the Preparation of Teacher Educator-Researchers. *Journal of Teacher Education* 57 (3): pp. 315-325.

Wu, Y., Hwang, S. and Cai, J. (2017) Being a Mathematics Teacher Educator in China: Challenges and Strategic Responses. *International Journal of Science and Mathematics Education* 15 (7): pp. 1365–1384. {100-set}

Yang, K., Hsu, H., Lin, F., Chen, J. and Cheng, Y. (2015) Exploring the educative power of an experienced mathematics teacher educator-researcher. *Educational Studies in Mathematics* 89 (1): pp. 19–39. {100-set}

Yang, X. and Leung, F. (2013) Conception of expert mathematics teacher: A comparative study between Hong Kong and Chongqing. *ZDM* 45 (1): pp. 121-132. {100-set}

Ye, J. and Zhao, D. (2019) Developing different identity trajectories: lessons from the Chinese teachers. *Teachers and Teaching* 25 (1): pp. 34-53.

Yuan, R. and Burns, A. (2017) Teacher identity development through action research: a Chinese experience. *Teachers and teaching* 23 (6): pp.729-749.

Zaiontz, C. (2019) *Real Statistics using Excel: Pearsons' Correlation Table* [Online]. Available at: http://www.real-statistics.com/statistics-tables/pearsons-correlation-table/ [Accessed 2 June 2019].

Zaslavsky, O. (2008) Meeting the Challenges. In: Jaworski, B. and Woods, T (Eds.) *The Mathematics Teacher as a Developing Professional*, pp. 93-114. Rotterdam: Sense Publishers.

Zaslavsky, O. and Leikin, R. (2004) Professional development of mathematics teacher educators: growth through practice. *Journal of Mathematics Teacher Education* 7 (1): pp. 5-32.

Zazkis, R. and Mamolo, A. (2018) From disturbance to task design, or a story of a rectangular lake. *Journal of Mathematics Teacher Education* 21 (5): pp. 501–516. {100-set}

Zazkis, R. and Zazkis, D. (2011) The significance of mathematical knowledge in teaching elementary methods courses: Perspectives of mathematics teacher educators. *Educational Studies in Mathematics* 76 (3): pp. 247-263. {100-set}

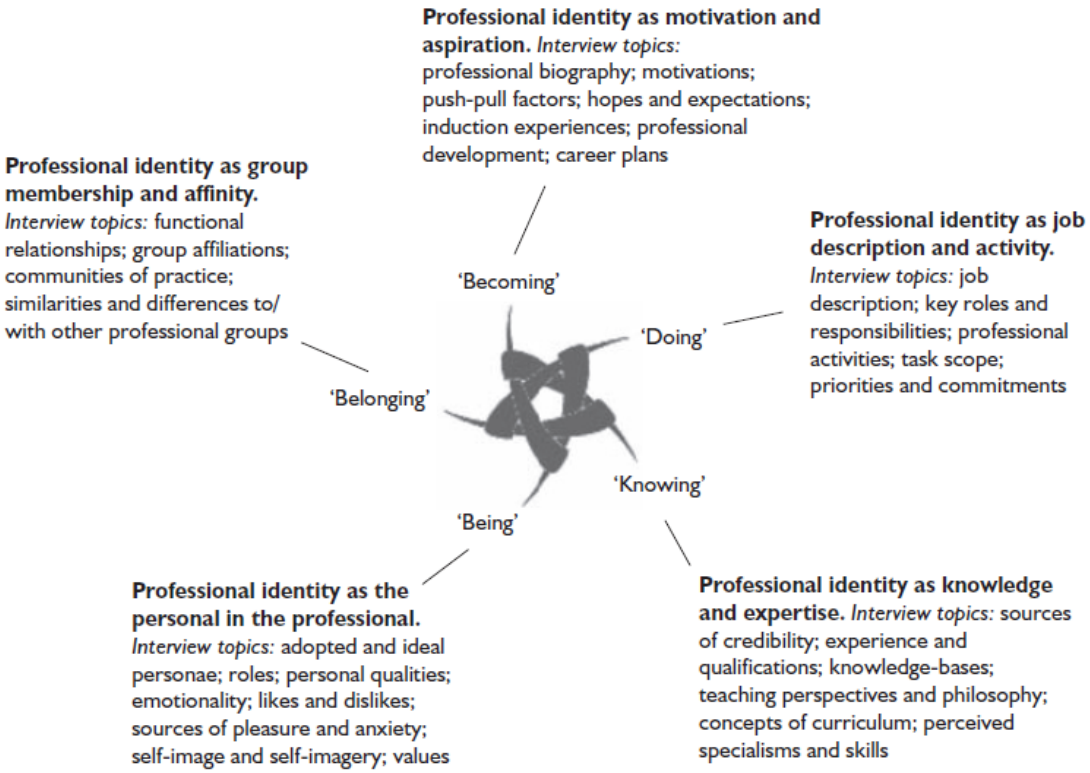
Zeichner, K. (2005) Becoming a teacher educator: a personal perspective. *Teaching and Teacher Education* 21: pp. 117-124.

Zembylas, M. (2003) Emotions and Teacher Identity: A poststructural perspective. *Teachers and Teaching* 9 (3): pp. 213-238.

Zhou, G. and Kim, J. (2010) Impact of an Integrated Methods Course on Preservice Teachers' Perspectives of Curriculum Integration and Faculty Instructors' Professional Growth. *Canadian Journal of Science, Mathematics and Technology Education* 10 (2): pp. 123-138. {100-set}

Appendix A1: The Davey Framework

The diagram below is taken from Davey (2013, p. 38, Fig. 3.1)



Appendix A2: The 100-Set

A2.1 Overview of the Papers and summary details

The full set of 100 papers for systematic review is listed in the bibliography at the end of this appendix. Table A2.1 summarises the papers in terms of the number from each Journal.

Table A2.1 Journal list for the 100-Set.

Journal	Number of Articles
ZDM	15
Canadian Journal of Science, Mathematics and Technology Education	8
International Journal of Science and Mathematics Education	3
Cogent Education	1
For the Learning of Mathematics	6
Research in Mathematics Education	4
Teacher Education Quarterly	2
Mathematics Education Research Journal	3
Journal of Mathematics Teacher Education	29
The Journal of Mathematical Behavior	2
Studying Teacher Education	7
Teaching and Teacher Education	7
Journal of Mathematics Education at Teachers College	1
Issues in Teacher Education	2
The Teacher Educator	2
Educational Studies in Mathematics	8
TOTAL	**100**

75 of the papers were classified as empirical research. The scope and timescales of that research are shown in Charts A2.2 and A2.3.

Chart A2.2 Methodology used in the 100-Set Empirical Studies

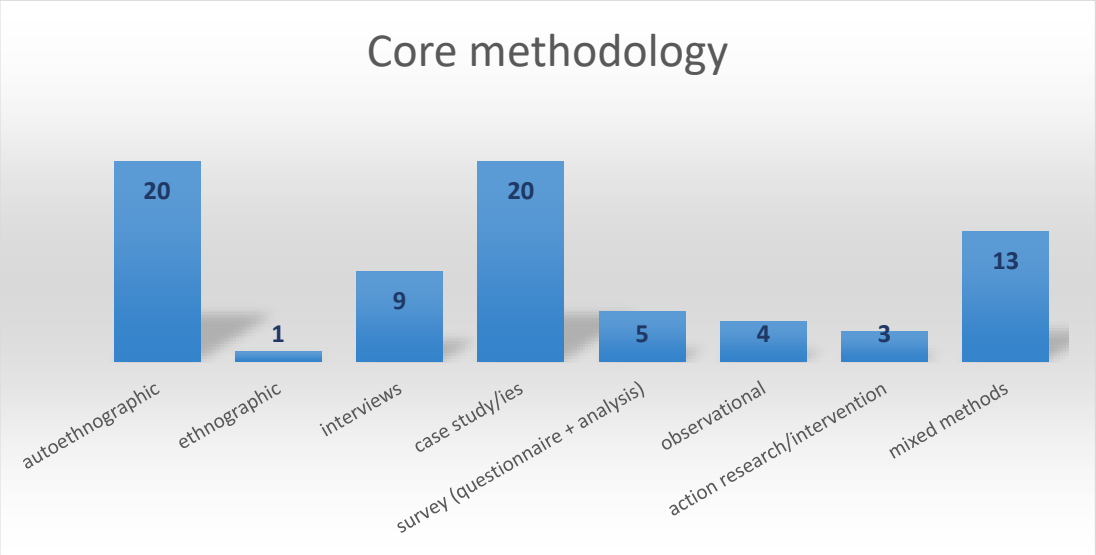
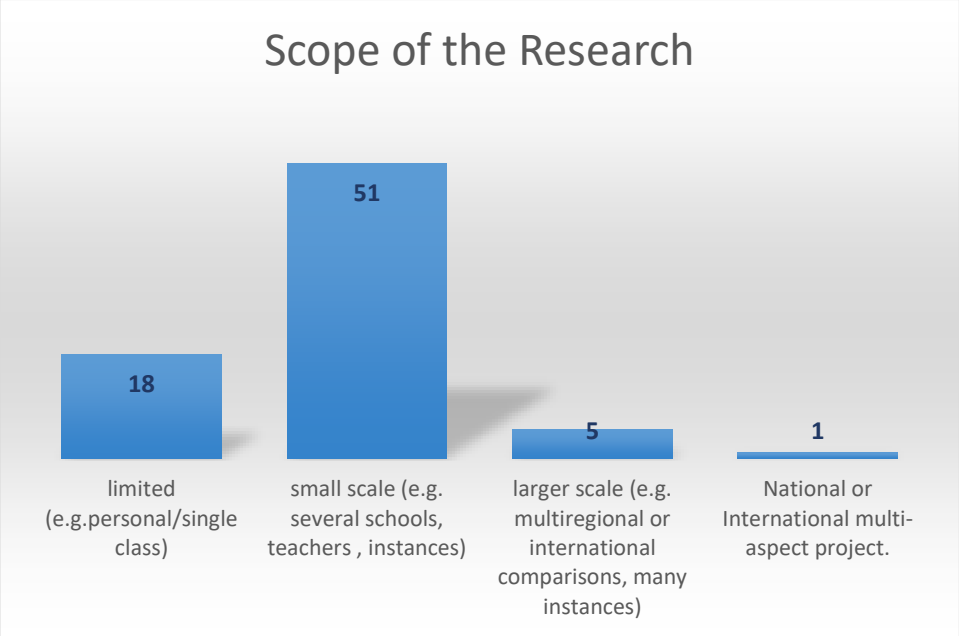


Chart A2.3 Scope of the Research in the 100-set Empirical Studies



The papers were also classified in terms of the Davey Framework. Papers could appear in more than one 'lens'. The cells in Chart A2.4 show the number of papers

classified in two or more lenses. Totals at the bottom show the total number within in each lens.

Table A2.4 Categorisations of the papers in terms of Davey Framework

Davey Categorization						
	Becoming	**Bec/PD**	**Being**	**Belonging**	**Knowing**	**Doing**
Becoming	**26**	7	8	8	1	6
Bec/PD	7	**23**	7	11	5	9
Being	8	7	**18**	2	2	8
Belonging	8	11	2	**18**	2	5
Knowing	1	5	2	2	**24**	8
Doing	6	9	8	5	8	**46**
TOTALS	**26**	**23**	**18**	**18**	**24**	**46**

It may be noticed here that right at the start, the literature references to *becoming* included a large number which were related to Professional Development, hence the column and row headings: “Bec/PD”.

A2.2: Bibliography for the Entire *100-Set*

In the final version of the thesis, a small number of articles (8) from the 100-set were not ultimately cited. These are indicated by the use of two asterisks (**).

Alderton, J. (2008) Exploring Self-Study to Improve My Practice as a Mathematics Teacher Educator. *Studying Teacher Education* 4 (2): pp. 95-104.

Amador, J. (2016) Professional noticing practices of Novice Mathematics Teacher Educators. *International Journal of Science and Mathematics Education* 14 (1): pp. 217–241.

Andrà, C. and Brunetto, D. (2017) The First Research Paper in Mathematics Education: A Beginner and His Young Mentor Talk About Their Experience. *Canadian Journal of Science, Mathematics and Technology Education* 18 (1): pp. 21-28.

Benken, B. and Brown, N. (2008) Moving beyond the Barriers: A Re-Defined, Multi-Leveled Partnership Approach to Mathematics Teacher Education. *International Journal of Science and Mathematics Education* 17 (2): pp. 63-82.

Beswick, K. and Goos, M. (2018) Mathematics teacher educator knowledge: What do we know and where to from here? *Journal of Mathematics Teacher Education* 21 (5): pp. 417–427.

Biza, I., Jaworski, B. and Hemmi, K. (2014) Communities in university mathematics. *Research in Mathematics Education* 16 (2): pp. 161-176.

Bjuland, R., Cestari, M. and Borgersen, H. (2012) Professional mathematics teacher identity: Analysis of reflective narratives from discourses and activities. *Journal of Mathematics Teacher Education* 15 (5): pp. 405–424.

Bleiler, S. (2015) Increasing awareness of practice through interaction across communities: the lived experiences of a mathematician and mathematics teacher educator. *Journal of Mathematics Teacher Education* 18 (3): pp. 231-252.

Boylan, M. (2015) Emotionality and relationship in teaching mathematics: a praxis of embodiment and uncertainty. *For the Learning of Mathematics* 35 (1): pp. 41-42.

Boylan, M., Brown, L., Nolan, K., Braathe, H.J., Portaankorva-Koivisto, P. and Coles, A. (2015) Praxis in mathematics teacher education: introduction to a series of short communications. *For the Learning of Mathematics* 35 (1): pp. 39.

Braathe, H.J. (2015) The new specialised Norwegian teacher education. *For the Learning of Mathematics* 35 (1): pp. 39-41.

Brown, L. (2015) Researching as an enactivist mathematics education researcher. *ZDM* 47 (2): pp. 185-196.

Brown, L. and Coles, A. (2010) Mathematics teacher and mathematics teacher educator change—insight through theoretical perspectives. *Journal of Mathematics Teacher Education* 13 (5): pp. 375-382.

Buchheister, K., Jackson, C. and Taylor, C. (2014) Integrating Universal Design and Response to Intervention in Methods Courses for General Education Mathematics Teacher. *Journal of Mathematics Education at Teachers College* 5 (2): pp. 63-71. **

Castro Superfine, A. (2019) Reconceptualizing ways of studying teacher learning: working with teachers rather than conducting research on teachers. *Journal of Mathematics Teacher Education* 22 (1): pp. 1-4.

Castro Superfine, A. and Li, W. (2014) Developing mathematical knowledge for teaching teachers: A model for the professional development of teacher educators. *Issues in Teacher Education* 23 (1): pp. 113-132.

Chauvot, J. (2008) Curricular Knowledge and the Work of Mathematics Teacher Educators. *Issues in Teacher Education* 17 (2): pp. 629-632.

Chauvot, J. (2009) Grounding practice in scholarship, grounding scholarship in practice: Knowledge of a mathematics teacher educator–researcher. *Teaching and Teacher Education* 25 (2): pp. 357-370.

Chen, J., Lin, F. and Yang, K. (2018) A novice mathematics teacher educator–researcher's evolution of tools designed for in-service mathematics teachers' professional development. *Journal of Mathematics Teacher Education* 21 (5): pp. 517–539.

Chick, H. and Beswick, K. (2018) Teaching teachers to teach Boris: a framework for mathematics teacher educator pedagogical content knowledge. *Journal of Mathematics Teacher Education* 21 (5): pp. 475–499.

Coles, A. (2014) Mathematics teachers learning with video: The role, for the didactician, of a heightened listening. *ZDM* 46 (2): pp. 267-278.

Coles, A. and Brown, L. (2015a) Being mathematics teacher educators in the praxis of living. *For the Learning of Mathematics* 35 (1): pp. 45-47.

Coles, A. and Brown, L. (2015b) Task design for ways of working: making distinctions in teaching and learning mathematics. *Journal of Mathematics Teacher Education* 19 (2-3): pp. 149–168.

Conner, A. and Gomez, C. (2019) Belief structure as explanation for resistance to change: The case of Robin. *The Journal of Mathematical Behavior* 53: pp. 196-209.

Ellis, V. and Childs, A. (2019) Innovation in teacher education: Collective creativity in the development of a teacher education internship. *Teaching and Teacher Education* 77: pp. 277-286.

Erbilgin, E. (2019) Two mathematics teacher educators' efforts to improve teaching and learning processes: An action research study. *Teaching and Teacher Education* 78: pp. 28-38.

Esmonde, I. and Caswell, B. (2010) Teaching Mathematics for Social Justice in Multicultural, Multilingual Elementary Classrooms. *Canadian Journal of Science, Mathematics and Technology Education* 10 (3): pp. 244-254.

Even, R. (2014) Challenges associated with the professional development of didacticians. *ZDM* 46 (2): pp. 329-333.

Fernandez, M. and Erbilgin, E. (2009) Examining the supervision of mathematics student teachers through analysis of conference communications. *Educational Studies in Mathematics* 72 (1): pp. 93-110.

Goodchild, S. (2014a) Mathematics teaching development: Learning from developmental research in Norway. *ZDM* 46 (2): pp. 305-316.

Goodchild, S. (2014b) Theorising community of practice and community of inquiry in the context of teaching-learning mathematics at university. *Research in Mathematics Education* 16 (2): pp. 177-181.

Goos, M. (2014) Researcher–teacher relationships and models for teaching development in mathematics education. *ZDM* 46 (2): pp. 189-200.

Goos, M. and Bennison, A. (2018) Boundary crossing and brokering between disciplines in pre-service mathematics teacher education. *Mathematics Education Research Journal* 30 (3): pp. 255–275.

Goos, M. and Bennison, A. (2019) A zone theory approach to analysing identity formation in mathematics education. *ZDM* 51 (3): pp. 405-418.

Goos, M. and Geiger, V. (2010) Theoretical perspectives on mathematics teacher change. *Journal of Mathematics Teacher Education* 13 (6): pp. 499-507.

Gueudet, G., Sacristán, A. , Soury-Lavergne, S. and Trouche, L. (2012) Online paths in mathematics teacher training: New resources and new skills for teacher educators. *ZDM* 44 (6): pp. 717–731.

Haser, Ç. (2018) Key Experiences in Becoming an Independent Mathematics Education Researcher. *Canadian Journal of Science, Mathematics and Technology Education* 18 (1): pp. 29-41.

Helliwell, T. (2017a) Mathematics teacher educator noticing: A methodology for researching my own learning. *Research in Mathematics Education: Proceedings of the Day Conferences March 2017 [Curtis, F. (Ed.)]* 37 (2): pp. 1-6.

Helliwell, T. (2017b) Salient moments: the potential for using multiple perspectives in mathematics teacher educator learning. *Research in Mathematics Education: Proceedings of the Day Conferences June 2017 [Curtis, F. (Ed.)]* 37 (2): pp. 1-6.

Hemmi, K. and Ryve, A. (2015) Effective mathematics teaching in Finnish and Swedish teacher education discourses. *Journal of Mathematics Teacher Education* 18 (6): pp. 501–521.

Høynes, S., Klemp, T. and Nilssen, V. (2019) Mentoring prospective mathematics teachers as conductors of whole class dialogues – Using video as a tool. *Teaching and Teacher Education* 77: pp. 287-298.

Huang, R., Su, H. and Xu, S. (2014) Developing teachers' and teaching researchers' professional competence in mathematics through Chinese Lesson Study. *ZDM* 46 (2): pp. 239-251.

Hunter, R. (2010) Changing roles and identities in the construction of a community of mathematical inquiry. *Journal of Mathematics Teacher Education* 13 (5): pp. 397-409.

Jankvist, U., Clark, K. and Mosvold, R. (2019) Developing mathematical knowledge for teaching teachers: potentials of history of mathematics in teacher educator training. Journal of Mathematics Teacher Education 23 (3): pp. 311-332.

Jansen, A. (2009) Prospective elementary teachers' motivation to participate in whole-class discussions during mathematics content courses for teachers. *Educational Studies in Mathematics* 71 (2): pp. 145-160.

Jaworski, B. and Huang, R. (2014) Teachers and didacticians: Key stakeholders in the processes of developing mathematics teaching. *ZDM* 46 (2): pp. 173-188.

Jung, H. and Brady, C. (2016) Roles of a teacher and researcher during in situ professional development around the implementation of mathematical modeling tasks. *Journal of Mathematics Teacher Education* 19 (2-3): pp. 277–295.

Kastberg, S., Lischka, A. and L. Hillman, S. (2018) Characterizing mathematics teacher educators' written feedback to prospective teachers. *Journal of Mathematics Teacher Education* [no volume assigned]: pp. 1-22.

Kathleen Rapke, T. (2014) Duoethnography: A New Research Methodology for Mathematics Education. *Canadian Journal of Science, Mathematics and Technology Education* 14 (2): pp. 172-186.

Koichu, B. and Pinto, A. (2018) Developing Education Research Competencies in Mathematics Teachers Through TRAIL: Teacher-Researcher Alliance for Investigating Learning. *Canadian Journal of Science, Mathematics and Technology Education* 18 (1): pp. 68-85.**

Kynigos, C. and Kalogeria, E. (2012) Boundary crossing through in-service online mathematics teacher education: The case of scenarios and half-baked microworlds. *ZDM* 44 (6): pp. 733–745.

Lai, Y. (2019) Accounting for mathematicians' priorities in mathematics courses for secondary teachers. *The Journal of Mathematical Behavior* 53: pp. 164-178.**

Leikin, R., Zazkis, R. and Meller, M. (2018) Research mathematicians as teacher educators: focusing on mathematics for secondary mathematics teachers. *Journal of Mathematics Teacher Education* 21 (5): pp. 451–473.**

Lerman, S. (2014) Mapping the effects of policy on mathematics teacher education. *Educational Studies in Mathematics* 87 (2): pp. 187–201.**

Li, W. and Castro Superfine, A. (2018) Mathematics teacher educators' perspectives on their design of content courses for elementary preservice teachers. *Journal of Mathematics Teacher Education* 21 (2): pp. 179–201.

Liljedahl, P. (2018) Mathematics Education Graduate Students' Thoughts About Becoming Researchers. *Canadian Journal of Science, Mathematics and Technology Education* 18 (1): pp. 42-57.

Lin, F., Yang, K., Hsu, H. and Chen, J. (2018) Mathematics teacher educator-researchers' perspectives on the use of theory in facilitating teacher growth. *Educational Studies in Mathematics* 98 (2): pp. 1-18.

Lloyd, G. M., (2018) Understanding elementary mathematics teacher education through the characteristics and activities of preservice teachers, elementary mathematics specialists, and mathematics teacher educators. *Journal of Mathematics Teacher Education* 21 (2): pp. 95–98.**

Lovin, L., Sanchez, W., Leatham, K., Chauvot, J., Kastberg, S. and Norton, A. (2012) Examining Beliefs and Practices of Self and Others: Pivotal Points for Change and Growth for Mathematics Teacher Educators. *Studying Teacher Education* 8 (1): pp. 51-68.

Males, L., Otten, S. and Herbel-Eisenmann, B. (2010) Challenges of critical colleagueship: Examining and reflecting on mathematics teacher study group interactions. *Journal of Mathematics Teacher Education* 13 (6): pp. 459-471.

Margolin, I. (2011) Professional development of teacher educators through a "transitional space": A surprising outcome of a teacher education program. *Teacher Education Quarterly* 38 (3): pp. 7-25.

Masingila, J., Olanoff, D. and Kimani, P. (2018) Mathematical knowledge for teaching teachers: knowledge used and developed by mathematics teacher educators in learning to teach via problem solving. *Journal of Mathematics Teacher Education* 21 (5): pp. 429–450.

Masingila, J., Olanoff, D. and Kwaka, D. (2012) Who teaches mathematics content courses for prospective elementary teachers in the United States? Results of a national survey. *Journal of Mathematics Teacher Education* 15 (5): pp. 347–358.

McGlynn-Stewart, M. (2010) Listening to Students, Listening to Myself: Addressing pre-service teachers' fears of mathematics and teaching mathematics. *Studying Teacher Education* 6 (2): pp. 175-186.

Monroe, E. (2013) Being and Becoming a Mathematics Teacher Educator in and for Differing Contexts: Some lessons learned. *Studying Teacher Education* 9 (2): pp. 96-107.

Nicol, C., Novakowski, J., Ghaleb, F. and Beairsto, S. (2010) Interweaving Pedagogies of Care and Inquiry: Tensions, dilemmas and possibilities. *Studying Teacher Education* 6 (3): pp. 235-244.

Nolan, K. (2012) Dispositions in the field: Viewing mathematics teacher education through the lens of Bourdieu's social field theory. *Educational Studies in Mathematics* 80 (1-2): pp. 201–215.

Nolan, K. (2015a) Beyond tokenism in the field? On the learning of a Mathematics teacher educator and faculty supervisor. Cogent Education 2 (1): [Online]. Available at: https://doi.org/10.1080/2331186X.2015.1065580 [Accessed 8 June 2019].

Nolan, K. (2015) Reflections on bright moments in teaching through inquiry. *For the Learning of Mathematics* 35 (1): pp. 42-44.

Noorloos, R., D. Taylor, S., Bakker, A. and Derry, J. (2017) Inferentialism as an alternative to socioconstructivism in mathematics education. *Mathematics Education Research Journal* 29 (4): pp. 437–453.**

Parker, D. and Adler, J. (2014) Sociological tools in the study of knowledge and practice in mathematics teacher education. *Educational Studies in Mathematics* 87 (2): pp. 203–219.**

Phelps-Gregory, C. and Spitzer, S. (2012) Systematically Improving Lessons in Teacher Education: What's Good for Prospective Teachers is Good for Teacher Educators. *The Teacher Educator* 47 (4): pp. 328 – 347.

Portaankorva-Koivisto, P. (2015) Theory vs. practice or theory vs. experiences. *For the Learning of Mathematics* 35 (1): pp. 44-45.

Potari, D. (2018) Teachers' and students' perspectives in mathematics teaching and teacher education. *Journal of Mathematics Teacher Education* 21 (6): pp. 541–543.

Potari, D., Sakonidis, H., Chatzigoula, R. and Manaridis, A. (2010) Teachers' and researchers' collaboration in analysing mathematics teaching: A context for professional reflection and development. *Journal of Mathematics Teacher Education* 13 (6): pp. 473-485.

Psycharis, G. and Kalogeria, E. (2018) Studying the process of becoming a teacher educator in technology-enhanced mathematics. *Journal of Mathematics Teacher Education* 21 (6): pp. 631–660.

Reid, D. and Zack, V. (2010a) Observing the process of mathematics teacher change—part 1. *Journal of Mathematics Teacher Education* 13 (5): pp. 371-374.

Reid, D. and Zack, V. (2010b) Observing the process of mathematics teacher change: Part 2. *Journal of Mathematics Teacher Education* 13 (6): pp. 441-444.

Reys, R. (2018) The Preparation of a Mathematics Educator: The Case of Carey. *Canadian Journal of Science, Mathematics and Technology Education* 18 (1): pp. 58-67.

Roth, W. (2012) Cultural-historical activity theory: Vygotsky's forgotten and suppressed legacy and its implication for mathematics education. *Mathematics Education Research Journal* 24 (1): pp. 87–104.

Rowland, T., Turner, F. and Thwaites, A. (2014) Research into teacher knowledge: A stimulus for development in mathematics teacher education practice. *ZDM* 46 (2): pp. 317-328.

Sakonidis, H. and Potari, D. (2014) Mathematics teacher educators'/researchers' collaboration with teachers as a context for professional learning. *ZDM* 46 (2): pp. 293-304.

Schuck, S. (2009) How Did We Do? Beginning teachers teaching mathematics in primary schools. *Studying Teacher Education* 5 (2): pp. 113-123.

Shaughnessy, M., Ghousseini, H., Kazemi, E., L. Franke, M., Kelley-Petersen, M. and Sugino Hartmann, E. (2019) An Investigation of Supporting Teacher Learning in the Context of a Common Decomposition for Leading Mathematics Discussions. *Teaching and Teacher Education* 80: pp. 167-179.

Silverman, J. and L. Clay, E. (2009) Online asynchronous collaboration in mathematics teacher education and the development of mathematical knowledge for teaching. *The Teacher Educator* 45 (1): pp. 54-73.

Stoehr, K. (2017) Building the wall brick by brick: one prospective teacher's experiences with mathematics anxiety. *Journal of Mathematics Teacher Education* 20 (2): pp. 119–139.

Stylianides, G. and Stylianides, A. (2010) Mathematics for teaching: A form of applied mathematics. *Teaching and Teacher Education* 26 (2): pp. 161-172.

Sztajn, P., Holt Wilson, P., Edgington, C. and Myers, M. (2014) Mathematics professional development as design for boundary encounters. *ZDM* 46 (2): pp. 201-212.

Tatto, M., Lerman, S. and Jarmila, N. (2010) The organization of the mathematics preparation and development of teachers: A report from the ICMI Study 15. *Journal of Mathematics Teacher Education* 13 (4): pp. 313-324.

Tirosh, D., Tsamir, P., Levenson, E., Barkai, R. and Tabach, M. (2014) Using video as a tool for promoting inquiry among preschool teachers and didacticians of mathematics. *ZDM* 46 (2): pp. 253-266.

Trumbull, D. (2009) Interrogating our Practices. *Studying Teacher Education* 5 (2): pp. 125-128.

Uerz, D., Volman, M. and Kral, M. (2018) Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teaching and Teacher Education* 70: pp. 12-23.

Vomvoridi-Ivanovic, E. and McLeman, L. (2015) Mathematics Teacher Educators Focusing on Equity: Potential Challenges and Resolutions. *Teacher Education Quarterly* 42 (4): pp. 83-100.

Wake, G., Swan, M. and Foster, C. (2016) Professional learning through the collaborative design of problem-solving lessons. *Journal of Mathematics Teacher Education* 19 (2-3): pp. 243-260.

Wu, Y., Hwang, S. and Cai, J. (2017) Being a Mathematics Teacher Educator in China: Challenges and Strategic Responses. *International Journal of Science and Mathematics Education* 15 (7): pp. 1365–1384.

Yang, K., Hsu, H., Lin, F., Chen, J. and Cheng, Y. (2015) Exploring the educative power of an experienced mathematics teacher educator-researcher. *Educational Studies in Mathematics* 89 (1): pp. 19–39.

Yang, X. and Leung, F. (2013) Conception of expert mathematics teacher: A comparative study between Hong Kong and Chongqing. *ZDM* 45 (1): pp. 121-132.

Zazkis, R. and Mamolo, A. (2018) From disturbance to task design, or a story of a rectangular lake. *Journal of Mathematics Teacher Education* 21 (5): pp. 501–516.

Zazkis, R. and Zazkis, D. (2011) The significance of mathematical knowledge in teaching elementary methods courses: Perspectives of mathematics teacher educators. *Educational Studies in Mathematics* 76 (3): pp. 247-263.

Zhou, G. and Kim, J. (2010) Impact of an Integrated Methods Course on Preservice Teachers' Perspectives of Curriculum Integration and Faculty Instructors' Professional Growth. *Canadian Journal of Science, Mathematics and Technology Education* 10 (2): pp. 123-138.

Appendix A3: Systematic Review- Tools used in the Analysis

A total of 100 papers were selected. These are listed as Bibliography in Appendix A2.2

Details of each paper were entered into a which I had equipped with various analytical tools and features. These tools and features are outlined below.

Figure A3.1: Part of the Main Spreadsheet

1	Brown, L.	2015	ZDM	Vol. 47 Issue 2	Researching as an enactivist mathematics education researcher	This paper focusses on how researching is done through reflections about, or at a meta-level to, the practice over time of an enactivist mathematics education	This paper begin autobiographica engagement witl development of
2	Jaworski, B. & Huang, R.	2014	ZDM	Vol. 46 Issue 2	Teachers and didacticians: Key stakeholders in the processes of developing mathematics teaching	This paper sets the scene for a special issue of ZDM—The International Journal on Mathematics Education—by tracing key elements of the fields of teacher and	
3	Goos, M.	2014	ZDM	Vol. 46 Issue 2	Researcher-teacher relationships and models for teaching development in mathematics education	This article offers theoretical and analytical approaches to investigating how researchers and teachers can work together to create knowledge in mathematics	A framework for researcher–teac presented and th in which I, as a u
4	Sztajn, P. et al.	2014	ZDM	Vol. 46 Issue 2	Mathematics professional development as design for boundary encounters	Theoretical paper examines a process for researchers and teachers to exchange knowledge.	
5	Huang, R. et al.	2014	ZDM	Vol. 46 Issue 2	Developing teachers' and teaching researchers' professional competence in mathematics through	This studyexamines co-learning of mathematics practicing teachers and mathematics teaching researchers through parallel lesson study in China. Two cases are	Two MTRs from d participated in th teaching researc research activiti
6	Tirosh, D. et al.	2014	ZDM	Vol. 46 Issue 2	Using video as a tool for promoting inquiry among preschool teachers and didacticians of mathematics	This paper explores the use of video as a tool for promoting inquiry among preschool teachers and didacticians. In this case, the didacticians are teacher educators who are	Preschool teach with video imple geometry tasks v these recordings
7	Coles, A.	2014	ZDM	Vol. 46	Mathematics teachers learning with video: the role, for the didactician, of a	This article addresses two main questions, how do mathematics teachers learn from using video? and, what is the role of the	On three occasi 2009, I gave over the watching of a

The text within the body of the spreadsheet was of three types:

- Factual details such as author, date, Journal etc.;
- Text from the abstract or the main body of the paper, cut and pasted;
- Classifications on the basis of content.

One of the tools developed allowed me to view all the entries for a single paper on one screen:

Figure A3.2: Screenshot of the entries for Lai, Y (2009)

Author(s)	Lai,Y.
Date	2019
Journal	Journal of Mathematical Behaviour
Volume & Issue	In Press
Title	Accounting for mathematicians' priorities in mathematics courses for secondary teachers
Key focus or Aim of Paper	Recent studies suggest that change is needed in undergraduate mathematics capstone courses for prospective secondary teachers. One promising but infrequently used strategy for improvement is to incorporate tasks that explicitly focus on pedagogical content knowledge (PCK). Expectancy-value theory provides an account for why instruction of these courses does not more regularly employ this strategy.
Declared research method style or approach taken (what/how?)	this paper uses an interview-based study of 9 mathematicians that investigated the process of prioritizing tasks and goals for these courses.
Declared theoretical perspective or research position (why?)	Wheatley (2005) observed that a key gap in teacher education research is "expectancy for learning to teach in new ways ... from skillful use of new curricula or methods with which they have little or no skill" (p. 751, emphasis in the original). Decisions about how to use curricula or methods, whether with new or old ways, factor in how much a person values the goals that the curricula or methods might serve, as well as how well a person expects to do at carrying out the curricula or methods (Schoenfeld 2010). This stance is consistent with expectancy-value theories, broad motivational theories in educational psychology that connect
Key Findings, Results or Conclusions	As the study found, these mathematicians valued developing teachers' PCK. However, they were unconfident of their ability to teach with tasks and goals focused on developing teachers' PCK relative to more purely mathematical tasks and goals. The central implication is that interventions in mathematicians' teaching must take into account the possibility that it may be just as important to improve confidence and resources as it is to change values.
Context of the study Country/ Countries of focus	USA
Type of paper (DD)	Journal Article (peer-reviewed)
Core Methodology (DD)	Empirical Research
Empirical Methodology subcategory 1: TYPE (DD)	interviews
Empirical Methodology subcategory 2: SCOPE (DD)	small scale (e.g. several schools, teachers , instances)
subcategory 2: TIMESCALE (DD)	Single Event
Subjects: MTER - TER- PST - IST - M- ME	M
Number of Subjects	9
Identity discussed explicitly?	No
Possible other links with Professional Identity	mathematicians are trained to use mathematical and meta-mathematical knowledge, and mathematicians use meta-mathematical knowledge to tackle problems in unfamiliar mathematical domains, as well as to analyze and improve students' capacity to do mathematical proof. The greater confidence of the two participants with prior experience with an approach emphasizing PCK at the primary level suggests that they saw potential similarities between primary level and secondary level, despite topical differences. Articulating "meta-PCK" understandings may go a long way in helping instructors develop the confidence to take on an

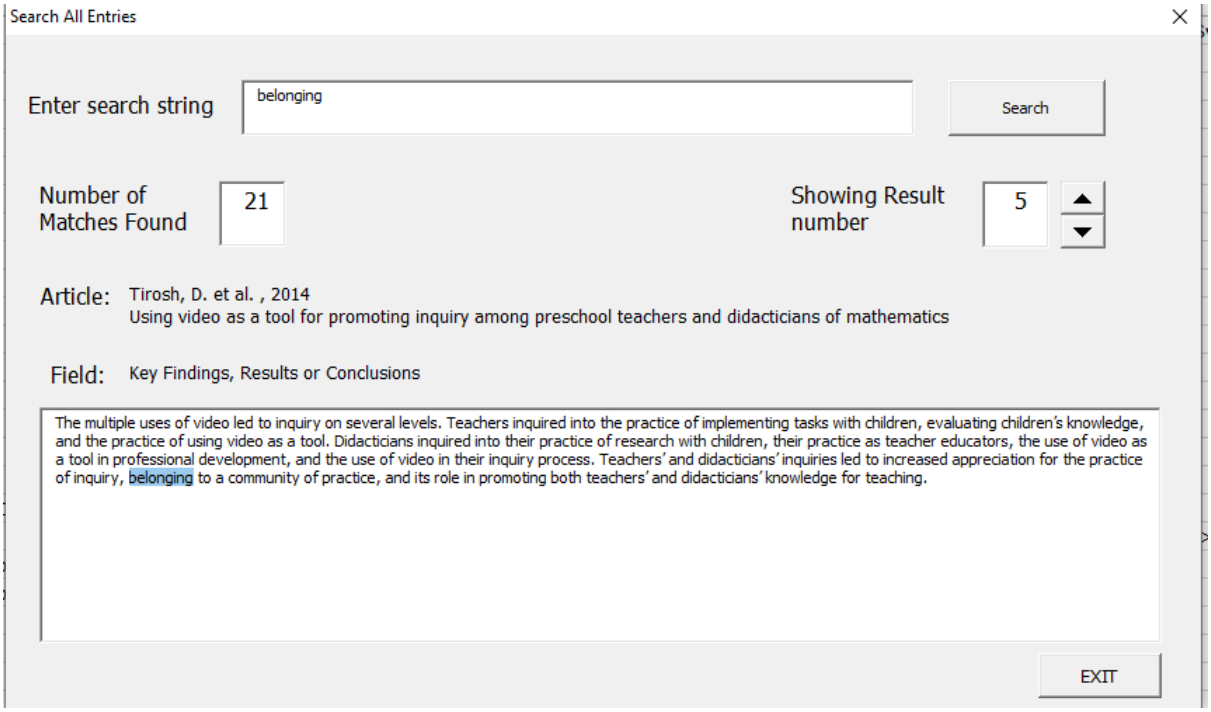
A further tool allowed me to directly compare all the entries on the same field for different papers on the same screen:

Figure A3.4 Comparisons of a single field

No.	Author	Key Findings, Results or Conclusions
14	Kynigos, C. & Kalogeria, E.	We consider these interactions as a forum for challenge and for professional development through frequent and relevant boundary crossing.
15	Haser, C.	Findings showed that doctoral students conceptualized a mathematics education researcher with several types of knowledge, skills, and attitudes, including research methods, mathematics, critical thinking, and being ethical and patient. They felt like a researcher when they collected and analyzed data at a research study. However, only the ones who were involved in team research identified themselves as independent researchers. Providing doctoral students with more research opportunities during the doctoral programsmight support their development as independent researchers. Providing doctoral students with more research opportunities during the doctoral programs might support
16	Goos, M. & Bennison, A.	Identity conceptualised as something we do. "Identity as becoming" Elaboration on Wenger's claims
17	Wu, Y., Hwang, S. & Cai, J.	The MTEs reported encountering more challenges when teaching pedagogical courses and supervising student teachers than when teaching college mathematics courses and teaching mathematical problem-solving courses. This finding reflects a key difference between the content, goals, and teaching demands of these 2 elements of mathematics teacher education programs (acting in the role of an MTE versus the role of a mathematics teacher). In this study, we also analyzed the strategies that MTEs use to deal with the challenges that arise in their work and the suggestions they have for the training of future MTEs. Discussion of strategies employed to respond to challenges in key areas of MTEs' work.
18	Nolan, K.	The data storylines presented in this paper convey one mathematics teacher educator's efforts to disrupt and reconceptualize the network of relations in teacher education field experience, with a goal of understanding how one's professional practice as a supervisor might shape and influence a more dynamic view of these networks. The paper argues for taking a reflexive stance in teacher education, to reveal the habits and cultural capital shaping action in/of the field, and to support teacher educators as they trouble the discursive network of relations—represented in this paper through five storylines—of mathematics teacher education field experience and associated supervision. Argues for
19	Coles, A. & Brown, L.	It is always possible to work on developing the sensitivity to notice when statements arise in discussion that are ones where a meaningful sharing of strategies can take place.
20	Ewing Monroe, E.	Patterns in changes of behaviour as an MTE noticed. Contextualised within descriptions of work in each location and cultural context. Author becomes convinced through the self-study that deliberations regarding maths education may be futile unless considerations regarding context or culture, are central to decision-making.
21	Lovin, L.H., et al.	Four shared beliefs: maths is problematic and generated through sense-making a community of learners enhances learning
22	Chauvot, J.B.	How to categorise MTE knowledge, Framework created using Shulman's three notions of K plus context knowledge (Grossman, 1990, and Olson, 1998), plus overarching 'research'.
23	Alderton, J.	Through this exploration I have begun to transform the way that I comprehend teaching and learning in teacher education. I identify several tensions and challenges in implementing the methodology within my professional context. I believe that self-study can help us in our roles as teacher educators to develop more reflexive self-awareness and to problematize taken-for-granted assumptions relevant to our contexts of practice.

A final tool allowed me to search for specific terms in all the entries for all the papers

Figure A3.5 Search Facility



Appendix A4 TEDS-M Tables and Charts

Selected Charts from: Tatto et al. (2012) - Exhibits 4.6, 4.8, 4.9 and 4.10

Exhibit 4.6: Disciplines taught by teacher educators (estimated percent)

Country	*n*	A. Mathematics and Mathematics Pedagogy		B. General Pedagogy		C. Both Areas A and B	
		Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Botswana	43	36.4	(0.0)	63.6	(0.0)	0.0	(0.0)
Chile[a]	392	18.0	(0.3)	58.8	(0.6)	23.1	(0.7)
Chinese Taipei	195	40.4	(4.1)	59.0	(4.1)	0.6	(0.2)
Georgia	62	65.6	(1.8)	31.3	(0.3)	3.1	(2.2)
Germany[b]	482	12.1	(3.2)	62.0	(5.9)	25.9	(4.6)
Malaysia[c]	255	59.1	(0.1)	13.4	(0.0)	27.5	(0.1)
Oman[d]	84	62.1	(0.1)	35.9	(0.1)	1.9	(0.0)
Philippines	589	29.5	(3.0)	46.0	(5.9)	24.5	(5.4)
Poland[e]	734	64.9	(0.3)	32.7	(0.2)	2.4	(0.1)
Russian Federation[f]	1,212	76.7	(2.4)	20.6	(1.9)	2.7	(0.9)
Singapore	77	33.0	(0.0)	67.0	(0.0)	0.0	(0.0)
Spain[g]	533	20.8	(0.7)	76.1	(2.2)	3.1	(2.4)
Switzerland[h]	220	18.5	(0.5)	81.3	(0.4)	0.2	(0.2)
Thailand	312	39.0	(0.1)	36.3	(0.1)	24.8	(0.1)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.8: Teacher educators rating mathematics as their "main specialty" by disciplines taught (estimated percent)

Country	A. Mathematics and Mathematics Pedagogy Teacher Educators			B. General Pedagogy Teacher Educators			C. Teacher Educators of Both Areas A. and B.		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	16	75.0	(10.8)	26	3.7	(2.6)			
Chile[a]	81	56.5	(5.4)	248	0.4	(0.4)	57	13.3	(4.1)
Chinese Taipei	84	51.9	(3.7)	107	0.0	(0.0)	2	0.0	(0.0)
Georgia	40	85.4	(4.5)	16	6.3	(6.3)	1	0.0	(0.0)
Germany[b]	114	94.5	(1.7)	224	1.0	(0.7)	140	63.6	(5.2)
Malaysia[c]	162	45.7	(4.0)	21	2.2	(2.2)	68	21.1	(3.9)
Oman[d]	50	90.6	(4.1)	29	6.8	(4.2)	2	100.0	(0.0)
Philippines	194	51.1	(5.7)	271	5.3	(2.4)	116	17.1	(6.9)
Poland[e]	452	73.7	(1.8)	252	0.7	(0.4)	22	36.6	(8.6)
Russian Federation[f]	904	58.5	(2.3)	268	1.8	(0.8)	17	18.3	(17.2)
Singapore	25	72.0	(8.9)	52	1.9	(1.9)			
Spain[g]	119	63.6	(5.8)	398	0.0	(0.0)	13	12.0	(16.2)
Switzerland[h]	51	75.8	(6.0)	167	0.7	(0.7)	1	100.0	(0.0)
Thailand	119	69.9	(3.6)	115	7.1	(2.5)	74	48.3	(4.9)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.9: Teacher educators who hold teaching certification by disciplines taught (estimated percent)

Country	A. Mathematics and Mathematics Pedagogy Teacher Educators			B. General Pedagogy Teacher Educators			C. Teacher Educators of Both Areas A. and B.		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	16	93.8	(6.3)	26	77.8	(7.9)			
Chile[a]	82	94.0	(2.4)	247	82.8	(2.3)	55	93.2	(3.6)
Chinese Taipei	85	29.4	(12.2)	107	45.7	(2.6)	2	50.0	(55.6)
Georgia	40	97.6	(2.4)	20	95.0	(5.0)	1	100.0	(0.0)
Germany[b]	114	11.6	(3.8)	225	89.1	(4.5)	141	90.8	(3.1)
Malaysia[c]	163	90.6	(1.9)	21	78.8	(14.1)	68	58.3	(5.6)
Oman[d]	47	22.3	(6.2)	28	57.6	(9.0)	2	100.0	(0.0)
Philippines	194	69.8	(5.2)	275	69.9	(4.8)	116	80.3	(7.5)
Poland[e]	444	67.0	(2.4)	252	54.9	(2.5)	24	82.2	(6.1)
Russian Federation[f]	912	83.6	(2.0)	275	98.1	(0.9)	17	100.0	(0.0)
Singapore	25	84.0	(5.7)	51	64.7	(6.8)			
Spain[g]	119	93.0	(2.4)	394	75.2	(3.3)	13	70.7	(4.4)
Switzerland[h]	48	96.3	(2.6)	162	89.2	(2.5)	1	100.0	(0.0)
Thailand	119	30.3	(4.2)	111	29.2	(4.5)	72	32.4	(5.8)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.10: Teacher educators' qualifications in mathematics, by disciplines taught (estimated percent)

Country	Master's-Level Qualifications in Mathematics									Doctoral-Level Qualifications in Mathematics								
	A. Mathematics and Mathematics Pedagogy Teacher Educators			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*			*A. Mathematics and Mathematics Pedagogy Teacher Educators*			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*		
	n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Botswana	12	58.3	(12.4)	7	0.0	(0.0)	0	0.0	(0.0)	12	16.7	(11.1)	7	0.0	(0.0)	0	0.0	(0.0)
Chile[a]	65	8.9	(4.2)	64	3.2	(2.8)	26	11.9	(6.8)	65	4.7	(2.8)	64	3.9	(2.8)	26	5.2	(5.3)
Chinese Taipei	74	11.0	(3.2)	58	1.4	(1.4)	1	0.0	(0.0)	74	64.9	(9.7)	58	0.0	(0.0)	1	0.0	(0.0)
Georgia	36	16.2	(5.7)	8	12.5	(11.2)	0	0.0	(0.0)	36	62.2	(6.0)	8	12.5	(13.1)	0	0.0	(0.0)
Germany[b]	110	0.0	(0.0)	135	25.3	(7.9)	131	68.0	(9.9)	110	88.0	(3.1)	135	0.0	(0.0)	131	10.3	(3.3)
Malaysia[c]	119	14.5	(3.0)	6	0.0	(0.0)	40	6.8	(4.0)	119	0.8	(1.1)	6	18.8	(15.7)	40	30.6	(5.8)
Oman[d]	45	1.8	(1.8)	9	0.0	(0.0)	2	100.0	(0.0)	45	82.6	(3.7)	9	0.0	(0.0)	2	0.0	(0.0)
Philippines	167	43.0	(5.6)	165	6.4	(3.1)	81	25.7	(8.3)	167	7.1	(4.0)	165	1.3	(1.3)	81	1.2	(0.8)
Poland[e]	440	23.0	(1.8)	135	4.5	(1.7)	18	48.5	(14.5)	440	71.6	(1.7)	135	1.2	(0.9)	18	24.2	(10.7)
Russian Federation[f]	814	55.3	(2.6)	150	43.2	(6.3)	12	43.8	(11.9)	814	35.5	(2.6)	150	0.0	(0.0)	12	3.0	(3.1)
Singapore	21	4.8	(3.4)	32	0.0	(0.0)	0	0.0	(0.0)	21	42.9	(7.6)	32	0.0	(0.0)	0	0.0	(0.0)
Spain[g]	111	69.1	(5.4)	249	2.4	(0.7)	9	16.9	(21.6)	111	17.5	(4.3)	249	0.0	(0.0)	9	0.0	(0.0)
Switzerland[h]	46	33.1	(7.0)	118	0.0	(0.0)	1	0.0	(0.0)	46	8.7	(4.1)	118	0.0	(0.0)	1	100.0	(0.0)
Thailand	82	52.1	(5.8)	51	3.8	(2.4)	40	28.4	(6.0)	82	11.8	(2.7)	51	0.0	(0.0)	40	4.6	(2.9)

Notes:

1. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Appendix A5: Extension of Pedagogical Content Knowledge

Frameworks for pedagogical content knowledge for teaching school mathematics and teaching school mathematics teaching

Extract (pp. 479-482) from

Chick, H. and Beswick, K. (2018) Teaching teachers to teach Boris: a framework for mathematics teacher educator pedagogical content knowledge. *Journal of Mathematics Teacher Education* 21(5) pp.475-499.

Table 1 Frameworks for pedagogical content knowledge for teaching school mathematics and teaching school mathematics teaching

PCK category	PCK for school mathematics teachers (SMTPCK)		PCK for mathematics teacher educators (MTEPCK)	
	Evident when the teacher…	Example	Evident when the maths educator…	Example
Clearly PCK				
Teaching strategies	Discusses or uses general or specific strategies or approaches for teaching a mathematical concept or skill	Uses concrete materials to demonstrate a concept	Discusses or uses general or specific strategies or approaches for teaching an SMTPCK concept or skill	Gives PSTs two contrasting examples of student responses and requests a "mark" for each, in order to address issues associated with assessment
Student thinking	Discusses or addresses student ways of thinking about a concept, or recognises typical levels of understanding	Identifies that a student doesn't recognise the equivalence of equivalent fractions	Discusses or addresses PST's ways of thinking about an SMTPCK concept	Knows PSTs may struggle to recognise that misconceptions may be based on generalising sound ideas inappropriately
Student thinking—misconceptions	Discusses or addresses student misconceptions about a concept	Recognises that students often think "multiplying makes bigger"	Discusses or addresses PST misconceptions about an SMTPCK concept	Knows that PSTs may believe that identifying the learning outcomes of a lesson is sufficient for lesson planning
Student affect (in relation to content)	Discusses or addresses students' affective responses to particular mathematics topics	Recognises that adolescent students may have negative emotional reactions to the prospect of learning algebra	Discusses or addresses PSTs affective reaction in relation to some SMTPCK ideas	Realises that some PSTs will be uncomfortable letting a student know that the student's mathematical thinking is incorrect
Cognitive demand of task	Identifies aspects of the (SMT) task that affect its complexity	Recognises 627–359 is more difficult to model than 687–321	Identifies aspects of the (MTE) task that affect its complexity	Knows PSTs may struggle to simulate responses of children with certain decimal misconceptions
Representations of concepts	Describes or demonstrates ways to model or illustrate a concept (can include materials or diagrams)	Uses MAB to model subtraction	Describes or demonstrates ways to model or illustrate an SMTPCK concept	Contrasts different representations (e.g. MAB and LAB) and what they offer for mathematics teaching
Explanations	Explains a topic, concept or procedure	Explains why we can write a 0 on the end of a whole number when multiplying by 10	Explains an SMTPCK topic, concept or procedure	Explains what "cognitive demand" means, and why this is important for teachers to know

Table 1 continued

PCK category	PCK for school mathematics teachers (SMTPCK)		PCK for mathematics teacher educators (MTEPCK)	
	Evident when the teacher…	Example	Evident when the maths educator…	Example
Knowledge of examples	Uses an example that highlights a concept or procedure	Uses the 5-12-13 Pythagorean triangle to model how to solve a right-angled triangle problem	Uses an example that highlights an SMTPCK concept	Uses an example of student work to show a misconception and find evidence of how it arose
Knowledge of resources	Discusses/uses resources available to support teaching	Identifies and uses a mathematics website that is useful for students	Discusses/uses resources that support SMTPCK teaching	Uses research papers about an aspect of SMTPCK as a stimulus for class discussion with PSTs
Curriculum knowledge	Discusses how topics fit into the curriculum	Recognises that multiplication should be understood by Year 4	Discusses how SMTPCK topics fit into the teacher education curriculum	Explains that knowing "mathematical structure and connections" helps with lesson sequencing
Purpose of content knowledge	Discusses reasons for content being included in the curriculum or how it might be used	Knows that knowledge of rounding is needed for money transactions	Discusses reasons for SMTPCK content being included in the teacher education curriculum or how it might be used	Explains how knowledge of misconceptions aids the design and interpretation of multiple choice test distractors
Content knowledge in a pedagogical context				
(Beliefs about) The nature of content	Expresses an appreciation of the nature of mathematics that goes beyond the school curriculum and aligns with mathematicians' view of the discipline	Compares the aesthetic qualities of two solution methods	Expresses an appreciation of SMTPCK that goes beyond the teacher education curriculum to include critique of the content and its conceptualisations	Discusses the relative merits of alternative static and dynamic conceptualisations/models of SMTPCK
Profound understanding of fundamental content	Exhibits deep and thorough conceptual understanding of identified aspects of mathematics [i.e. Profound Understanding of Fundamental Mathematics (Ma 1999)]	Understands why we "invert and multiply" when dividing fractions	Exhibits deep and thorough conceptual understanding of identified aspects of SMTPCK	Identifies and explains the importance of identifying and addressing student misconceptions evident in a teaching episode

Table 1 continued

PCK category	PCK for school mathematics teachers (SMTPCK)		PCK for mathematics teacher educators (MTEPCK)	
	Evident when the teacher…	Example	Evident when the maths educator…	Example
Deconstructing Content to Key Components	Identifies critical mathematical components within a concept that are fundamental for understanding and applying that concept	Refers to the importance of the distributive law in the long multiplication algorithm	Identifies SMTPCK components within a concept that are fundamental for understanding and applying that concept	Identifies critical aspects of content knowledge, cognitive demand, misconceptions, and representations that affect the design of an assessment task
Structure and connections	Makes connections between mathematical concepts and topics, including interdependence of concepts	Links percentages with decimals and the base 10 system	Makes connections among SMTPCK concepts and topics, including interdependence of concepts	Recognises that the SMTPCK framework has overlapping components (e.g. PUFM can help evaluate cognitive demand)
Procedural knowledge	Displays skills for solving mathematical problems (conceptual understanding need not be evident)	Can apply the long division algorithm	Displays skills for solving SMTPCK problems (conceptual understanding need not be evident)	Uses the strategy of "reverse questions" as a potential way for constructing an open ended task
Methods of solution	Demonstrates a method for solving a mathematical problem	Adds fractions using both an algorithm and a visual representation	Demonstrates a method for solving an SMTPCK problem	If a PST asks how to help a student, the MTE suggests possible models or explanations that might help
Pedagogical knowledge in a content context				
Assessment approaches	Discusses or designs tasks, activities or interactions that assess learning outcomes	Designs a multiple choice quiz with appropriate distractors	Discusses or uses assessment tasks purposefully to evaluate PSTs' knowledge of SMTPCK	Uses a "lesson-plan assignment" to examine PSTs' understanding of planning for student learning
Goals for learning	Describes a goal for students' learning	Justifies an activity as developing understanding of long-term probability	Describes a goal for PSTs' learning	Plans to build PSTs' capacity to develop appropriate questioning techniques for running whole class discussions
Getting and maintaining student focus	Discusses or uses strategies for engaging students	Designs a puzzle that is solved by answering some routine exercises	Discusses or uses strategies for engaging PSTs	Shows a student work sample and asks PSTs to find and explain the error

Table 1 continued

PCK category	PCK for school mathematics teachers (SMTPCK)		PCK for mathematics teacher educators (MTEPCK)	
	Evident when the teacher…	Example	Evident when the maths educator…	Example
Classroom techniques	Discusses or uses generic classroom practices	Talks about grouping students according to ability levels	Discusses or uses generic classroom practices	Uses "think-pair-share" as a way for PSTs to come up with a counterexample for a child's erroneous reasoning
Student affect (general)	Describes how student affect influences pedagogical approach	Knows a particular student will respond to negatively to being asked for an answer in a large group session	Discusses typical PST affective reactions to learning about SMTPCK	Discusses the importance of helping PSTs to appreciate the classroom relevance of what they are learning about SMTPCK

Sources: Chick (2007) (near-complete presentation of SMTPCK); Chick et al. (2006) (earlier partial presentation of SMTPCK); Baker (2008) (some illustrative examples of SMTPCK); Chick and Beswick (2013) (first presentation of MTEPCK framework)

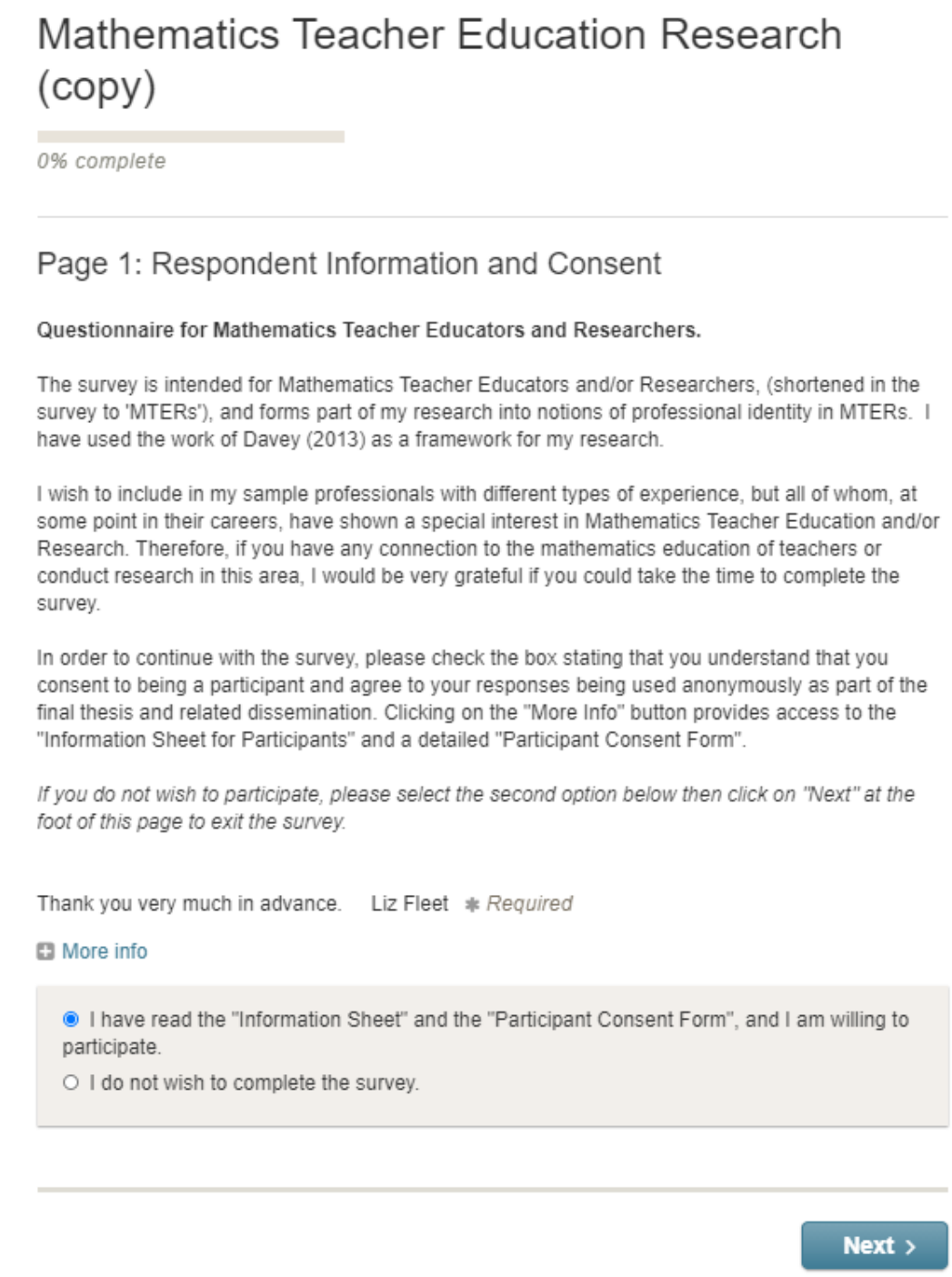
Appendix B1 The Survey Questionnaire

Please note the labelling of the survey questions appears differently dependent on the view requested when the survey results are presented in the Online Survey tool.

In this section the view obtained when previewing the survey is presented in order to illustrate what the participant sees. However, for clarity, I also refer to the Questionnaire Sections as they appear when presented in the Results Format of the Online Survey tool. These Questionnaire Sections (QS) are referred to within the body of the thesis within Section 3.3.5 “Structure of the Questionnaire” and summarised in Table 3.1 within that section.

This feature of the Online Survey tool is perhaps something that could be improved so as to ensure the viewing formats match in terms of their references to survey question numbers specifically.

The first page is referred to as Questionnaire Section 1 (QS1) when presented in Results Format.



Mathematics Teacher Education Research (copy)

0% complete

Page 1: Respondent Information and Consent

Questionnaire for Mathematics Teacher Educators and Researchers.

The survey is intended for Mathematics Teacher Educators and/or Researchers, (shortened in the survey to 'MTERs'), and forms part of my research into notions of professional identity in MTERs. I have used the work of Davey (2013) as a framework for my research.

I wish to include in my sample professionals with different types of experience, but all of whom, at some point in their careers, have shown a special interest in Mathematics Teacher Education and/or Research. Therefore, if you have any connection to the mathematics education of teachers or conduct research in this area, I would be very grateful if you could take the time to complete the survey.

In order to continue with the survey, please check the box stating that you understand that you consent to being a participant and agree to your responses being used anonymously as part of the final thesis and related dissemination. Clicking on the "More Info" button provides access to the "Information Sheet for Participants" and a detailed "Participant Consent Form".

If you do not wish to participate, please select the second option below then click on "Next" at the foot of this page to exit the survey.

Thank you very much in advance. Liz Fleet * *Required*

More info

- (●) I have read the "Information Sheet" and the "Participant Consent Form", and I am willing to participate.
- ( ) I do not wish to complete the survey.

Next >

This page appears as Questionnaire Section 2 (QS2.1 to QS2.8) when presented in Results Format and the open-ended text box as QS2a.

Mathematics Teacher Education Research (copy)

12% complete

Page 2: Section 1.1 : 'Becoming' an MTER - Motivations

This part of the survey uses a table of questions, view as separate questions instead?

Please read through all the statements outlining possible reasons for becoming an MTER. For each one, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I felt I was ready for a greater educational challenge.	☐	☐	☐	☐	☐
I wanted to share my understanding of mathematics teaching and learning with others.	☐	☐	☐	☐	☐
I saw it as an opportunity to specialise in mathematics.	☐	☐	☐	☐	☐
I saw it as an opportunity to combine mathematics with my interest in pedagogy.	☐	☐	☐	☐	☐
I wanted to develop further my own understanding of mathematics teaching and learning.	☐	☐	☐	☐	☐
I was interested to pursue research in the area of mathematics education.	☐	☐	☐	☐	☐
I saw a role in teacher education as a natural extension of what I had been doing in school.	☐	☐	☐	☐	☐
It was part of my career plan.	☐	☐	☐	☐	☐

Please note any other specific motivations for becoming an MTER especially if not covered in the options above.

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Finish later

Note this page appears as Questionnaire Section 3 (QS3.1 to QS3.4) when presented in Results Format and the open-ended text box as QS3a.

Mathematics Teacher Education Research (copy)

25% complete

Page 3: Section 1.2: 'Becoming' an MTER – Induction and Aspirations

This part of the survey uses a table of questions, view as separate questions instead?

Please read all the statements relating to induction into the role of MTER. For each statement, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
Experiences and knowledge gained previously were of significant help in enabling me to become an MTER.	☐	☐	☐	☐	☐
When I was new to the role, I was able to observe, plan or work alongside other MTERs.	☐	☐	☐	☐	☐
When I took up my role as an MTER, I was formally inducted into this role by an experienced tutor.	☐	☐	☐	☐	☐
I had a strong role model who was the focus of my aspiration.	☐	☐	☐	☐	☐

Please add any comments you wish to make concerning the support and challenges as you started out in your MTER role.

Note this page appears as Questionnaire Section 4 (QS4.1 to QS4.6) when presented in Results Format and the open-ended text box as QS4a and QS4b respectively.

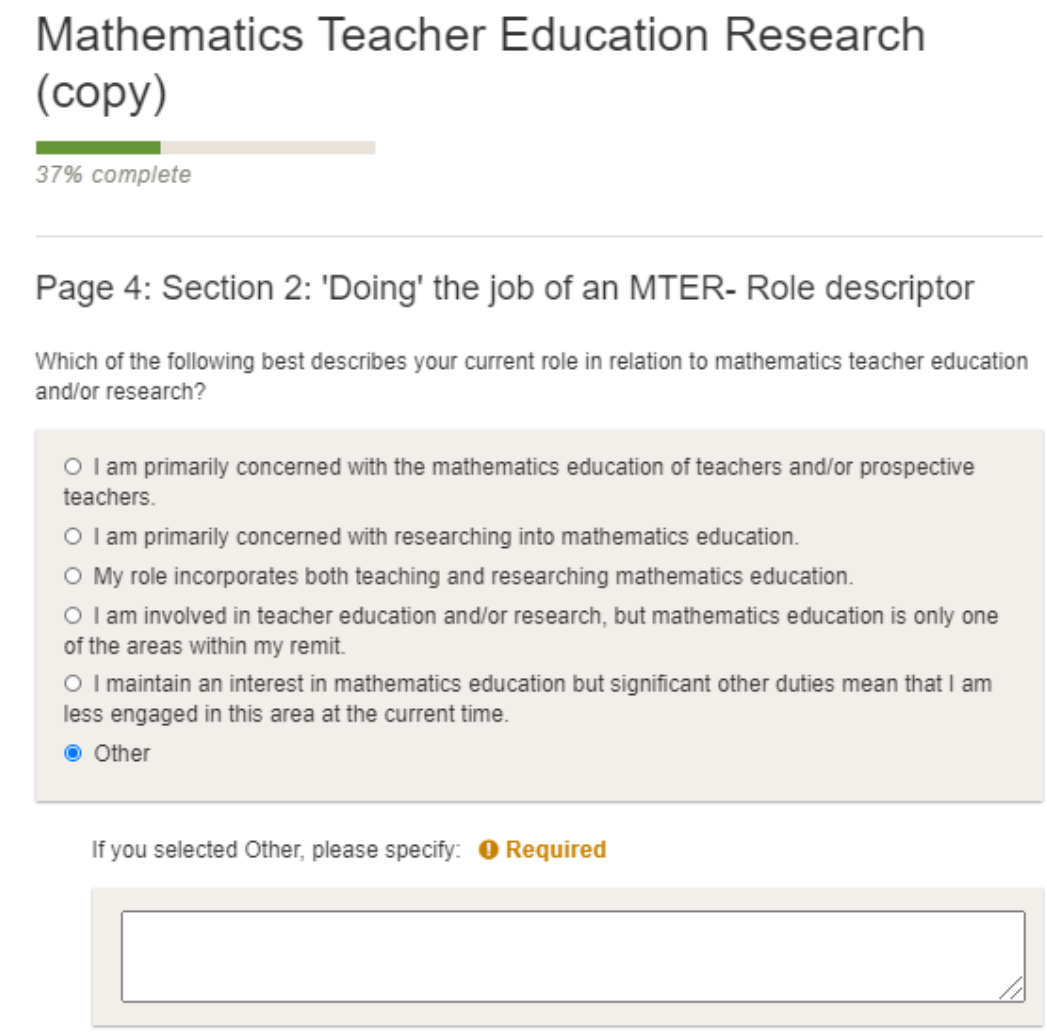
Please read the statements relating to ongoing development as an MTER. For each statement, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I am keen to understand my role as an MTER and to develop it further.	☐	☐	☐	☐	☐
I think I have developed in my role as an MTER over time.	☐	☐	☐	☐	☐
I see my own professional development as a crucial part of being an MTER.	☐	☐	☐	☐	☐
I see being an MTER mainly as a stepping stone to other roles.	☐	☐	☐	☐	☐
I view my role as MTER as the major focus of my career.	☐	☐	☐	☐	☐
I feel that I have gone as far as I can in developing my role as an MTER.	☐	☐	☐	☐	☐

What has been significant in supporting your development as an MTER?

Note down any factors, should they exist, which may have impeded your development in the role.

Note this page appears as Questionnaire Section 5 (QS5) when presented in Results Format and the open-ended text box as QS5a.

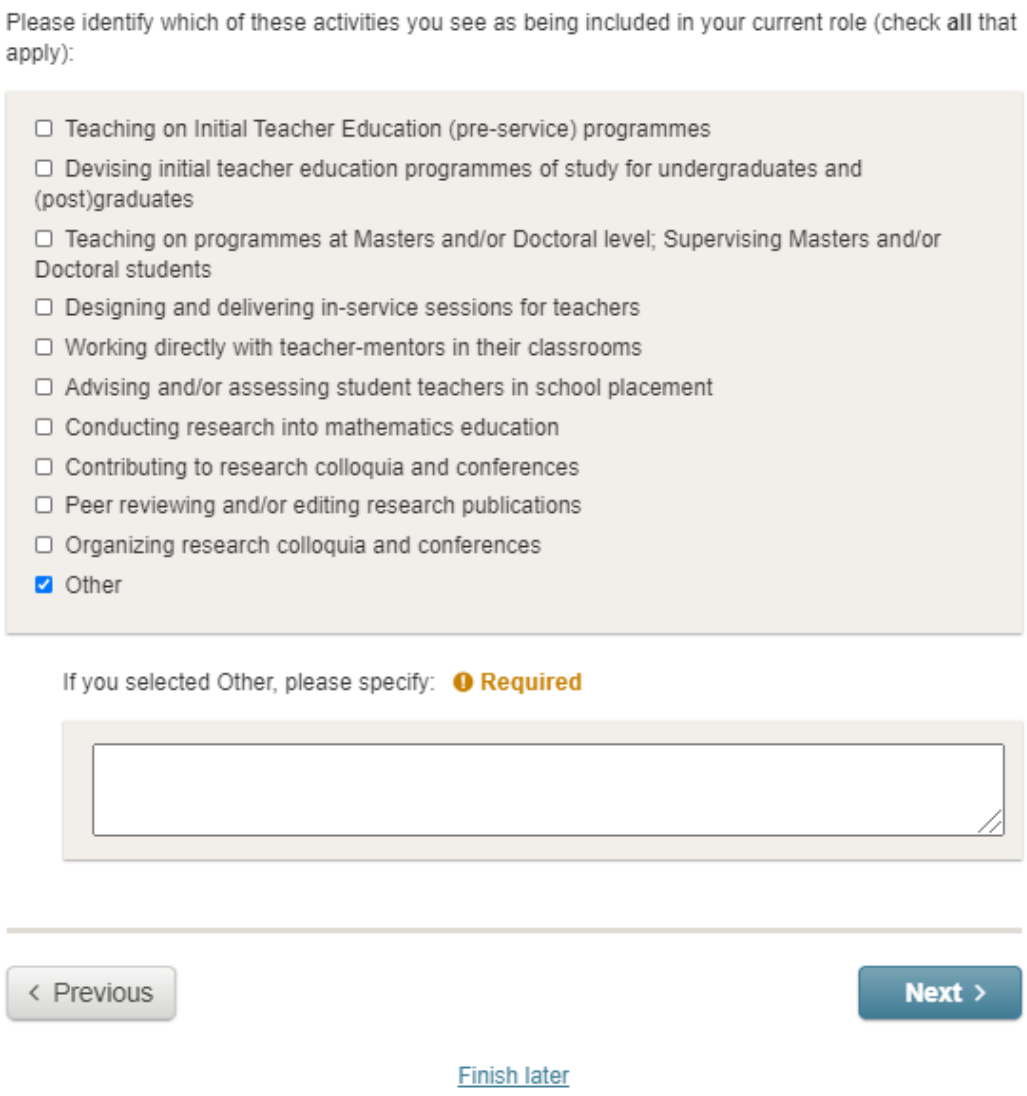


Note this page appears as Questionnaire Section 6 (QS6.1 – QS6.4) when presented in Results Format.

Please read through the statements relating to understanding of roles and responsibilities as an MTER. For each one, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I have a full job description which sets out my key roles and responsibilities as an MTER.	☐	☐	☐	☐	☐
A list of the professional activities undertaken by an MTER cannot fully encapsulate the role.	☐	☐	☐	☐	☐
I personally set my own agenda of priorities and commitments in my role as an MTER.	☐	☐	☐	☐	☐
I see the main focus of the role is to engage in teaching rather than research activity.	☐	☐	☐	☐	☐

Note this section appears as Questionnaire Section 7 (QS7) when presented in Results Format. Where participants checked the "Other" option box, they were asked to specify which activities (reflected as response QS7a).



Note this following two screen images (over two pages for legibility) appear as Questionnaire Section 8 (QS8.1 to QS8.8) when presented in Results Format and the open-ended text box as QS8a.

Mathematics Teacher Education Research (copy)

50% complete

Page 5: Section 3: 'Knowing' - Knowledge & Expertise of an MTER

This part of the survey uses a table of questions, view as separate questions instead?

Please read the items listed below of what may be considered as the 'knowledge requirements' of an MTER. For each one, check the box which most nearly reflects your level of agreement that the item specified is a necessity.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
Specific minimum academic qualifications.	☐	☐	☐	☐	☐
An extensive knowledge base in regard to mathematics teaching and learning.	☐	☐	☐	☐	☐
A single consistent view of how best to teach particular aspects of the subject.	☐	☐	☐	☐	☐
A deeper understanding of mathematics subject knowledge than that held by most classroom teachers.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
A different skill set to the ones applied in the education of teachers in other subject areas.	☐	☐	☐	☐	☐
A thorough understanding of pedagogical approaches.	☐	☐	☐	☐	☐
A good understanding of how student teachers learn to teach.	☐	☐	☐	☐	☐
A detailed knowledge of the relevant school curriculum expectations.	☐	☐	☐	☐	☐

In brief, what do you consider the essential knowledge, skills and expertise required by MTERs.

Note this section appears as Questionnaire Section 9 (QS9.1 – QS9.5) when presented in Results Format and the open-ended text box as QS9a.

Below are a list of possible sources of information which may support someone in the role of MTER. For each one, check the box which most nearly matches your level of reference to the particular type of source.

	Do not use (or not applicable)	Use infrequently	Use quite often	Use very often
Library stock of academic books and journals including those accessed electronically	☐	☐	☐	☐
Personal collection of academic books	☐	☐	☐	☐
Personal collection of resource books for teachers	☐	☐	☐	☐
My own experiences as a teacher and/or researcher	☐	☐	☐	☐
Information gained by attending conferences aimed specifically at MTERs	☐	☐	☐	☐

Please list your preferred sources of information, especially if not covered above.

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Note this section appears as Questionnaire Section 10 (QS10.1 – QS10.4) when presented in Results Format and the open-ended text box as QS10a.

Mathematics Teacher Education Research (copy)

62% complete

Page 6: Section 4: 'Being' an MTER – Personal Attributes

This part of the survey uses a table of questions, view as separate questions instead?

Please read the statements concerning possible attributes needed in order to be an MTER. For each one, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I think it takes a particular kind of personality to be an MTER.	☐	☐	☐	☐	☐
In order to be an MTER, you need to possess specific attributes and qualities.	☐	☐	☐	☐	☐
MTERs need a clearly thought through philosophy of education.	☐	☐	☐	☐	☐
Established MTERs should be making a significant contribution to research in their field.	☐	☐	☐	☐	☐

Please note any qualities, attributes or values that you feel are vital to being an MTER.

Note this section appears as Questionnaire Section 11 (QS11.1 – QS11.6) when presented in Results Format and the open-ended text box as QS11a.

Please read the statements reflecting personal views on being an MTER. For each one, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I derive great satisfaction from my role as MTER.	☐	☐	☐	☐	☐
I am sometimes anxious about aspects of my role as MTER.	☐	☐	☐	☐	☐
I see MTERs as upholding specific values within the education profession.	☐	☐	☐	☐	☐
I have a clear understanding of what it takes to be an MTER.	☐	☐	☐	☐	☐
Being an MTER is often very challenging.	☐	☐	☐	☐	☐
The values of an MTER are inherently different from those upheld by specialists in other subjects/areas of education.	☐	☐	☐	☐	☐

Please add any further comments you might have about being an MTER.

Note this section appears as Questionnaire Section 12 (QS12.1 – QS12.5) when presented in Results Format and the open-ended text box as QS12a.

Page 7: Section 5: 'Belonging' as an MTER

This part of the survey uses a table of questions, view as separate questions instead?

Please read the statements reflecting status within the MTER community. For each one, please check the box most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I feel that I have established good working relationships with many other MTERs.	☐	☐	☐	☐	☐
Where I work, I feel fairly isolated in my role as an MTER.	☐	☐	☐	☐	☐
I benefit from membership of professional organisations which focus on mathematics teacher education.	☐	☐	☐	☐	☐
With the contacts I have with other MTERs, I feel as if I am part of a community of like-minded individuals.	☐	☐	☐	☐	☐
I feel that my work is well-known and well-respected by other MTERs.	☐	☐	☐	☐	☐

Please add any further comments which elaborate on your views of being part of a community or feeling isolated if either one applies to you.

Note this section appears as Questionnaire Section 13 (QS13.1 – QS13.6) when presented in Results Format and the open-ended text box as QS13a.

Please read the statements concerning collaboration with other MTERs. For each statement, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I engage in online dialogue with other MTERs.	☐	☐	☐	☐	☐
I regularly engage in discussions with other MTERs at colloquia and conferences.	☐	☐	☐	☐	☐
I often present the results of my research at conferences and/or via peer-reviewed journals.	☐	☐	☐	☐	☐
I have engaged in research and/or teaching projects with other MTERs.	☐	☐	☐	☐	☐
I enjoy my viewpoints being challenged by colleagues at conferences.	☐	☐	☐	☐	☐
I am currently, or have been in the past, actively engaged in organising conferences, reviewing research papers for publication or editing journals.	☐	☐	☐	☐	☐

Please elaborate on ways in which you have interacted with other MTERs and note any types of collaboration which differ from those covered above.

Note the sections below appear as Questionnaire Section 14 (QS14) and Section 15 (QS15.1 – QS15.4) when presented in Results Format, and the open-ended text box as QS13a.

Are you currently a Mathematics Teacher Educator or Researcher who is based in a University?

- ○ Yes
- ○ No

If you answered "Yes" to the question above, please read the statements below and for each one, check the box which most nearly matches your level of agreement.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I feel that university MTERs have an important role to play in teacher education.	☐	☐	☐	☐	☐
My impression is that student teachers value input into their programmes by university MTERs.	☐	☐	☐	☐	☐
I find that teachers welcome the opportunity to engage with university MTERs.	☐	☐	☐	☐	☐
Within my national context, the role of the university MTER is well-regarded.	☐	☐	☐	☐	☐

Elaborate further on your perceptions of the value of the role of the University MTER from (a) your perspective and (b) the perspective of others (please specify).

Note the section below appears as Questionnaire Sections 16 to 18 (QS16, QS17, QS18 and QS18a respectively) when presented in Results Format.

Page 8: Personal Information

Please note:
All information supplied is confidential. Data will only be used in statistical summaries or anonymised narrative to illustrate points made within the study. Email addresses may be used as a means of contacting you, in order to clarify responses or possibly to explore your views further.

Please look through the information below. If any is incorrect or out of date, please amend it.

Your Name: * *Required*

Email Address: * *Required*

Please enter a valid email address.

For which University, Local Authority, SCITT or other organisation are you currently working? If you are self-employed, please write "none" * *Required*

In which country is this located? * *Required*

Note the questions below appear as Questionnaire Sections 19 to 21 (QS19, QS20 and QS21 respectively, and QS21a for the open-ended response box) when presented in Results Format.

Which phases of mathematics education/schooling are you concerned with? (Check all that apply to your role)

- ☐ Early years / Kindergarten
- ☐ Primary / Elementary
- ☐ Secondary / High School
- ☐ Further/Continuing Education
- ☐ Higher Education/University

For how many years have you been involved in Teacher Education?
Please select the nearest time-period:

- ○ This is my first year
- ○ 1-2 years
- ○ 3-5 years
- ○ 6-10 years
- ○ 11-15 years
- ○ More than 15 years

What pre-university mathematics qualifications have you gained?
Please choose all that apply:

Please select at least 1 answer(s).

- ☐ End of compulsory schooling certificate in mathematics (e.g. GCSE/equivalent)
- ☐ 'A' level (or equivalent) in mathematics, or mathematics-related subject
- ☐ Other

If you selected Other, please specify: **Required**

Note the section below appears as Questionnaire Sections QS22.1, QS22.2, QS22.3 and QS22.4 according to the qualifications listed when presented in Results Format.

Please check all the boxes which most accurately describe your post-compulsory education qualifications.

You may check more than one box in each row, or omit rows entirely.

	Included mathematics as a subject discipline	Included mathematics-education as a key area of study	Not focused on mathematics as a subject discipline or mathematics education
Undergraduate Degree or equivalent	☐	☐	☐
PGCE or equivalent	☐	☐	☐
Masters' Degree	☐	☐	☐
Doctorate	☐	☐	☐

Note the final section below appears as Questionnaire Section QS23.

Please list any Professional Associations of which you are a member.

End of Survey

Please click on "Finish√" on the bottom right of this page.

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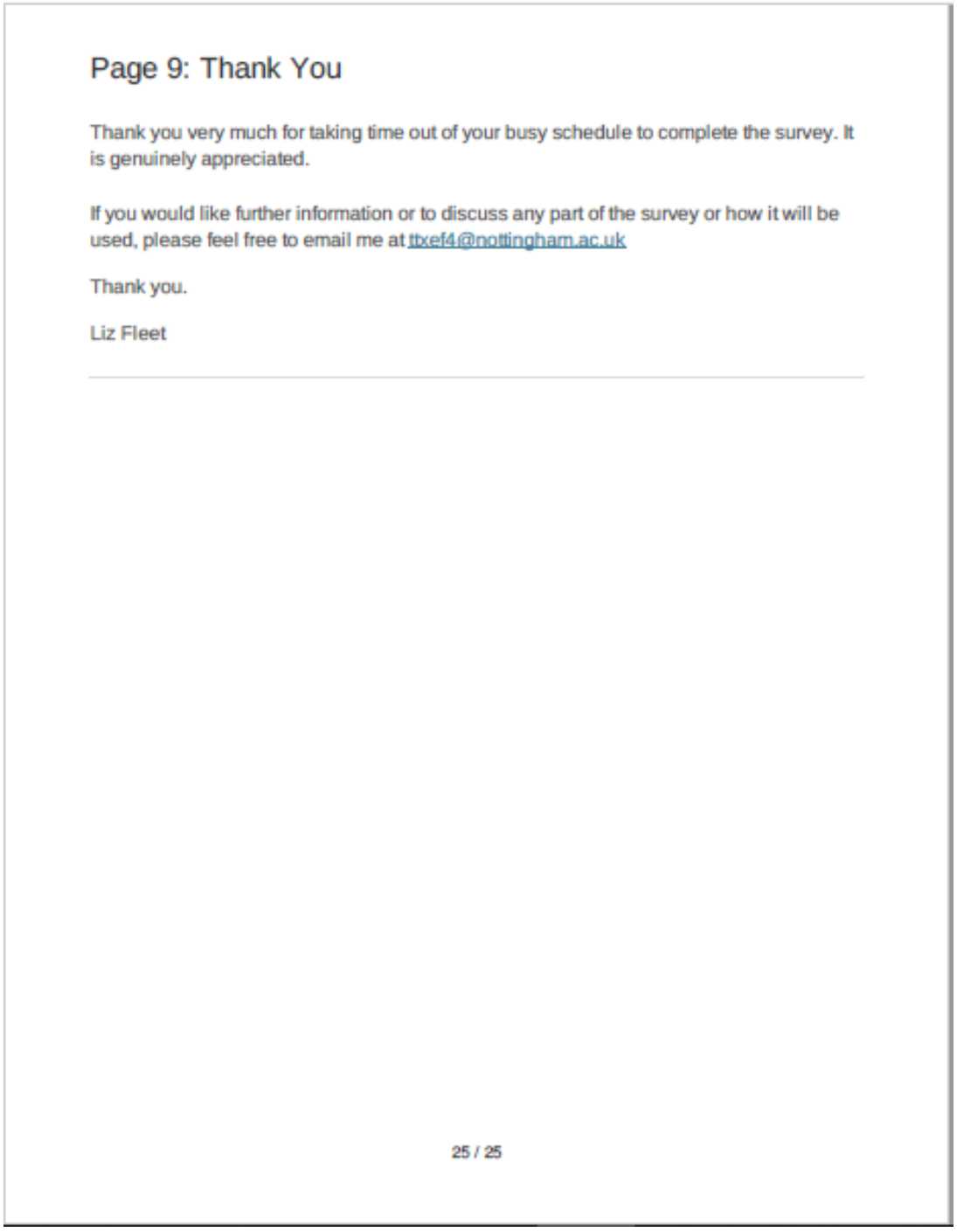
Finish ✔

Finish later

The final page of the survey offers participants a note of thanks.



Page 9: Thank You

Thank you very much for taking time out of your busy schedule to complete the survey. It is genuinely appreciated.

If you would like further information or to discuss any part of the survey or how it will be used, please feel free to email me at ttxef4@nottingham.ac.uk

Thank you.

Liz Fleet

25 / 25

Appendix B2 Questionnaire Information and Consent

Accompanying the Questionnaire were two forms:

- An Information Sheet (Appendix B2.1)
- A Consent Form (Appendix B2.2)

The documents were attached to the survey and were available for participants to download and read prior to agreeing to participate. They formed part of the ethical considerations discussed in Section 3.3.10, which required informed consent from participants.

The Information Sheet sets out the purposes of the study, how potential participants have been identified and what will be required of them, how their data will be treated, and their rights in agreeing to participate or withdraw from the study at any stage

The *Consent Form* explains what the participant is agreeing to, and explains that they are agreeing to consent by filling in the check box and proceeding to answer the items.

Just in case these were not downloaded, the information in these forms is summarised on the opening page of the questionnaire, so that potential participants see it before they can click the “proceed” button and undertake the survey.

B2.1 Questionnaire Information Sheet

Below the line is the Information Sheet which accompanied the Questionnaire.

Information Sheet for Research Participants

Aims of the Study

The study forms the basis of my doctoral thesis in which I seek to investigate the notion of "professional identity" in Mathematics Teacher Educators and Researchers. I am keen to consider whether such a concept of 'professional identity' exists in regard to professionals engaged in mathematics teacher education and/or research, to explore ways in which professional identity might manifest itself or be recognised, and to undertake some analysis of the attributes that may be connected with it.

How have participants been identified?

An intensive search of the online profiles of university 'Education Faculty' staff both in the UK and the USA has been undertaken to identify potential participants to be invited to take part in the research study. Colleagues who were identifiable, from their profiles, as having some involvement in mathematics teacher education programmes and/or related research were selected. In the main, the colleagues were selected because they either teach or research, or both, in the area of primary and/or secondary mathematics teacher education. In addition to this, some participants have been identified because we have met previously through professional engagement in teacher education activity, or their names have been included on the 'list of delegates', where these were supplied, in attendance at conferences or workshops that I have previously attended. This latter source has enabled me to select some school-based colleagues involved in mathematics teacher education.

What will be required of participants?

The mathematics teacher educators and/or researchers ("MTERs") invited to participate in this research are asked to complete an online questionnaire which is estimated to take approximately 30 minutes.

A sub-group of those completing the questionnaire will be asked if they are willing to undertake face to face or skype interviews anticipated to last between 45 and 60 minutes.

Confidentiality and Security of Information

Data resulting from responses to questionnaires and interviews will be stored electronically in a password protected system. Where hard copies of data may be printed to support analyses, these will be locked securely in a filing cabinet. The data will be used purely for the purposes of the research study (including dissemination of findings). No-one other than research colleagues, supervisors or examiners will have access to any of the data collected prior to it being anonymised. The original data will be destroyed after the research and its reporting is complete, and permission is obtained from the University of Nottingham.

Participation in the Research

Participation in the research is completely voluntary and participants are at liberty to withdraw at any time from the study should they choose to do so. In participating it is important that the questions are answered as honestly and candidly as is possible, clarifying personal perspectives where appropriate. Any concerns should be communicated to me, as researcher, and I will endeavour to alleviate these in negotiation with my supervisor, if appropriate. Participants also have the right to contact the education research ethics committee should the need arise.

Contact Details:

The Researcher Elizabeth (Liz) Fleet ttxef4@nottingham.ac.uk

Research Supervisor Dr. Philip Hood ttaph6@nottingham.ac.uk

Ethics Research Co-ordinator EDUCATIONRESEARCHETHICS@NOTTINGHAM.AC.UK

B2.2 Questionnaire Consent Form

Below the line is the Consent Form which accompanied the questionnaire.

PARTICIPANT CONSENT FORM

Project title: An investigation into 'professional identity' in Mathematics Teacher Educators and Researchers (MTERs)

Researcher's name Elizabeth Fleet **Supervisor's name** Dr. Philip Hood

- I have read the Participant Information Sheet in which the research project has been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be personally identified and my responses will remain confidential.
- I understand that data resulting from responses to questionnaires will be stored electronically. Data files will be stored in a safe and secure location in a personal password-protected electronic space, and will be used purely for the purposes of the research project (including dissemination of findings). No-one other than research colleagues, supervisors or examiners will have access to any of the data collected prior to it being anonymized. Once the study is complete, and permission from the University of Nottingham has been granted, the data will be deleted.
- I understand that I may contact the researcher if I require further information or have any concerns about my involvement in the research. I acknowledge receipt of the relevant contact email addresses (provided below) should I need further information or wish to contact the Research Ethics Coordinator of the School of Education at the University of Nottingham.

To provide your consent as a PARTICIPANT in the questionnaire stage of this research, you are asked to please check the box on the online survey.

Contact details:

Researcher: Liz Fleet *ttxef4@nottingham.ac.uk*

Supervisor: *Dr. Philip Hood* *ttaph6@nottingham.ac.uk*

School of Education Research Ethics Coordinator:

educationresearchethics@nottingham.ac.uk

Appendix C1 Chapter 5 Factor Analysis Additional Tables

The tables below are generated by SPSS (Statistical Package for the Social Sciences).

Table L1: Initial Principal Components Analysis

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.881	14.329	14.329	7.881	14.329	14.329
2	5.999	10.907	25.236	5.999	10.907	25.236
3	3.092	5.621	30.857	3.092	5.621	30.857
4	2.796	5.083	35.940	2.796	5.083	35.940
5	2.590	4.708	40.648	2.590	4.708	40.648
6	2.066	3.757	44.405	2.066	3.757	44.405
7	2.002	3.640	48.045	2.002	3.640	48.045
8	1.711	3.110	51.155	1.711	3.110	51.155
9	1.684	3.061	54.217	1.684	3.061	54.217
10	1.559	2.835	57.052	1.559	2.835	57.052
11	1.512	2.749	59.801	1.512	2.749	59.801
12	1.350	2.454	62.255	1.350	2.454	62.255
13	1.245	2.263	64.518	1.245	2.263	64.518
14	1.217	2.213	66.731	1.217	2.213	66.731
15	1.054	1.916	68.647	1.054	1.916	68.647
16	.987	1.794	70.442			
17	.966	1.756	72.197			
18	.913	1.660	73.857			
19	.879	1.597	75.455			
20	.819	1.489	76.944			
21	.812	1.477	78.421			

22	.810	1.472	79.893			
23	.742	1.350	81.243			
24	.680	1.236	82.478			
25	.648	1.178	83.656			
26	.631	1.148	84.804			
27	.612	1.113	85.917			
28	.567	1.031	86.948			
29	.531	.966	87.914			
30	.495	.900	88.814			
31	.491	.892	89.707			
32	.456	.828	90.535			
33	.435	.790	91.325			
34	.408	.742	92.067			
35	.378	.687	92.754			
36	.361	.656	93.410			
37	.348	.633	94.043			
38	.325	.591	94.634			
39	.300	.546	95.179			
40	.277	.503	95.682			
41	.273	.496	96.179			
42	.245	.445	96.624			
43	.233	.424	97.048			
44	.226	.411	97.460			
45	.191	.348	97.807			
46	.184	.335	98.142			
47	.163	.296	98.438			
48	.150	.272	98.710			
49	.144	.262	98.972			
50	.124	.225	99.197			
51	.106	.193	99.390			

52	.098	.179	99.569			
53	.089	.161	99.730			
54	.083	.151	99.881			
55	.065	.119	100.000			

Extraction Method: Principal Component Analysis.

Table L5: Component Loadings on the Rotated Factors

Rotated Component Matrix[a]

	Component	
	1	2
Item2_1	.119	.341
Item2_2	.050	**.533**
Item2_3	.146	.342
Item2_4	.238	.359
Item2_5	.322	.319
Item2_6	.514	-.122
Item2_7	.156	.417
Item2_8	.205	.179
Item3_1	.208	.375
Item3_2	.318	.049
Item3_3	.159	.228
Item3_4	.360	.193
Item4_1	.358	.351
Item4_2	.390	.267
Item4_3	.509	.241
Item4_4	-.129	-.045
Item4_5	.427	.338
Item4_6	-.223	.054

Item6_1	.034	.454
Item6_2	.293	.203
Item6_3	.264	-.263
Item6_4	-.453	.431
Item8_1	-.001	.134
Item8_2	.109	.447
Item8_3	-.230	.320
Item8_4	-.035	.477
Item8_5	.213	.049
Item8_6	-.006	**.535**
Item8_7	.046	**.657**
Item8_8	-.182	**.643**
Item10_1	-.031	.388
Item10_2	-.028	**.532**
Item10_3	-.042	**.598**
Item10_4	.303	.085
Item11_1	.425	**.566**
Item11_2	-.061	.297
Item11_3	-.050	**.504**
Item11_4	-.033	**.514**
Item11_5	.058	.143
Item11_6	-.107	-.061
Item12_1	.598	.321
Item12_2	-.187	-.174
Item12_3	.472	.148
Item12_4	.551	.301
Item12_5	**.709**	-.022
Item13_1	**.687**	-.096
Item13_2	**.767**	-.155
Item13_3	**.733**	-.387

Item13_4	**.729**	-.163
Item13_5	.618	-.098
Item13_6	**.689**	-.233
Item15_1	.310	**.573**
Item15_2	.208	**.587**
Item15_3	.267	.284
Item15_4	.164	.184

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table L8 Factor Analysis (5 components) Rotated Factor Analysis for 5 Components suppressing all loadings less than 0.4

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
Item2_1		.419			
Item2_2					
Item2_3		.558			
Item2_4		.420			
Item2_5		.638			
Item2_6	.477	.487			
Item2_7		.485			
Item2_8		.522			
Item3_1				.458	

Item3_2					.730
Item3_3					.634
Item3_4		.416			.507
Item4_1		.456			
Item4_2				.410	
Item4_3		.631			
Item4_4					
Item4_5		.588			
Item4_6					
Item6_1					
Item6_2					
Item6_3					
Item6_4	-.562		.412		
Item8_1				.428	
Item8_2				.752	
Item8_3					
Item8_4				.564	
Item8_5					
Item8_6				.772	
Item8_7				.660	
Item8_8				.675	
Item10_1			.678		
Item10_2			.679		
Item10_3			.529		
Item10_4					
Item11_1			.513		
Item11_2		.416			
Item11_3			.571		
Item11_4			.455		
Item11_5					

Item11_6					-.402
Item12_1	.411				.464
Item12_2					-.570
Item12_3					
Item12_4					.404
Item12_5	.663				.417
Item13_1	.699				
Item13_2	.769				
Item13_3	.853				
Item13_4	.728				
Item13_5	.708				
Item13_6	.775				
Item15_1		.508	.400		
Item15_2			.450		
Item15_3			.448		
Item15_4					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

This yields factors approximating to (1) Research Collaboration (2) Personal Development (3) Attributes and Values, (4) Knowledge and (5) Community

Appendix C2: Davey's Lenses – Correlational Analysis

The material below is related to the Discussion in 5.8.2, and is provided for completeness.

In the discussions which follow, all correlations quoted are based variously on N= 138 to N=144. Taking the lower figure, a correlation coefficient of r= +/- 0.17 is significant at the 5% level (two-tailed), with r= +/- 0.24 at the 0.5% level, and r= +/- 0.28 at the 0.1% level (Zaiontz, 2019). In Tables H8-H13 which follow, all correlations of 0.25 and above, or -0.25 and below have been highlighted. These values lie outside the three-sigma limits comprising 99.7% of all values which might be expected to occur if there were no correlation between items, which will be used to indicate the degree to which there is internal consistency between the responses to items within a specific lens.

C2.1 *Becoming*

There are 18 items in three questionnaire sections: 8 on motivation (QS2); 4 on induction (QS3); and, 6 on ongoing development (QS4). Just under half of all correlations are statistically significant, with a third of these above r=0.25. However, most of the correlations are intra-sectional, rather than inter-sectional correlations, for example with items on motivations and induction being internally well correlated as cohesive units, but with lower correlations between items in different questionnaire sections, where almost all fall below even a 5% level of significance. Correlations between QS2 and QS4, are somewhat stronger, but still less than one third are significant, even at the 5% level. QS3 and QS4 show similar levels of inter-sectional consistency, this is due to strong correlations between QS4.2 (Role Development) and QS3.4 (Role Model) with items in the other questionnaire sections.

Chart H8: Tables of Correlations between the "being" items.

	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4	4.5	4.6
2.1	1.00	0.33	0.29	0.17	0.35	0.20	0.30	0.18	0.18	0.08	0.17	0.19	0.16	0.30	0.16	0.11	0.14	0.11
2.2	0.33	1.00	0.16	0.26	0.23	0.08	0.29	0.07	0.30	0.15	0.13	0.16	0.08	0.15	0.26	-0.06	0.17	0.07
2.3	0.29	0.16	1.00	0.44	0.25	0.21	0.21	0.24	0.10	0.01	0.11	0.11	0.05	0.06	0.23	-0.03	0.30	0.01
2.4	0.17	0.26	0.44	1.00	0.38	0.23	0.32	0.14	0.07	0.13	0.06	0.14	-0.02	0.04	0.16	-0.10	0.10	-0.06
2.5	0.35	0.23	0.25	0.38	1.00	0.35	0.41	0.27	0.03	0.00	0.10	0.16	0.14	0.01	0.28	0.00	0.30	-0.04
2.6	0.20	0.08	0.21	0.23	0.35	1.00	0.08	0.32	0.01	-0.02	-0.08	0.13	0.18	0.19	0.31	0.12	0.22	-0.26
2.7	0.30	0.29	0.21	0.32	0.41	0.08	1.00	0.25	0.08	0.10	0.14	0.11	0.06	0.06	0.20	0.02	0.35	0.00
2.8	0.18	0.07	0.24	0.14	0.27	0.32	0.25	1.00	0.04	0.06	0.14	0.27	0.13	0.10	0.26	0.21	0.25	-0.01
3.1	0.18	0.30	0.10	0.07	0.03	0.01	0.08	0.04	1.00	0.26	0.12	0.09	0.07	0.31	0.15	-0.18	-0.02	-0.09
3.2	0.08	0.15	0.01	0.13	0.00	-0.02	0.10	0.06	0.26	1.00	0.56	0.44	0.13	0.30	0.22	-0.12	0.07	-0.17
3.3	0.17	0.13	0.11	0.06	0.10	-0.08	0.14	0.14	0.12	0.56	1.00	0.54	0.15	0.21	0.21	0.01	0.20	-0.11
3.4	0.19	0.16	0.11	0.14	0.16	0.13	0.11	0.27	0.09	0.44	0.54	1.00	0.29	0.32	0.33	-0.03	0.30	-0.10
4.1	0.16	0.08	0.05	-0.02	0.14	0.18	0.06	0.13	0.07	0.13	0.15	0.29	1.00	0.31	0.43	0.11	0.18	-0.45
4.2	0.30	0.15	0.06	0.04	0.01	0.19	0.06	0.10	0.31	0.30	0.21	0.32	0.31	1.00	0.40	-0.05	0.25	-0.09
4.3	0.16	0.26	0.23	0.16	0.28	0.31	0.20	0.26	0.15	0.22	0.21	0.33	0.43	0.40	1.00	-0.07	0.47	-0.42
4.4	0.11	-0.06	-0.03	-0.10	0.00	0.12	0.02	0.21	-0.18	-0.12	0.01	-0.03	0.11	-0.05	-0.07	1.00	-0.17	0.04
4.5	0.14	0.17	0.30	0.10	0.30	0.22	0.35	0.25	-0.02	0.07	0.20	0.30	0.18	0.25	0.47	-0.17	1.00	-0.06
4.6	0.11	0.07	0.01	-0.06	-0.04	-0.26	0.00	-0.01	-0.09	-0.17	-0.11	-0.10	-0.45	-0.09	-0.42	0.04	-0.06	1.00

C2.2 *Doing*

Chart H9: Tables of Correlations between the "doing" items.

	6.1	6.2	6.3	6.4
6.1	1.00	0.24	-0.09	0.13
6.2	0.24	1.00	0.30	-0.01
6.3	-0.09	0.30	1.00	-0.17
6.4	0.13	-0.01	-0.17	1.00

Of the four items within *Doing*, three (QS6.1, 6.2, and 6.3) are well correlated with one another ("I have a job description", "The role cannot fully be encapsulated" and "I set my own agenda"). However, QS6.4 ("… main focus […] is to engage in teaching rather than research activity") is poorly correlated with the other three item. However, its correlations with items in QS12 and QS13 are strong, and all those on QS13 are statistically significant. Perhaps this indicated that this item is out of place here.

C2.3 *Knowing*

Chart H10: Tables of Correlations between the "knowing" items.

	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8
8.1	1.00	0.34	0.07	0.29	0.13	0.16	0.09	0.13
8.2	0.34	1.00	0.12	0.40	0.02	0.54	0.38	0.41
8.3	0.07	0.12	1.00	0.27	0.10	0.17	0.06	0.27
8.4	0.29	0.40	0.27	1.00	0.15	0.39	0.27	0.43
8.5	0.13	0.02	0.10	0.15	1.00	0.06	0.12	-0.04
8.6	0.16	0.54	0.17	0.39	0.06	1.00	0.54	0.46
8.7	0.09	0.38	0.06	0.27	0.12	0.54	1.00	0.51
8.8	0.13	0.41	0.27	0.43	-0.04	0.46	0.51	1.00

Questionnaire Section 8 is internally well correlated. In particular, there is a cohesive core of items: QS8.2; 8.4; 8.6; 8.7; and, 8.8 (Deep Understandings of Subject Knowledge and of Pedagogy, Extensive Knowledge Base, including How students Learn and Knowledge of School Curricula) which all have highly significant correlations and form the cohesive core of *knowing*. Items QS8.1, 8.3 and 8.5 are less well correlated (specific minimum qualifications, a single view on how to teach and a different skill set from other non-maths TERs). In a revision to the questionnaire, item 8.5 should probably be removed, reworded or replaced.

C2.4 *Being*

Chart H11: Tables of Correlations between the "being" items.

	10.1	10.2	10.3	10.4		11.1	11.2	11.3	11.4	11.5	11.6
10.1	1.00	0.54	0.33	0.20		0.23	0.05	0.40	0.15	0.13	0.31
10.2	0.54	1.00	0.51	0.11		0.29	-0.02	0.35	0.34	0.08	0.11
10.3	0.33	0.51	1.00	0.26		0.32	0.10	0.30	0.42	0.11	0.06
10.4	0.20	0.11	0.26	1.00		0.05	0.06	0.17	0.06	0.02	0.11
11.1	0.23	0.29	0.32	0.05		1.00	0.04	0.29	0.45	0.18	0.01
11.2	0.05	-0.02	0.10	0.06		0.04	1.00	0.18	-0.08	0.16	-0.03
11.3	0.40	0.35	0.30	0.17		0.29	0.18	1.00	0.36	0.19	0.30
11.4	0.15	0.34	0.42	0.06		0.45	-0.08	0.36	1.00	0.02	0.04
11.5	0.13	0.08	0.11	0.02		0.18	0.16	0.19	0.02	1.00	0.18
11.6	0.31	0.11	0.06	0.11		0.01	-0.03	0.30	0.04	0.18	1.00

In the *Being* Questionnaire Sections (QS10 and QS11), around half of the correlations are significant; however, while QS10 is reasonably internally consistent,

(the exception being QS10.4 -contribution to research), QS11 is somewhat less consistent, with QS11.2 (Anxiety), QS11.5 (Challenge) and QS11.6 (MTERs possessing different values than other TERs) not particularly well correlated with the other items or elsewhere in the questionnaire.

The consistent core of QS10 and QS11 comprises items on personal attributes, personality, and personal philosophy, together with satisfaction, personal values and a thorough understanding of the role. The main focus of this block, therefore seems to be centred around "Personal Attributes, Qualities and Values".

C2.5 *Belonging*

Over three quarters of the correlations between items in this block are significant, with QS13 forming a cohesive unit, with the lowest correlation at 0.43, well above the criterion for significance.

Chart H12: Tables of Correlations between the "belonging" items.

	12.1	12.2	12.3	12.4	12.5		13.1	13.2	13.3	13.4	13.5	13.6
12.1	1.00	-0.35	0.38	0.61	0.55		0.37	0.45	0.25	0.45	0.20	0.25
12.2	-0.35	1.00	-0.09	-0.23	-0.23		-0.03	-0.06	0.04	-0.16	0.03	-0.01
12.3	0.38	-0.09	1.00	0.51	0.31		0.40	0.48	0.31	0.25	0.25	0.29
12.4	0.61	-0.23	0.51	1.00	0.50		0.41	0.39	0.22	0.30	0.13	0.21
12.5	0.55	-0.23	0.31	0.50	1.00		0.55	0.48	0.50	0.47	0.42	0.48
13.1	0.37	-0.03	0.40	0.41	0.55		1.00	0.61	0.54	0.54	0.43	0.54
13.2	0.45	-0.06	0.48	0.39	0.48		0.61	1.00	0.66	0.57	0.46	0.54
13.3	0.25	0.04	0.31	0.22	0.50		0.54	0.66	1.00	0.57	0.54	0.68
13.4	0.45	-0.16	0.25	0.30	0.47		0.54	0.57	0.57	1.00	0.51	0.51
13.5	0.20	0.03	0.25	0.13	0.42		0.43	0.46	0.54	0.51	1.00	0.48
13.6	0.25	-0.01	0.29	0.21	0.48		0.54	0.54	0.68	0.51	0.48	1.00

Within QS12, all items are well correlated except for QS12.2 "I feel isolated in my role", and fails to correlate significantly with other items in QS12 or QS13. Removing QS12.2 (or rewording it as being positive) would produce a cohesive unit giving a consistent profile on a "belonging" dimension.

C2.6 Questionnaire Section 15

QS15, on the perceived value of MTERs was additional to the Davey framework. In Chart H13, the items appear well correlated, and a reasonably cohesive unit, with the possible exception of QS15.4.

The Principal Components Analysis in 5.8.1 above, indicated that QS15.2 and QS15.3 formed a Component together with items from Questionnaire Sections 8, 10 and 11 summarised as "Knowledge, Understanding and Values". In terms of the Davey Framework, this is the core of the *Being* lens. However, from the inter-sectional correlations here, QS15 is about equally aligned with *Belonging* as with *Being*, but while there are significant correlations between QS15 and both questionnaire sections comprising *Being*, there are no significant correlations with QS13, the core of *Belonging*.

From this evidence, QS15 would be best placed within the *Being* lens.

Chart H13: Table of correlations between the items of Questionnaire Section 15.

	15.1	15.2	15.3	15.4
15.1	1.00	0.50	0.29	0.03
15.2	0.50	1.00	0.48	0.16
15.3	0.29	0.48	1.00	0.34
15.4	0.03	0.16	0.34	1.00

Appendix D1: Prompts for the Interviews

Interview questions and prompts were focused around Davey's five lenses: becoming, doing, knowing, being and belonging.

D1.1 *Becoming*

When did you start to think about an MTER role?

What brought you into the role?

What was your background that led to applying for an MTER role?

Tell me about your induction into the role.

- University-wide
- Maths-education specific?

And your ongoing development, tell me what is helpful.

Thinking about progression, do you see yourself continuing as an MTER? Do you have any plans?

……

D1.2 *Doing*

Thinking about the job itself, what does that entail?

What professional activities do you engage in?

Are there particular priorities, commitments?

Any conflicts?

Role of research

Scope of the role – are there other non-MTER responsibilities?

……

D1.3 *Knowing*

What knowledge-base do you think MTERs need to have?

Are there particular skills that are needed?

Are there particular theorists that you draw on to inform your practice?

What level of mathematics understanding/qualification do you think is necessary/important?

Thinking about currency, some MTERs have used that language.

Is there a difference for someone recently out of school?

As someone having been in the role for a few years what do you feel the experienced MTER offers that perhaps a person newer into the role doesn't?

……

D1.4 *Being*

Thinking about the personal side of the role, the more emotional side …

Where do you get your enjoyment in the role?

Is there any anxiety associated with the role?

Are there particular values that you hold?

Do you have an ideal persona that you wish to present?

……

D1.5 *Belonging*

What sense of belonging to any groups do you have?

Primary maths team, wider educational team, other?

Interaction with secondary colleagues?

Outside of university? Associations?

……

D1.6 Additional

Do you have a sense of being valued?

- By students / by teachers / at a higher level – DfE/Government

……

Appendix D2: Interview Information and Consent

Prior to the Interview, respondents were emailed two documents:

- An Information Sheet about the Interviews (Appendix D2.1)
- An Interview Consent Form (Appendix D2.2)

As with the parallel documents for the Questionnaire in Appendix B2, they form part of the ethical considerations discussed in Section 3.3.10, which require informed consent from participants.

The Information Sheet sets out the purposes of the interviews, how potential participants have been identified and what will be required of them, how their data will be treated, and their rights in agreeing to participate or withdraw from the study at any stage

The *Consent Form* explains what the participant is agreeing to, and explains that they are agreeing to consent by filling in the check box and proceeding to answer the items.

D2.1 Interview Information Sheet

Below the line is the Information sheet which was emailed prior to the Interview.

Information Sheet for Research Participants

Aims of the Study

The study forms the basis of my doctoral thesis in which I seek to investigate the notion of "professional identity" in Mathematics Teacher Educators and Researchers. I am keen to consider whether such a concept of 'professional identity' exists in regard to professionals engaged in mathematics teacher education and/or research, to explore ways in which professional identity might manifest itself or be recognised, and to undertake some analysis of the attributes that may be connected with it.

How have participants been identified?

An intensive search of the online profiles of university 'Education Faculty' staff both in the UK and the USA has been undertaken to identify potential participants to be invited to take part in the research study. Colleagues who were identifiable, from their profiles, as having some involvement in mathematics teacher education programmes and/or related research were selected. In the main, the colleagues were selected because they either teach or research, or both, in the area of primary and/or secondary mathematics teacher education. In addition to this, some participants have been identified because we have met previously through professional engagement in teacher education activity, or their names have been included on the 'list of delegates', where these were supplied, in attendance at conferences or workshops that I have previously attended. This latter source has enabled me to select some school-based colleagues involved in mathematics teacher education.

What will be required of participants?

The mathematics teacher educators and/or researchers ("MTERs") invited to participate in this research are asked to complete an online questionnaire which is estimated to take approximately 30 minutes.

A sub-group of those completing the questionnaire will be asked if they are willing to undertake face to face or skype interviews anticipated to last between 45 and 60 minutes.

Confidentiality and Security of Information

Data resulting from responses to questionnaires and interviews will be stored electronically in a password protected system. Where hard copies of data may be printed to support analyses, these will be locked securely in a filing cabinet. The data will be used purely for the purposes of the research study (including dissemination of findings). No-one other than research colleagues, supervisors or examiners will have access to any of the data collected prior to it being anonymised. The original data will be destroyed after the research and its reporting is complete, and permission is obtained from the University of Nottingham.

Participation in the Research

Participation in the research is completely voluntary and participants are at liberty to withdraw at any time from the study should they choose to do so. In participating it is important that the questions are answered as honestly and candidly as is possible, clarifying personal perspectives where appropriate. Any concerns should be communicated to me, as researcher, and I will endeavour to alleviate these in negotiation with my supervisor, if appropriate. Participants also have the right to contact the education research ethics committee should the need arise.

Contact Details:

The Researcher Elizabeth (Liz) Fleet **ttxef4@nottingham.ac.uk**

Research Supervisor Dr. Philip Hood **ttaph6@nottingham.ac.uk**

Ethics Research Co-ordinator **EDUCATIONRESEARCHETHICS@NOTTINGHAM.AC.UK**

D2.2 Interview Consent Form

Below the line is the Consent Form which potential interviewees were required to sign and return, either by email or by post. All of the interviewees did so.

PARTICIPANT CONSENT FORM

Project title: An investigation into 'professional identity' in Mathematics Teacher Educators and Researchers (MTERs)

Researcher's name Elizabeth Fleet **Supervisor's name** Dr. Philip Hood

- I have read the Participant Information Sheet in which the research project has been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be personally identified and my responses will remain confidential.
- I understand that should I be interviewed as part of the study this will be audio-recorded.
- I understand that data resulting from responses to questionnaires, and interviews where undertaken, will be stored electronically and where appropriate as digital audio files. These will be stored in a safe and secure location, that is hard copy materials will be retained in a locked filing cabinet and electronic material in a personal password-protected electronic space) and will be used purely for the purposes of the research project (including dissemination of findings). No-one other than research colleagues, supervisors or examiners will have access to any of the data collected prior to it being anonymized. Once the study is complete and I have permission from the University of Nottingham, the data will be deleted.

- I understand that I may contact the researcher if I require further information or have any concerns about my involvement in the research. I acknowledge receipt of the relevant contact email addresses (provided below) should I need further information or wish to contact the Research Ethics Coordinator of the School of Education at the University of Nottingham.

For those RESEARCH PARTICIPANTS who have completed the online questionnaire and agree also to be interviewed, please sign and complete your details below, returning the signed form to me at **ttxef4@nottingham.ac.uk**

Signed …… (Research participant)

Print name …… Date ……

Contact details:

Researcher: Liz Fleet *ttxef4@nottingham.ac.uk*

Supervisor: *Dr. Philip Hood ttaph6@nottingham.ac.uk*

School of Education Research Ethics Coordinator: educationresearchethics@nottingham.ac.uk

Appendix E1: The Classification and Use of Qualitative Data.

This appendix documents how responses given, both in the questionnaire and in the subsequent interviews, were treated in order to code and collate to provide summaries and charts. It also provides an example of how *respondent validation* was used within the study to validate the results from Likert-scaled items in the questionnaire. The sections below illustrate the methodology and provide specific examples, and are provided in line with the principle of *confirmability* (Bryman, 2008) as noted in Appendix G1.

E1.1: The Open-Response items in the Questionnaire.

Altogether there were 19 Open Response items in the questionnaire. However, not all of these were items which needed to be coded. Some were merely asking for additional clarification or alternative categories. There were 13 items in all where respondents provided textual material which required analysis and coding.

The prompts for many of these responses merely ask for additional comments or notes in relation to the items in that particular section. It is clear that respondents used this opportunity in three different ways: firstly, to elaborate or to clarify, and sometimes simply reiterate what they had said in the Likert items; secondly, responses often brought up additional points which were not covered in the Likert items; and thirdly, they were used to comment on other issues, sometimes on the validity of the question - or even the process - itself. This range of responses in some cases presented challenges in dealing with the text.

In most cases however, the responses were relatively straightforward elaborations of the Likert items, giving far more detail, and providing a range of similar, often repetitious elements.

I followed the methodology outlined in Section 3.5 and reiterated in Section 4.7.4, using a method of “emerging categories” as outlined below. I felt it was crucial here, since I had already imposed categories in the Likert scaling, to use the respondents’ own words and phrases to define the tags for the categories, and to

retain as much of the text as possible. I therefore worked with the text as an entity, rather than creating labels for the text. All of the items were entered into a single column of a spreadsheet, and then sections were copied and pasted into adjacent columns, appropriate to the existing tags or any newly devised tags. All tags were derived from the respondents' own words.

I followed closely the three principles suggested by Bryman (2008) for the post-coding of open questions, that:

> "… categories generated must not overlap…
>
> … the list must be complete and therefore cover all categories …
>
> … there should be clear rules about how the code should be applied…"

(Bryman, 2008, p. 233)

The method used below involves copying the whole or sections of each response, into one column. This uses the entire text, and each section can only be in one column. This clearly satisfies the first two of Bryman's criteria. Furthermore, because the tags used are explicit, phrases derived from the text itself, the coding rules are immediate and transparent, and while it could be argued that some tags which are collated might be better split, the classification itself is clear and unambiguous.

E1.1.1 Coding Questionnaire Item 2a

As an example, I have used the section from the first of the open response sections, item 2a, where respondents were instructed to "… note any other specific motivations for becoming an MTER especially if not covered in the options above".

I summarised these in Chart A4.

Taking the first response,

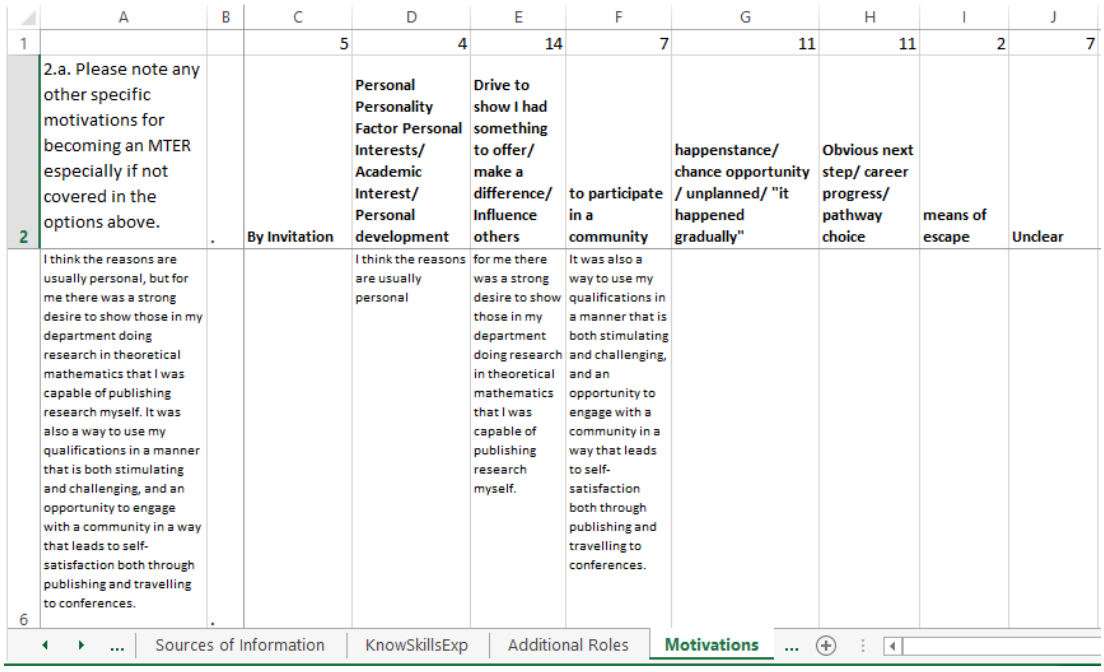
"I think the reasons are usually personal, but for me there was a strong desire to show those in my department doing research in theoretical mathematics that I was capable of publishing research myself. It was also a way to use my qualifications in

a manner that is both stimulating and challenging, and an opportunity to engage with a community in a way that leads to self-satisfaction both through publishing and travelling to conferences."

I detected three elements here: that the first part was related to a need to demonstrate a certain level of personal achievement to others, while the second was more about personal fulfilment, but also a third element, that of the engagement with a community.

I used a separate page on a spreadsheet to split the text up into three parts, in separate columns, which had been provisionally tagged as "*Personal"*, "*Drive to show I had something to offer"* and "*to participate in a community*". I tried as far as possible when creating these tags, to quote verbatim from what the individuals had said. The results are shown below.

Chart E1.1: Spreadsheet containing the first part of the analysis of item 2a, showing the tags and classified text.



	A	B	C	D	E	F	G	H	I	J
1			5	4	14	7	11	11	2	7
2	2.a. Please note any other specific motivations for becoming an MTER especially if not covered in the options above.	.	By Invitation	Personal Personality Factor Personal Interests/ Academic Interest/ Personal development	Drive to show I had something to offer/ make a difference/ Influence others	to participate in a community	happenstance/ chance opportunity / unplanned/ "it happened gradually"	Obvious next step/ career progress/ pathway choice	means of escape	Unclear
6	I think the reasons are usually personal, but for me there was a strong desire to show those in my department doing research in theoretical mathematics that I was capable of publishing research myself. It was also a way to use my qualifications in a manner that is both stimulating and challenging, and an opportunity to engage with a community in a way that leads to self-satisfaction both through publishing and travelling to conferences.	.		I think the reasons are usually personal	for me there was a strong desire to show those in my department doing research in theoretical mathematics that I was capable of publishing research myself.	It was also a way to use my qualifications in a manner that is both stimulating and challenging, and an opportunity to engage with a community in a way that leads to self-satisfaction both through publishing and travelling to conferences.				

... Sources of Information | KnowSkillsExp | Additional Roles | Motivations ...

One of the issues here is that the text under the "*community*" tag, was a mixture of personal reasons, personal satisfaction as well as the desire to participate in a

community. In this case, I left the text intact, as I had already recorded the note of "*personal*" reasons from the first part of the first sentence.

My aim here was to try to achieve a simple classification, without disrupting the text too much. I could always come back and split up material later. The text in each column in the spreadsheet became a "constant comparator" to see whether anyone had said anything similar to be slotted in within that particular column.

Some comments fitted quite straightforwardly into existing columns: *"To be part of a vibrant and engaged community of like minded people"* clearly expresses a desire to *"participate in a community*". Others were less straightforward. This response, for example, from another respondent did not fit any of the tags created thus far:

"the post in teacher traiing [sic] was the one I was successful in - so my motivation was almost entirely solely to change my place of work and an advert for Teacher training just happened to come up at the right time."

This required a new category which I called "*chance opportunity*". Others subsequently fitted in this category: "*an advert for Teacher training just happened to come up at the right time"*; "alignment of circumstances"; "my entry into ITE was almost fortuitous"; and the category was broadened out to be labelled as "*happenstance/ chance opportunity / unplanned/ "it happened gradually"* " – keeping as many slightly different variants as it warranted.

As part of this process, the following comments:

"I wanted more than just the teachers in my school to see the beauty and wonder in teaching mathematics and wanted to 'put my money where my mouth was'." and

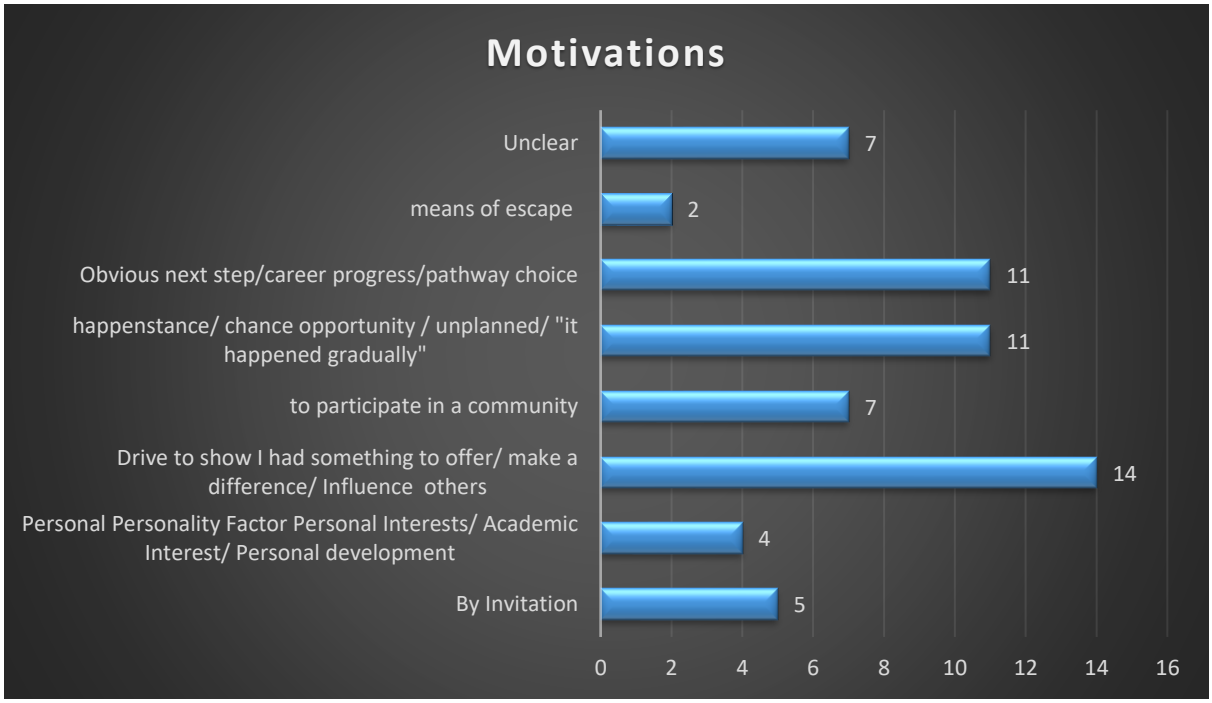
"I wanted to influence mathematics teaching more widely than within one school or MAT" were tagged with "*influence others*", along with "*it became clear that I might have something to offer those who are training to be primary teachers".* However, it seemed to me that many responses here were not just expressing the desire to influence others, but in doing so, they were saying that they had specific skills, qualities or understandings which would allow them to do just that. I had already tagged some comments, such as "I wanted to try and help", and "to deepen and

extend my impact "with "*make a difference*". On reflection, while these used different words, they seemed to address the same issue, so I merged the columns, but retained the same tags. Eventually the whole tag was extended to: "*Drive to show I had something to offer/ make a difference/ influence others*".

In keeping tags like this, it was possible to both merge ideas and separate them, if it became clear that there were sufficient comments to warrant this. Clearly there is a subtle difference between "*making a difference*" and "*influencing others*", since one is thinking about the global effect, over say a lifetime in the professions, where the other is more about what happens to individuals. However, both of these are clearly of a fundamentally different character than any of the reasons in "*happenstance/ chance opportunity / unplanned/ it happened gradually*".

Initially, the number of items in each category were summarised are in Chart E1.2.

Chart E1.2 Initial chart derived from the analysis of item 2A



The headings show exactly which tags were collated together. This chart was then tidied by arranging the data in columns of descending frequency and summarising

the tags in a few words, while still attempting to retain their essence. The resulting revisions were presented as chart A4 in the main body of the thesis.

It should be noted from the method used to derive the categories, that individuals might be represented in multiple categories. The frequency of occurrence, therefore should merely be taken as a measure of the relative importance of that particular category to respondents, rather than indicating a specific number of individuals for whom that was their main reason for joining the profession. Such a comment would apply to all such charts and tables derived using this method.

The methods described here, while being systematic, are clearly subjective, and different researchers may well have produced a different classification system, or even classified the material somewhat differently using the same headings. This former is more like than the latter, since by use of constant comparison with representative sections of text, the categorisations coalesce on an overall meaning which becomes clearer with each new response, as text is accepted into the category, or rejected from it. Thus, the categorizations which have larger numbers of items within them are relatively stable, and therefore reliable. However, their validity can be questioned, especially because of the selection of a single word or phrase to summarise whole sections of comments, which may not appropriately encapsulate the whole.

For this reason, I have tried to illustrate each of the summaries of the open-ended responses in Chapter 5, with sufficient text that the reader can judge for themselves whether the categorisations are robust or not. The material presented below illustrates clearly the challenges in undertaking this type of classification.

E1.1.2 The Responses to Item 2a classified as "Making a Difference"

The following is the complete set of all 14 responses summarised in the longest bar of Chart E1.2 above, as "*Making a difference*". Clearly while all of these are expressing roughly similar sentiments, that the respondents thought that they had something to offer, each rationale is very different. Together they represent a diverse set of different motivations, ranging from those who feel the need to demonstrate to peers that they are intellectually capable, to those who are driven by their commitment to the subject, to those who see this as righting social injustices, to those who simply want to share the passion they feel with learners.

"*Making a difference*" appears to me to summarise these sentiments effectively, since each respondent is looking towards an outcome which changes or improves on a current situation, even though the changes they envisage may be very different in each case. The texts also vary in length considerably, and it should be noted that summarising them in this manner, simply does not do justice to the effort that some have invested in sharing their opinions. This is another compelling reason to include as much of this material in the main text as possible.

All of the responses below are presented exactly as they were written:

Response 1: " *for me there was a strong desire to show those in my department doing research in theoretical mathematics that I was capable of publishing research myself.* "

Response 2: "*I wanted to work with others to support them in developing as a critically reflective teachers of mathematics, from beginning teachers to more experienced practitioners."*

Response 3: "*I felt that a research mathematician was needed to ensure the quality of math content courses for elementary education majors*."

Response 4: "*I wanted to be a gatekeeper to the profession. I was disillusioned with new (and established) teachers attitude to issues of racism, sexism and the impact of discrimination for learners*."

Response 5:"*To share my passion for the teaching and learning of mathematics via new teachers.*"

Response 6: "*I felt that my mathematics education up until Higher Education had been inadequate. I was lucky enough to understand the mathematics I needed to succeed but felt that if the teaching had been better I would have been a better mathematician. I wanted to try and help in someway by being an educator of beginning teachers and, if possible, current teachers*."

Response 7: "*To raise awareness of the issues adult learners face, whether they are UK educated or non first language English speakers. To give those learners a voice."*

Response 8*:"I wanted to influence mathematics teaching more widely than within one school or MAT"*

Response 9: "*I had noted throughout my career as a primary practitioner that my colleagues either lacked confidence in their abilities to teach mathematics or did not put as much time and effort into providing engaging learning experiences in mathematics. I wanted more than just the teachers in my school to see the beauty and wonder in teaching mathematics and wanted to 'put my money where my mouth was'*."

Response 10: "*I became interested in mathematics education research whilst studying for my Master's, which I embarked upon because I wanted to further my own understanding of how children learn mathematics. As a Year 6 class teacher, I was intrigued by those children who found mathematics difficult, and did not enjoy mathematics. It was my aim to support these children in seeing themselves as mathematicians. Whilst studying for my Master's, it became clear that I might have something to offer those who are training to be primary teachers, and this is when I became a mathematics teacher-educator*."

Response 11: "*By coaching and mentoring new teachers in best practice maths pedagogy, significantly impacts on the quality of maths teaching and learning in schools; I was keen to extend my impact on raising standards pupil learning outcomes. Becoming a MTER built on my strong maths subject knowledge from my*

maths under graduate degree; the strength in my sk was recognised by the schools that employed me; from the start of my career I was passionate about becoming a future maths sk leader. A way to deepen and extend my impact as a MTER was to work on PGCE as part of maths teaching team."

Response 12: "*I was always interested in influencing what was happening in mathematics classrooms as, generally, children could be getting much more engaging and insightful experiences than is often the case in many classrooms. My career started off by trying to give the children I taught myself a more productive experience, I then began to work with others within the mathematics department (as a second in mathematics and then Head of Mathematics), I then enlarged this to working with mathematics teachers across the educational authority and trying to influence other teachers nationally through articles in Mathematics Teaching and running sessions at conferences (also began working with teachers in other subject disciplines within my school). I felt a natural extension was to try to influence the experiences of children through working with prospective teachers, so that potentially even more children can benefit. I would add that I am not so much about 'sharing my understanding' (see second question above) but about working with prospective teachers' understanding. Thus I am working with and influencing their understanding rather than sharing my own. This is an important difference and one at the heart of what education is about in my view. My student teachers come to get a sense of what I might think only implicitly through the nature of the questions I ask and the type of challenges I offer, rather than hearing anything explicitly stated by me.*"

Response 13: "*There was an evident need, and it seemed that my experience could make a contribution*"

Response 14: "*Interest in supporting new teachers*."

E1.2 The Interview Data

Analysis of the qualitative data arising from the interviews involved the process of coding, and interview transcripts were uploaded into the NVivo system to support this activity.

There were several purposes in collecting the interview data: for respondent validation of the survey items, to explore and challenge the hypotheses set out in Chapter 6, and to allow additional material and results related to MTER identity to emerge, which might have been overlooked by solely using a questionnaire approach.

By the time the interviews were carried out, the hypotheses set out in Chapter 6 had already begun to emerge from analysis of the questionnaire data; these would provide not only a focus for specific questions, but also a focus for the analysis. While the hypotheses provided a focusing mechanism, they were not restrictive: any material within the broad topic covered by the hypothesis was systematically investigated utilising the interview data held within NVivo. In exploring each hypothesis topic, data supporting the hypothesis was used critically, with counter-case data systematically sought in keeping with a critical realist approach. However, the first step in the process of analysis in each case, began with a careful reading of the transcripts; the full process of developing coding is described below.

E1.2.1 The Coding Process for the Interview data

The process of coding responses started with a thorough review of the interview transcripts to seek text specifically related to a particular area under investigation, for example, *research* or *values*. The particular theme under investigation was then sub-themed by an inductive process, that is, as related ideas were identified in the text (the interview transcripts in the NVivo system) they were noted and grouped into new emerging sub-categories of the main theme, using “Grounded Theory” principles (Glaser and Strauss, 1967). Where this resulted in a large number of sub-categories being formed, re-reading and further consideration took place.

This process of internalising others' thoughts, and seeking to find meaning, is by necessity a form of interpretation. However, when processes are applied methodically, that is: coding decisions are reviewed carefully and revisited; the process is repeated; and, categories are revised until the researcher is satisfied consistency of decision-making is reached, it is expected that the process could be followed by a second researcher with very similar results being obtained. This is the in line with the principles of *dependability* and *inter-observer consistency* (Bryman, 2008).

The degree to which there is interpretation of participant statements and phrases will clearly impact both on the reliability and the validity of any conclusions. Where the direct words of a participant are reported, as is done within sections of this study, any misinterpretations by the researcher of the participant's meaning is clearly more open for scrutiny by peers when the work is published. Within this study, I have provided examples of both utilising the exact words of participants to form a narrative around a particular idea, and also used coding to explore particular themes affecting MTERs in the hope of extracting deeper understandings. This is in line with the principles of *transferability* and *confirmability* (Bryman, 2008).

The core of the process I followed in regard to coding the data was based on that of **Bleiler (2015, p.237**), who created her methodology by adapting the recommendations of Smith et al. (2009). This is a four-stage method, including: (1) Reading and re-reading; (2) Initial noting; (3) Developing emergent themes; and, (4) Searching for connections. I adapted **Bleiler**'s (2015) process as indicated in Table E1.3 below.

Table E1.3 The Four stage analytic process of Coding

Stage	Name	Description
1	Reading and re-reading	Conduct holistic reading of the data (i.e., interview transcripts) whilst listening to audio files. Engage in marking the text to indicate initial inclinations as to relevancy to the investigation.
2	Initial noting	Conduct closer textual analysis. Highlight key words/phrases related to the theme under consideration. Assign codes to sections/words/phrases of text which have a commonality.
3	Developing emergent themes	Note emergent themes. Consider appropriate overarching language or descriptions to encapsulate these themes. Continue reading and assigning sections/words/phrases of text to the emergent/emerging themes. Revisit the earlier decision-making in this process. Maintain a focus on the circular hermeneutic nature of the activity, examining the parts in the context of the whole and the whole in the context of its parts.
4	Searching for connections across emergent themes	Especially where a large number of emergent themes have been identified, consider whether this presents a potentially unwieldy picture of the overarching theme. Search for connections across the emergent themes/sub-themes. Consider whether the sub-themes can be re-grouped to create fewer sub-themes yet ones which are more manageable and still retain internal coherence.

N.B. The categories and methodology in the table above have been adapted from Bleiler (2015, p. 237) and Smith et al. (2009).

Whilst all interview transcripts were contained in the NVivo system, and the system enables coding to take place in the manner described, I found it helpful, in terms of supporting the thinking processes taking place whilst reading and re-reading themed material to create additional hand-written notes and word documents containing the statements, categorising them into emerging themes. This was a purely personal choice rather than a limitation of NVivo. Paper-based versions

were helpful in visualising statements and ideas, and allowed them to be grouped and regrouped; this proved to be more manageable than continuing to use the system. Although facilities in Nvivo such as the word clouds and tree maps were investigated, they did not fully support the type of analysis I needed on this occasion.

An example of how this methodology was used in a specific case is provided blow.

E1.2.2 Example of how the Coding Principles were applied.

In the material below, I demonstrate how the interview material was used to examine Research Hypothesis 5, from Section 6.3.3:

Research Hypothesis 5: The values of MTERs, and their perceived sense of being valued by others, differ between newer and more well-established MTERs.

Initially the process was not focused on this specific hypothesis, but part of a broader exploration of MTER values, which led to the identification of a number of emergent themes, and the subsequent recombining and reduction of these themes into the four areas of "values" identified within Section 6.3.3: Affective matters, Cognitive concerns, Professionalism and Social Justice.

The four stages of analysis adapted from (**Bleiler, 2015;** Smith et al. 2009) as detailed in the previous section were applied as described below. Screen snips are included at the end of the summaries of activity as illustration.

1 Reading and re-reading

In order to internalise the participants' responses and their thinking in regard to their values, the relevant sections of the interview transcripts were read multiple times. In the instances where participants had spoken in some detail about their values, I found it useful to re-listen to the original recording. I began to mark in the text specific points of relevance in relation to the theme of values.

2 Initial noting

This stage involved closer analysis of sections of text and key ideas and thoughts as articulated by the participants. I used an inductive approach to code statements in the transcripts (Strauss and Corbin, 1990). I did this methodically, so, for example, as I read through each script in turn, I was able to highlight the text and create a new code (a node in NVivo) as an idea emerged. It was clear from early on that attitudes were clearly an important consideration from a values perspective. This related not only to PSTs' attitudes towards mathematics but also MTERs' comments on their own attitudes about how they portray themselves, for example. A number of examples are provided in Figs. E1.4-6 below as excerpts of interest at the beginning stages of categorising into themes. It should be noted that elements of the same statements might be categorised in multiple ways in some instances.

Figure E1.4 Nvivo Node Labelling: "Addressing attitudes of students"

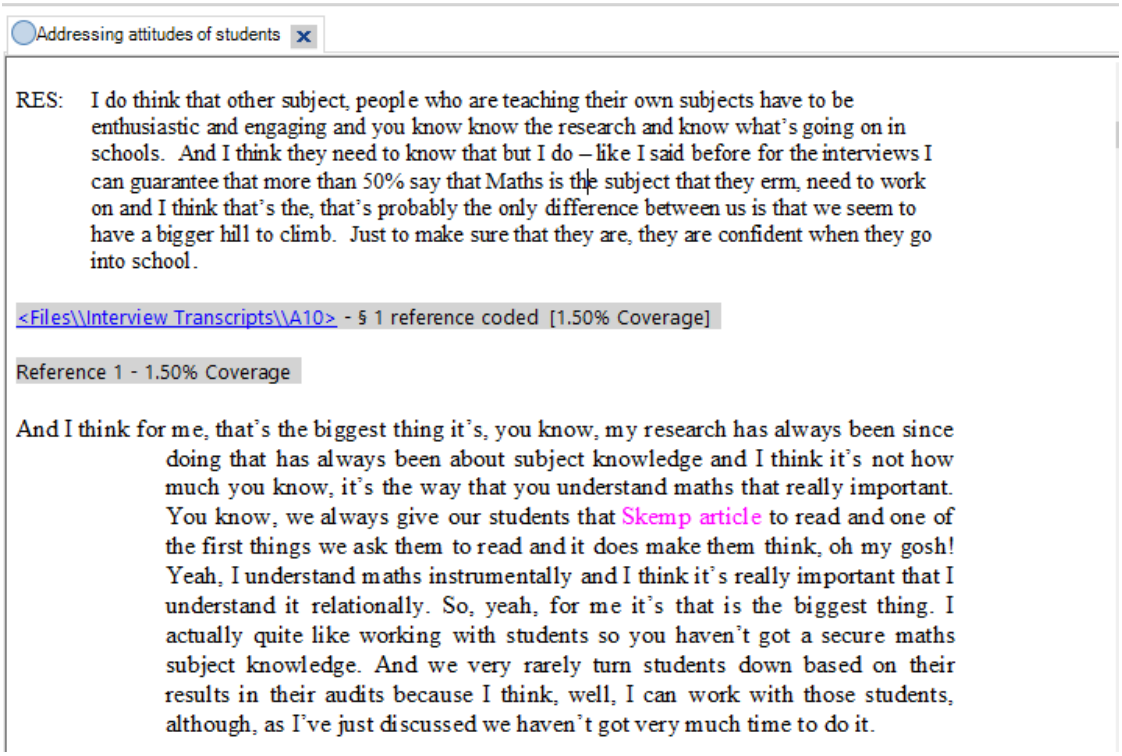
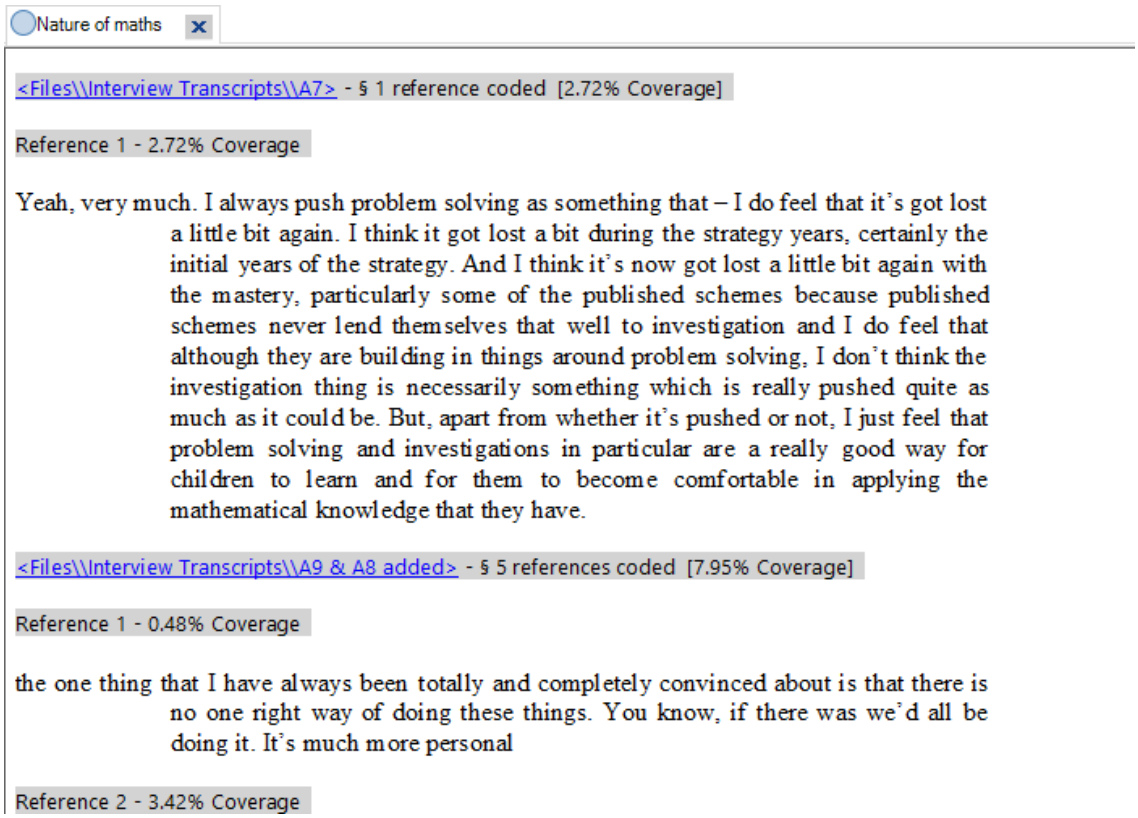


Figure E1.5 Nvivo Node Labelling: "Nature of maths"


Nature of maths

<Files\\Interview Transcripts\\A7> - § 1 reference coded [2.72% Coverage]

Reference 1 - 2.72% Coverage

Yeah, very much. I always push problem solving as something that – I do feel that it's got lost a little bit again. I think it got lost a bit during the strategy years, certainly the initial years of the strategy. And I think it's now got lost a little bit again with the mastery, particularly some of the published schemes because published schemes never lend themselves that well to investigation and I do feel that although they are building in things around problem solving, I don't think the investigation thing is necessarily something which is really pushed quite as much as it could be. But, apart from whether it's pushed or not, I just feel that problem solving and investigations in particular are a really good way for children to learn and for them to become comfortable in applying the mathematical knowledge that they have.

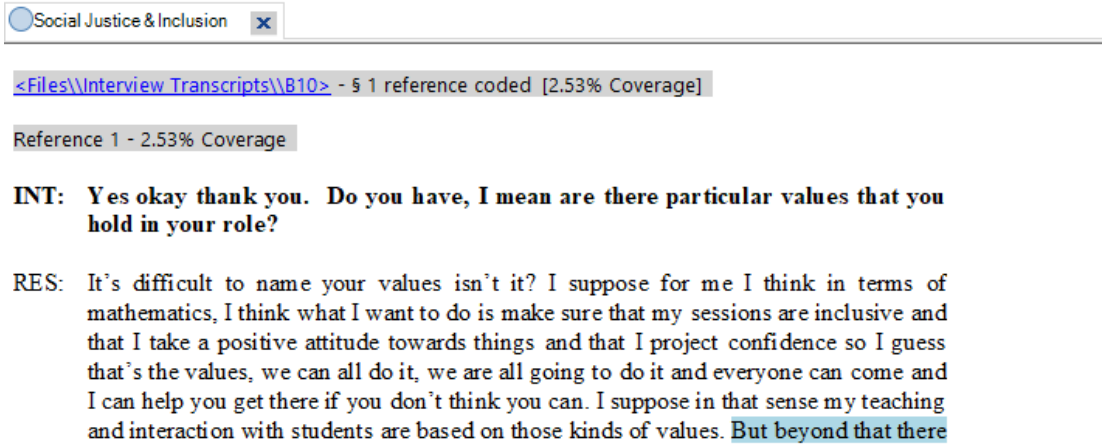
<Files\\Interview Transcripts\\A9 & A8 added> - § 5 references coded [7.95% Coverage]

Reference 1 - 0.48% Coverage

the one thing that I have always been totally and completely convinced about is that there is no one right way of doing these things. You know, if there was we'd all be doing it. It's much more personal

Reference 2 - 3.42% Coverage

Figure E1.6 Nvivo Node Labelling: "Social Justice & Inclusion"


Social Justice & Inclusion

<Files\\Interview Transcripts\\B10> - § 1 reference coded [2.53% Coverage]

Reference 1 - 2.53% Coverage

INT: Yes okay thank you. Do you have, I mean are there particular values that you hold in your role?

RES: It's difficult to name your values isn't it? I suppose for me I think in terms of mathematics, I think what I want to do is make sure that my sessions are inclusive and that I take a positive attitude towards things and that I project confidence so I guess that's the values, we can all do it, we are all going to do it and everyone can come and I can help you get there if you don't think you can. I suppose in that sense my teaching and interaction with students are based on those kinds of values. But beyond that there

3 Developing emergent themes

As I came across similar ideas, these could be highlighted and categorised as fitting within an existing code. As the process continued, new themes were also identified. In total 12 emergent themes were developed. In some cases, the emergent themes were subdivided. This can be seen in Fig. E1.5 below.

Figure E1.5 NVivo Node tree structure: "Values held by MTER"

Nodes

Name	Files	References
Values - held by MTER	2	3
Academic underpinning & Research	4	5
academic underpinning	3	3
Attitudes to maths	3	4
Addressing attitudes of students	24	43
MTER attitude	20	39
Being engaging & Enjoyment for learners	5	5
Building resilience in students	3	3
Cross-curricular approaches	2	4
Empathy with learners	8	8
Knowing your stuff	5	5
Maths for understanding	7	12
Nature of maths	9	19
Professionalism & Leadership	2	2
Social Justice & Inclusion	6	6
Valuing & supporting your colleagues	1	1

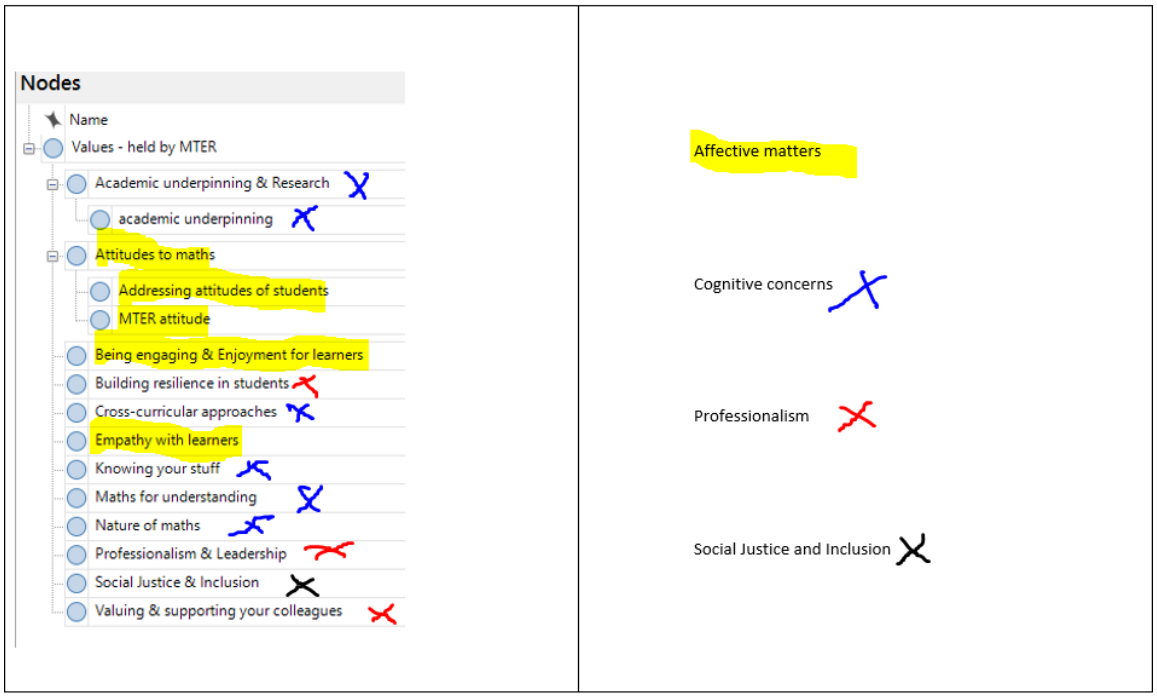
4 Searching for connections across emergent themes

At this point, I considered that 12 themes were probably too many, and I had already begun to see consonances within the interview data across each of these themes. I tried out different ways of grouping the themes, then checking that they worked, using the principle of analytic induction (Ragin and Amoroso, 2019), to hypothesise a grouping, then check the transcripts one by one to ensure they

matched, and where they seemed to conflict, to modify the grouping label or structure so as to retain the overall sense, but so as to be able to incorporate the new item within the structure. This procedure follows the methodology of analytic induction described in a presentation by Hammersley (2012, Slide 5).

After considerable thought, and multiple iterations, I was able to reformulate the 12 emergent themes into four overarching themes: affective; cognitive; professionalism and social justice. The way that the 12 subthemes fall under each heading can be seen in Figure E1.4.

Figure E1.4 Overarching Theme Categorisation: "Values held by MTER"



The transcript elements within each of these subthemes form the basis of each of the sections within 6.3.3. However, in discussing the material there, it was often necessary to contextualise the statement, either by referring to the particular MTER's circumstances, their survey responses, or what they had said elsewhere in the interview. In other words, while the material within each of the four overarching themes is broadly consonant, none of the material stands alone, it has to be contextualised, to be fully understood.

E1.3 An Example of Respondent Validation

As part of the triangulation of the results from the survey, responses and specific items from the survey were fed back to respondents, to ask for clarification or explanation, or simply to allow them to elaborate further and explain their thinking. Such feedback also formed part of the retroduction process, where I was attempting either to understand the context in order to compare cases, or to seek out extreme or counter-cases.

In the two cases below, the question being examined was QS8.3, which stated that there is: "*a single consistent view on how best to teach particular aspects of the subject*", and with which most MTERs had disagreed, only 12% agreeing. The discussion of this item in Section 5.3 revealed that the results were complex, with more EYS and Primary agreeing than Secondary and FE, and with agreement decreasing with Career Stage. As stated at the end of the section, a possible abduction here is that the types and levels of knowledge required may be different in different phases. It might also be the case that some respondents had interpreted the question differently – although what that might be was unclear, and no real clarity on this was gained from the open response items.

This item therefore was one of the ones which I targeted for respondent validation, and below I examine in some detail the responses from two MTERs.

The first respondent had answered in line with the majority of MTERs, whereas the second had agreed with it. Both respondents here might be considered "extreme cases", in terms of the critical realist perspective: one having *strongly* disagreed with it, the other in the very small minority who agreed with it. However, in this case, perhaps the view of the first respondent is not so extreme, since 29 others also strongly agreed with the item

From the interview transcript, this extract reveals the explanation given by the first respondent:

INT: *I'm just going to pick up on one of the statements again from your questionnaire. This is one you 'strongly disagreed' on. So, I think it links with what you've just been saying to me, but if you could elaborate that would be great. So, you strongly disagreed with, "A consistent single view of how best to teach particular aspects of the subject*."

RES1: Straight away two things strike me there. One thing we do is, if we're teaching multiplication let's say, there are all these different ways we can teach it, and I want you to be able to understand and analyse which way will be best for the children you're teaching. In terms of their particular level of development, in terms of what they already know, in terms of where they want to get to. So, we try to arm our students with lots and lots of approaches and lots of suggestions, that give them the skill to analyse which is going to be the most effective approach, or representation, or image, for a particular child.

So, in that sense, I don't believe that there is one perfect way to teach anything. Because the more and more I learn, and the more and more I think about the social and culture formation of learning, what might work on one day, doesn't work on another day. I remember that from my time as a teacher. Something could work brilliantly one day, you'd teach in a similar way the next day, but because they'd not had their Shreddies, or it was lunch time, and they'd all had a big argument, it didn't work.

So, you need lots of tools in your toolkit. And, I think that in terms of what they need, but I also think that in terms of how I teach, as well. For me, the worst thing would be to come to my session and think I've been taught in exactly the same way for an hour and a half, every week for a year, would be awful wouldn't it? So, I try to make sure that my sessions are slightly different, and I try to deliver things in a slightly different way or do slightly different activities. Or, try to group the students in slightly different ways, just to show that there are different ways that they learn as well, and different ways that I can teach, as I'm modelling for them, how to teach.

As can be seen from the transcript, the respondent explains that "*we try to arm our students with lots and lots of approaches"*, and stresses: *"I don't believe that there is one perfect way to teach anything"*, reaffirming her response to the Likert-scaled item. She also provides her rationale for this, and the consequences for her own practice: "*I try to make sure that my sessions are slightly different, … just to show that there are different ways that they learn as well, and different ways that I can teach, as I'm modelling for them, how to teach."*

The explanations from the second respondent who agreed, are possibly even more illuminating:

INT: *Do you think that it's one, single consistent view of how to teach aspects of the subject? Or what's your thinking around there? You agreed with the statement that there's a single, consistent view on how best to teach particular aspects of the subject. Do you just want to elaborate on that a little?*

RES2: For me, I think yes, there is a single consistency. Whether that's shared, and everyone has the same single consistency. But, for me, it is this idea of the concrete of the idea and the abstract and using resources to get the conceptual understanding. I think that can be applied to any aspect of mathematics, any age group in mathematics. I don't think that's something that we should lose. I think, that if you apply those principles in your teaching, alongside the reasoning, alongside the mindset that says, "Actually, anybody can achieve in mathematics. It's those things that I think are across all of mathematics. I think that's what I mean when I say, yes, there is a single consistent view, in terms of maths education. There's not any aspect I would teach in a different way, there are no exceptions to the rules. I think that's my views on best practice and maths education across the board. Whether that's the same as everybody else, I don't know.

I detected in the answer here, a slightly nuanced understanding of "consistency", the idea that there were general principles underlying teaching which should be consistently promoted, rather than my own perceptions and intentions underlying item QS8.3, which was to ask whether there are specific single "best" teaching methods should be promoted and offered to PSTs and teachers. I tried to clarify this point:

INT: *What I was thinking of there, is, is there a specific method then, a single consistent view of how to teach particular aspects of the subject. I don't know whether you're thinking, I've got a specific method in mind, when I teach division, because I want children to understand and build up this notion of the concept. In order to do that, they've got to do this, this and this? Or whether it's wider than that, and you're talking about your single consistent view. This is really tricky because I don't want to twist what you think, either.*

RES2: In terms of teaching mathematics, I think that's it's really important that you don't stick to just one method. I say that with a caveat of actually, I also think, at times, that is really helpful. Because I think actually, you should know what you're aiming for. I know there has been controversies, in terms of the new curriculum, in

terms of this is what they value as an efficient proof of method. People argue, well, actually, does it have to be? But, if that is what we're aiming for, if that's what the curriculum says, then that is what we should be aiming for. However, in order to get there, different children are going to understand it in different ways, and at different times.

I've got a repertoire of methods, for each. Let's take calculation, that will evidence the conceptual understanding of that formal written method, in different ways. So, the first 10 children in a class, may get it one way. The next five may get it in a different way. It's actually having that repertoire in your understanding of a concept, that you can then talk to children, break it down in different ways, see it from a different perspective. But, ultimately, aiming towards the same thing. That is probably my views on that. I know that in my old school, we had this situation where across three classes in a new group, children were taught three different methods for the same thing.

So, then they'd come into different rooms and it'd be, well that doesn't work. And, so that's my conceptions about the kids, we're going to have a calculation policy, to avoid that sort of confusion. But, in order to attain what you want to get from your end goal, of the calculations, for example, I think you do need that repertoire of strategies to unpick it and explore it.

As can be seen, in fact this respondent reiterated many of the points made by the first respondent, that she had a "repertoire of methods", because different children in the class "... may get it one way. The next five may get it in a different way". This kind of rationale is very reminiscent of when the first respondent says: "what might work on one day, doesn't work on another day". Hence while the second respondent had agreed with QS8.3, it was not because she had specific methods for teaching, it was because she had interpreted the question somewhat differently.

I did not simply leave the conversation there, I wanted to probe this to learn more about her nuanced understanding.

INT: *Can you remember the example in school? What that was to do with? What the different methods were? Just out of interest really.*

RES2: It was two-digit multiplication. So, in one class there was partitioning and the other class it was a method using brackets, similar to expanding equations. It

was essentially partitioning, but done in brackets, and laid out in a different way. Then, they came and, "Oh no, that's not how we do." But, I think, ultimately, I think all of these methods rely on the same principles. So, for me, it's drawing out those principles, rather than peculiarities of a particular method. It's this idea that each method leads beautifully over to multiplication methods. But, only if we can see, okay that bit, that bit is just that bit. So, enabling children to see that as well, rather than seeing them as separate methods, I think is key.

This particular respondent appears to be saying that a teacher educator should not simply be offering PSTs single best methods, but the consistent principle which underlies sets of methods, so that they are able to understand the methods, and use them as and when appropriate, since PSTs like MTERs need to recognize that there is no "one size fits all".

I halted the discussion about the topic at this point, but then asked a broader "opening out" question. The respondent went on to elaborate even further:

INT: *Thank you for exploring that in a little more detail with me. I just wanted to understand what your perspectives were there. And, I feel as though I've got a better understanding from what you've explained. Is there anything else you want to add in terms of your role as a mathematics teacher educator, your particular professional identity?*

RES2: I think there's something [unclear 0:53:08]

INT: *It's breaking up slightly, do you mind saying that again?*

RES2: In terms of professional identity, there's something I've come to. It's the one thing, we do get challenged on. One of our colleagues did some research and talked about universities promoting best practice. And, students almost getting a little bit of upset, as in is university a bit of a utopia, where you can talk about these ideas, but actually you don't have to…Like I said earlier, that is absolutely key within maths education, in terms of the ideas that we, perhaps, present as best practice, are not the ones that are implemented in schools. So, for me, it's almost being honest about that. But, almost at the same time, saying, "This is, genuinely, what I believe. This is what we believe, this is what I can evidence to you. I can find lots and lots of research, which will say this is going to work. But you've got to have the confidence to try it."

For me, I suppose it's that identity of not being somebody who just portrays and, in the crowd, beautiful, oh this is how maths education could be. But then, picking those ideas and through our modules, in the first few we embed the aims of our

curriculum into our teaching of the content of the curriculum. In the third year we very much look at the use of rich tasks, and open tasks, and really enrich those threshold high ceiling tasks. So, we look at the other aspects of the curriculum we looked at in the first year. But, in the third year we do it through the use of which tasks we're promoting. So, my role, as a maths educator, is not to just promote good practice, and say, "Oh this is best practice, it says here in the research." But, actually, to say, "And here's how you can do it." So, they've then got a confidence to say, "Okay, even if I don't see it on my teaching placements, I can do it in my classroom and I believe it will work."

Clearly, for this respondent, QS8.3 had triggered the memory of a whole set of professional conversations about the promotion of "best practice", which as it appears here, is not about teaching specific techniques of doing multiplication or anything else, it is about promoting a framework within which PSTs have the confidence to adopt the range of styles and methods that they need to become good teachers. This to me runs almost entirely counter to the text of QS8.3 as I had originally intended it to be understood.

As can be seen from these exchanges, *respondent validation* was not as a simple process of "checking" that the respondent actually meant to tick that particular box on the Likert scale, but to uncover their rationale for doing so, and understand their thinking which surrounded their choice. In this particular case, it revealed that at least for some of the 12% who agreed with QS8.3 had perhaps done so because they had interpreted the statement in a different manner to what I had intended, and to how others had understood the statement. However, despite the fact that the second respondent agreed, rather than disagreed with the statement, what appears to be the case is that both MTERs expressed the same types of view – that as part of their MTER role they needed to offer PSTs a multiplicity of teaching techniques and strategies, and that while there may well be general underlying principles to be understood, there is not just one way of doing anything.

Appendix F1: Reformulating the Davey framework:

This appendix takes the Davey Framework, as presented in Appendix A1, and reformulates it as a result of the research set out in this study.

F1.1: A brief summary of the findings

It is challenging to take a diagram summarising the work of another researcher, and reformulate it, because inevitably what appears on paper as the end-product, is a mere distillation of an entire study. In addition, I should be extremely wary of doing this, partly because this study has only ever been exploratory, and secondly, it has used Davey's framework extensively throughout, as a methodological tool, as an organising structure and as an analytical instrument which has been quite successful in allowing me to examine a complex topic. In that sense, the framework has exceeded expectations, and despite any shortcomings, it still remains a highly valuable piece of work.

There are several issues, however, that would need to be addressed, if the framework is to have any more value than an organisational tool.

First of all, from the Factor and Correlational analyses in Section 5.8 and Appendix C1, it can be seen that there are no clear-cut distinctions between the different lenses, and while the items within individual lenses were often well correlated, providing a range of good insights, there was so much overlap between different lenses, that it was difficult to see them as different "dimensions", and as noted in 5.8.3, the coherence of some of the lenses is questionable. Clearly, Davey understood this, and it was not her intention to produce five different independent aspects or lenses of identity, merely that these were merely different ways of looking at the same things.

Secondly, it was seen almost from the start, that some elements, while not exactly missing, had not been given the prominence that they might have had. For example, as noted in Section 3.3.3, while *valuing* is an intrinsic part of *being*, the aspect of "*feeling valued*", especially by those in authority, was less evident in the

framework although "*sense of worth*" came out in Davey's discussions with participants. Items related to value and being valued (QS15.2 and QS11.3) formed part of the important core of items of Component 2 "Knowledge Understanding and Values", arising from the Factor Analysis reported on in Section 5.8, and specified in Table L5 in Appendix C1. Furthermore, while within the lens of *becoming*, there was a sense of "constant becoming", and this included the idea of professional development, *developing* as a discrete lens was missing. When this was explicitly addressed in Chapter 6, it yielded very useful detail.

Thirdly, the lenses seemed to fall naturally into two groups: this was initially highlighted by the Principal Components Analysis in Section 5.8, but was reinforced by other considerations, as noted in Section 6.1. This led to the following two groups of items:

Group A: *Becoming* and *Belonging*, echoing the ongoing personal and professional development and the "embedding" of MTERs into different communities at different stages of their careers.

Group B: *Being*, *Knowing* and *Doing*, echoing the maturing knowledge, practices, values and personal philosophies of MTERs.

These two groups formed a modified basis for the analysis of the material in Chapter 6.

Group A describes not only the processes leading up to, and the induction into the role, and in taking on the identity of MTER, but also describes what happens as an MTER takes on further challenges within the role itself, and encounters new communities of MTERs or begins to change focus to take on the role of researcher, rather than of teacher or learner, eventually *becoming* an expert in the field. To do this requires a commitment to the role – a feeling of *belonging* and a large investment in terms of personal and professional development. From the literature review, and from the empirical research in this study, much of this could be described in terms of interactions between MTERs and their peers, and the communities with whom MTERs engage. These communities are diverse, and extend well beyond just the community of other MTERs; they include for example,

communities of teachers, learners, and colleagues at other institutions. Such issues were highlighted in the Literature Review, Sections 2.7.1-2, and arose again when considering the different ways in which collaborations between MTERs can occur in Section 5.5.

In fact, *becoming* and *developing* are actually part of the same process, with over four-fifths of respondents expressing the views that professional development is fundamental to being an MTER, that they have developed during their time in post, and wish to go on doing this in the future (QS4, Chart C1). *Becoming*, therefore is not limited to an initial period, but is part of a career-long commitment. This claim is neatly summarised in Chart 6.1 (Section 6.2.3), which shows the differences in engagement with the MTER community between those with less than 10 years in the profession, and those with more. This claim formed the basis of Research Hypothesis 1, which was tested in Section 6.2.1 against the interview data. For most of the respondents, *becoming* is not just the period at the start of their career, but marks the transition to different stages in the life-cycle of an MTER: they might have "become", and "developed" as a Teacher Educator, but then decided to deepen their commitment by *becoming* and *developing* as a researcher or as a mentor to new MTERs. Interestingly, the counter-cases in Section 6.2.1, who seemed not to exhibit this behaviour, had either moved onto other roles, or had left the profession.

Group B encapsulates the role itself, together with all its knowledge, beliefs, skills, values, and while much of an MTER's knowledge base will remain as a core to be drawn on throughout their careers, in this study, it has also become apparent that many of the elements within the lenses described by Davey are processes rather than single events, and are transitory rather than fixed. *Belonging*, for example as seen above is clearly a process, which is manifested not just in terms of the induction into the profession, but in the commitment to professional development which inevitably follows. This was exemplified in Research Hypothesis 4 (Section 6.3.2), which proposed that MTERs tend to supplant currency of classroom experience with research-related material over time, and while this claim turned out not to be fully correct, what was clear is that initial currency and experience get

supplanted by other forms of currency: research, working with teachers, school-based supervision and moderation activities.

Thus, *Being*, *Doing* and *Knowing*, can be seen as potentially changing and developing throughout an MTER's career, even to the extent that what MTERs "do", or need to "know", may be different in different contexts. In Section 6.3.3, *valuing* and the sense of "*being valued*", the latter not being explicit within the Davey Framework, were both explored within the lens of "Doing", where four key areas were identified. *Valuing*, as noted above, arose as an important correlate of component 2 from the Factor Analysis in Section 5.8. Here the term should be understood, not only in terms of the values held by MTERs, but also the way that others value the work of MTERs –learners, teachers, educational leaders, education ministers and secretaries of state, and reciprocally, the way that MTERs perceive this sense of feeling valued by them.

F1.2 The Revised Model

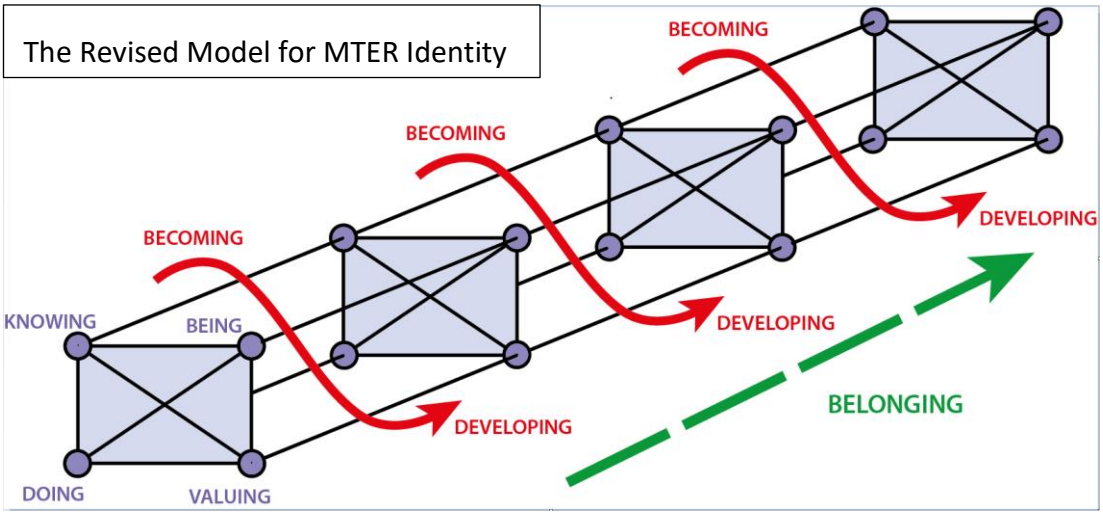
This section offers a reformulation of Davey's framework, to produce a revised model which includes the results of this study.

First of all, it should be noted that Davey simply provided a framework for classifying the different aspects of identity. The framework itself did not seek explicitly to explain what that identity was, nor how it had been acquired, nor how it developed. Davey did address these ideas in her study, but they were not expressed explicitly within the actual framework. Davey described processes which would account for such ideas, but the framework itself was descriptive, not explanatory. The revised model below attempts to see MTER identity as an ongoing process; not something that is held and fixed, but something which develops over time, and, in the words of Jenkins (2014, p.6) "*it is something that one does*".

At the core of the model, shown as the vertices of the shaded blue rectangle are a group of Davey's lenses: *Knowing, Being* and *Doing*. These are joined by a fourth lens, as noted above: *Valuing*. Each of these provides a different perspective on

identity, and on each other, and forms the essence of the identity of an MTER at any point in time.

The Revised Model for MTER Identity



However, that point in time is not fixed: MTERs did not start out as MTERs; they became MTERs, and acquired the identity they now have, and MTERs may go on to acquire new facets of their identity – new knowledge, skills, values. What these will be in five years, even a year, may well be different to what they are today. This is the ongoing process of development that was apparent from the study, that *Becoming* and *Developing* go hand in hand. Both of these are now part of the deeper commitment described by Davey as *Belonging*. In this model, *Belonging* therefore is seen as a series of *Becomings* and *Developings*, with an individual MTER deepening their commitment to the profession over time, and with it their sense of identity.

The model is both predictive and explanatory. It requires that there are deep connections between knowledge, skills, and values and how an MTER sees themselves, and presents themselves to the world: this hypothesis can be tested by further research. It also suggests that many new MTERs will go through various transitions of different types throughout their career; again research will be able to test this hypothesis by examining the career development of recent inductees to the professions.

The sense of *belonging*, and the act of *belonging* itself, is represented by a broken line; whilst this is a significant feature of an MTER's identity, there are times for individuals when this is less important or when the sense of *belonging* means possibly breaking away from one element of, or one part of a community and *belonging* to a new and different one.

The model is also useful in suggesting new ways of looking. The fact that the core aspects of *Knowing, Being, Doing* and *Valuing* continue throughout the career begs the question of the extent to which any part of these is fixed and unchanging. As is noted above, the recent school experience which informs practice for a beginning MTER is augmented and possibly even supplanted by other experiences during their career. However, there may well be core values and principles, together with understandings and beliefs, which do not change, even over the course of a career. The model, while suggesting the possibility of change over time, does not preclude stability. Determining what types of an MTER's beliefs, practices, knowledge and values change, and which remain stable over the course of a career, could be the basis of an interesting research study. Other possible research hypotheses arising from the model are given in F1.4.

F1.3 Elements of the Aspects and Processes

Tables F1.1 and F1.2 below lay out the different elements of each of the aspects and processes in the revised model. In each case, items shown in black are original to Davey's Framework, but the descriptors used may have been modified slightly from Davey's own words. Items shown in green are present in the Davey Framework, but in a different form or place. Items shown in red are additional and were not included in the original Framework.

As an example of how items have been modified, "roles" originally appeared within the *Being* lens, and "key roles and responsibilities" appears in the *Doing* lens. Davey (p. 39) clarifies that the nature of the *Being* lens concerns self-image, while the *Doing* lens concerns daily experiences. Clearly the term "role" means different

things in different contexts; the way we project our self-image in the roles we act out contrasts with the day-to-day task requirements as a professional. Accordingly, these have been split into “roles acted out”, and “responsibilities undertaken”.

While the model appears visually very different from Davey’s Framework, to a very large degree there is a great deal of similarity in the detail, because by and large the framework was successful in providing a basis for exploring a complex topic. There are three main changes: a splitting of the five lenses into two groups; viewing these groupings as a stable core of aspects together with a set of processes; and, extending the initial five lenses to seven by creating a new aspect and a new process.

Perhaps it also needs to be noted here, that the very first structure detailed in Section 2.1.4, the Advance HE Framework which was investigated as a possible way of organising the study has at its core three dimensions: “activity”, “knowledge” and “values”. A comparison to the items within each of the panels in the framework in Fig 2.1 reveals strong similarities to the revised elements of each of the aspects in Table F1.1 below. Furthermore, the processes outlined in Table F1.2 in many respects are reflected in the progress through the different levels of the Advance HE framework. However, the difference here is that the revised model is non-hierarchical and non-judgmental; transitions can be made to different identities without necessarily “advancing” in career terms.

Table F1.1 The Core Aspects of the Model and their Elements

The Core Aspects				
Aspect:	Being	Doing	Knowing	Valuing
Focus on:	Self-image	Professional daily concerns	Forms of Knowledge and experience	Values held and perceived value
Elements:	*Adopted "personae"*	*Job descriptions*	*Sources of credibility: currency*	*Personal values & beliefs*
	Roles acted out	*Responsibilities undertaken*	*Experience & qualifications gained or held*	*Professional values & beliefs*
	Personal Qualities	*Professional Activities*	*Bases for Knowledge*	*Integrity and honesty*
	Emotional positioning	*Perceived scope of the role*	*Teaching perspectives and philosophy*	*Perceived value from peers*
	Personal & Professional Likes & Dislikes	*Tasks undertaken*	*Concepts of the curriculum*	*Perceived value from others: learners, teachers, government etc.*
	Sources of pleasure & anxiety	*Priorities and prioritisation*	*Perceived specialisms & skills*	*Perceived value of own contributions*
	Self-image and self-imagery	*Personal & Professional Commitments*	*Sources of knowledge and information*	*Ideas of Social Justice*
	Self-awareness and self-criticism			

Table F1.2 The Process Elements of the Model

The Processes			
Process:	Becoming	Developing	Belonging
Focus on:	Aspirations and Intentions	Professional motivations	Relationship to Communities of Interest
Elements:	*Hopes and expectations*	*Professional biography*	*Functional relationships*
	Induction experiences	*Career plans*	*Group affiliations*
	Motivations	*Professional Development Activities*	*Communities of practice*
	Transitioning to new situations	*Motivations for change*	*Similarities or differences to other groups*
		Narrowing or Broadening of focus	*Group ethos and values*
		Handling transition	*Peer support and pressure*

F.1.4 Research Questions generated by the Reformulated Model:

The Reformulated Davey Model provides a basis for understanding the core elements of MTER identity and the processes by which this identity is acquired and changes. Below is a short list of potential research questions generated by this model

1. Which, if any of the elements of the core aspects of MTER identity are stable over the course of an MTER's career, and which are subject to change? How does this change occur, and when?
2. What are the relationships between each of the aspects in the core, and does holding a particular position in one of the aspects correlate with another?
3. At what points and under what circumstances do transitions occur? What types of circumstances trigger an MTER to start the process of *belonging* to a new community or group?
4. Do MTERs recognise these identity "transitions" in their career? If so, are they conscious of the need to "become" part of a new group, or community, and if so, how do they go about this?
5. How do MTERs go about "developing" the core aspects of identity in response to external change, or when encountering a new community?
6. At what point do MTERs feel that they "belong" to a particular community, and change their understanding of their own identity – or do they still feel they retain previous identities, and simply acquire an additional one?

There are clearly many such research questions which might be considered, and the answers to these questions would form interesting studies in their own right, even without the support of the model.

Appendix G1: Reliability and Validity – Methods adopted

The material in this appendix summarises the criteria by which potential threats to reliability and validity have been addressed in this study. The criteria in the main are those described by Bryman (2008), pp.149-153 (Quantitative data) and pp.376-379 (Qualitative data). However, in deriving his list of criteria, Bryman cites the work of other authors such as Geertz (1973), Lincoln and Guba (1985) and LeCompte and Goetz (1982). The work of these authors is referred to in Section 3.3.2, and the criteria in the tables below have been supplemented with material from these authors.

It should be noted that while the various criteria below have been adopted in order to address the potential threats to validity and reliability, that does not in itself guarantee that these threats have been avoided. For example, the construct "age-phase", derived from the responses to the question about which phase of schooling the respondents are concerned with, has significant construct validity issues as discussed in Section 4.6.1, because almost all respondents identified multiple phases in their answer; hence compiling any data about the "primary phase", for example will inevitably use much of the same data as for the "secondary phase". That means the two constructs are not independent. In this case, validity concerns have led me to minimise all findings related to any of the age-phase constructs.

Table G1.1: Qualitative Data – Reliability and Validity Criteria

Qualitative Data			
	Criterion	Description/Issue	Example of how addressed in the study
Validity Criteria	credibility	"respondent validation"	*Feeding back sample of responses to respondents, seeking agreement or clarification of findings*.
	comparability	Delineation of group and constructs	*Summary descriptions of the interview group, with demographic data to enable comparisons with other groups.*
	transferability	Production of "thick descriptions"	*Material presented in enough detail, with respondents' own words together with specific context and interpretations, so that others can judge the generalizability to other contexts.*

Reliability Criteria	dependability	"auditing"	*Full records and transcripts kept at all stages to ensure that in principle peers can audit the material to judge whether the researcher has validly extracted the meaning. In this study, long extracts are provided together with interpretative material.*
	confirmability	"acting in good faith"	*Attempts not to allow personal values or opinions to bias the research in specific ways, by letting the respondents speak for themselves, with minimal editing.*

Table G1.2: Quantitative Data – Reliability and Validity Criteria

Quantitative Data			
	Criterion	Description/Issue	Example of how addressed in the study
Reliability Criteria	Stability	Different measures of the same item should agree.	*Established by the level of agreement between respondents on each item, summarised as charts and statistical measures.*
	Internal reliability	Cognate items should produce similar results.	*Comparison of results within a category, correlation between items in the same category.*
	Inter-observer consistency	Different observers may classify differently: checked via open-ended items.	*Questionnaire items may be interpreted differently by different respondents; open response items used as comparison to ensure that respondents are interpreting items in the same way, and the manner intended.*
Validity Criteria	Face validity	Questionnaire item wording may not accurately reflect content.	*Part of pilot study asked experienced MTERs to review the wording and suggest amendments.*
	Construct validity	Concepts derived from data must accurately reflect a reality.	*Variables used in all statistical analyses should be robust and should represent the respondents' attributes and attitudes clearly and unambiguously.*
	Concurrent validity	Do related constructs give similar results?	*Measured by the correlation between whole sections, such as comparing induction and motivation*.
	Convergent validity	Different methods of producing data provide similar results.	*Examined by comparing the summarised results of item groups against similar results from open response items.*

Since this is a "mixed methods" study, many of these criteria are used throughout, with some "qualitative" criteria being used in a quantitative context and vice versa. For example, it is necessary to consider whether the sample of MTERs used for the survey has been subject to selection bias. However, as noted in Chapter 2, there is sparse data on MTERs with which to compare. In order to address this, I have adopted the comparability criterion from qualitative data. Accordingly, the whole of Chapter 4 should be seen as an exercise in attempting to document the 144 respondents in sufficient detail as to expose any internal biases or skews within the sample of 144, and thus allowing judgments to be made about the comparability of this sample of MTERs with other groups of MTERs, in order to determine whether generalisations made from this sample to other MTERs might or might not be valid.

In addition, triangulation has been used systematically throughout the study. The purpose of triangulation, is "*using more than one method or source of data in the study of phenomena so that findings may be cross-checked*" (Bryman, 2008, p. 700). Triangulation methods are used at both large and small scales, and on both qualitative and quantitative data. In fact, one of the principles I have adopted in this research is that for each of the findings, it should be cross-checked where possible, by a different method, or by reference to another, related result.

Triangulation has been used at all scales. Some of the ways that this has been carried out are highlighted below.

At the largest scale, Davey's lenses themselves provide five different ways of examining identity. We should expect to find that when similar topics are examined via each of the lenses, they will produce similar results. This will occur at all scales, for example that the idea of "a community of MTERs" should emerge with a core of similar, but complementary features from several of the lenses. This also should be true at the small scale, within lenses, so that, for example QS4.4 and QS5.8 both refer to making research contributions, one in the context of what an MTER needs to know, the other in the context of personal attributes.

The twin approaches of using a questionnaire and interviews was a triangulation response to the validity concerns of basing a study mainly on a questionnaire

approach. In order to compensate for potential threats to validity, I saw interviews yielding "thick" data (Geertz, 1973), derived from a relatively open agenda, as a way to compensate for imposing pre-defined set response options in a questionnaire, which might have restricted the responses from participants, or even have created artefacts of the research. In fact, because of the way that many MTERs used the open response items to elaborate on their views, the questionnaire provided a strong methodological base for triangulation. However, I could not anticipate that MTERs would be so forthcoming in their views, and so the interviews were a necessary part of the overall methodology.

Triangulation has also been used on smaller scales: for example, each of the lenses in Davey's framework, consists of multiple items. This is an attempt to triangulate within each lens, by asking similar, but related questions. Each lens is accompanied by open response items, collecting the data and analysing it in a different manner, in order to arrive at a triangulated summary to allow comparisons.

Each of the statistical methods used to analyse the data has been subject to two different approaches: percentage agreement and average scores, and this is followed up by two different methods of ANOVA, together with a Levene's test. The overall scrutiny of the Questionnaire items and the Davey Framework was carried out both by Factor Analysis and Principal Components Analysis, and this was explored further by using the item-item correlations between and within the different lenses. The use of dual methods is important, in that in a study such as this, where there are large numbers of statistical outcomes, some will appear to be significant simply by chance. By using multiple measures, some of these can be detected.

Reporting from the Qualitative data presents both summaries and detailed "thick" data, simply as a way of ensuring that different approaches are used to examine whether conclusions are valid and reliable.

It is not always the case in this study that these comparisons yield consonances. In the text, the reader's attention is drawn to cases where such multiple methods yield conflicting outcomes – for example in the use of Kruskal-Wallis, and ANOVA, as well

as cases where the results from the questionnaire seem to conflict with data from the open-ended items.

Such cases should not be regarded as a failure of the research methodology, but a success, in that the methodology is robust enough to detect such cases. Where these occur, the reasons why the differences occur is often at least as illuminating as the case where the two approaches are in agreement.

Appendix H1 The 27 PMTER Interviewees

This purpose of the material in this appendix is to determine whether the choice of a specific group of PMTERs to interview, poses a validity threat to the analyses and findings in this study, and would limit generalisability of results. The material below compares the demographic data and some of the responses to the Likert-scaled items given by the 27 respondents selected for interview, with the results from the entire cohort. In this way, it is possible to determine whether there are any features, characteristics or opinions which are held by this group which would potentially bias the sample in any manner.

H1.1 Rationale for the PMTER Sample

This section presents a detailed rationale as to why the sample was chosen, and the selection method used to recruit respondents.

After the first few completed questionnaires arrived, it became clear that the "filter" for age-phase (QS19) was not working as I had originally intended. I had used a multiple option approach to allow for those who shared their time equally across phases. However, some respondents whose work I knew personally, responded by checking multiple age-phases as ones with which they were 'concerned': to the best of my knowledge their roles almost entirely focused on one or two phases (usually primary and EYS) however with hindsight I could see my choice of the language of 'concerned' was being interpreted as 'interested in'. This was what first alerted me to the fact that there were serious issues with the "age-phase" construct as I had intended to use it in the survey.

One option would have been to simply marginalise this aspect of the data, and use the interview sample as I had originally intended in Section 3.5, for respondent validation, as in the example provided in E1.3 of this Appendix, and to produce a rich source of data, drawing out further details and issues. However, a different option was to use my knowledge of the field to look at the profiles of respondents

and choose respondents with a specific focus, in order to rescue some possible age-phase comparisons, or at least to be able to derive generalisations about one specific group.

The methodological issues in doing this were:

(1) Selecting a particular age-phase group would not in principle affect the essential "respondent validation" aspects of this part of the study, since this was to be based on individual responses. However, the group composition and their profiles of agreement on each section would need to be compared against the results for the whole sample.

(2) Selecting a specific age-phase, for example Primary, would allow a comparison with others in the survey with a specifically primary focus, and more generally those in the full survey. Any differences could potentially be attributed to age-phase focus. Thus, while we might not be able to compare Primary versus Secondary directly, for example, the sampling method might potentially reveal features specific to Primary.

(3) Further to this last point, since Primary is my field, I am more aware of issues related to primary, and I felt that I was able to seek more in-depth answers in particular areas.

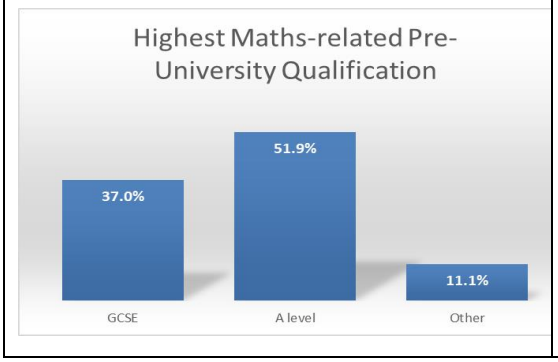
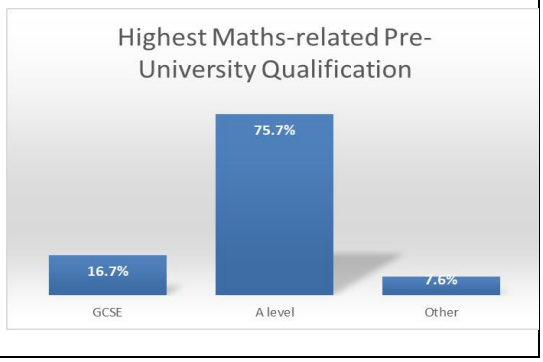
For these reasons, I opted to recruit a sample of MTERs who appeared to have a strong focus on Primary. In choosing a focused sample, any specific conclusions, apart from the respondent validation aspect, which might be drawn from such data would probably only be generalizable to Primary MTERs, unless there were support for such generalisations from the full set of data. For example, if I were to uncover an issue in the interview data, not present in the survey, then that particular issue could only be claimed to be applicable to Primary, as there would be no evidence of its relevance to other phases.

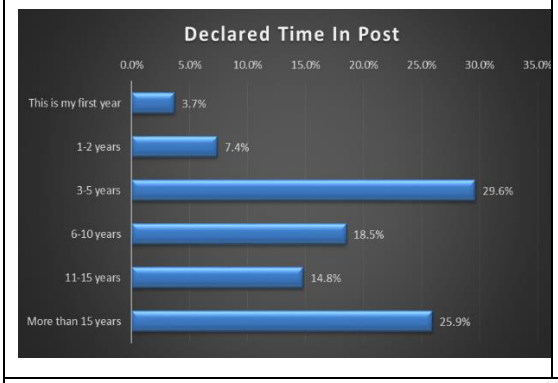
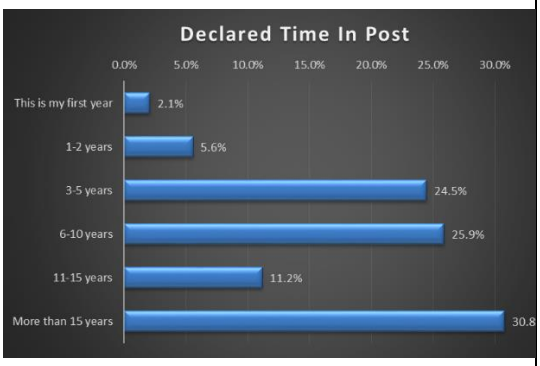
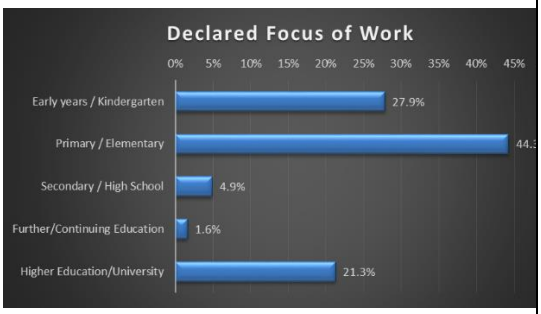
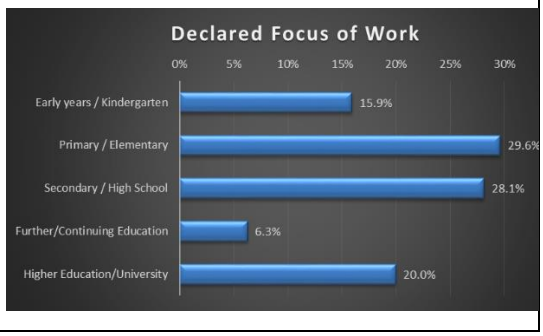
The recruitment procedure I adopted was to sort through the responses as they arrived in the portal, and select those which appeared to have a predominantly Primary focus for interview, and so begin the processes of contacting them. The

main reason for this was that I wanted their questionnaires to be fresh in their minds, rather than having completed the survey many months earlier. In that way I could address any lack of clarity in their responses, and pursue credibility issues via respondent validation.

This procedure turned out to have some interesting consequences.

H1.2 Demographic Data

Interview Sample	All Respondents
Highest Qualifications	
	
Percentage with A Level Maths	
	

Interview Sample	All Respondents
Declared Time in Post	
	
Declared Focus of Work	
	

Commentary on the differences in the Demographic data

The qualifications between the two groups are largely similar. However, there are some key differences:

Overall, the sample has slightly more respondents with higher degrees (74.1%) compared to the whole group (72.9%). However, there are marginally fewer doctorates in the sample group (29.6%) as compared to overall (40.3%). Out of the 27 in the sample, there were 8 people with doctorates; if the sample had been exactly representative, we might have expected 10 or 11; however, the difference is not statistically significant.

The split between Maths-related and Maths Ed related higher degrees is approximately the same for both groups:

25.9% Maths- related versus 48.1% Maths Ed Related for the sample,

compared with

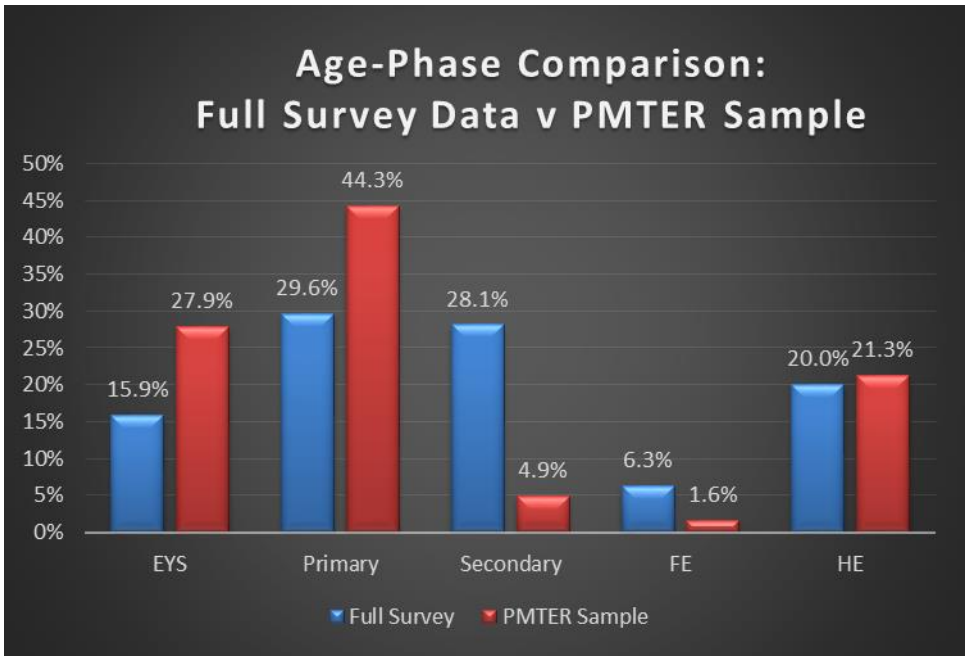
27.1% Maths- related versus 45.8% Maths Ed Related for the entire survey.

Fewer within the sample group have an A-level in mathematics, (51.9% compared to 75.7%), and using a Chi-squared test, the profile of pre-university qualifications is significantly different between the two groups (p=0.01, Chi-squared = 9.03, 2df). However, it has already been noted in Chart 4.14, that a lower percentage of those declaring a Primary focus possessed an 'A' level (68.8%), as compared to the whole group (75.7%). Here the figure is even lower, and is possibly evidence of a real difference in pre-university qualifications between those with a different age-focus.

The "time in post" profiles are largely similar; the 3-5 year category in the sample contains proportionately more PMTERs than the whole sample, but the difference in actual numbers would represent no more than two individuals.

The major significant difference is in the age-phase focus. Here it is to be expected that proportionately more respondents would cite a focus on the Primary age-phase, and this is what we see: 44.3% compared to 29.6% for the whole survey. These differences can be seen in chart H1.1 below.

Chart H1.1 Comparing the Age Phase profile of PMTERs with the entire survey data



The effect of respondents choosing multiple categories can be seen clearly in this chart. All of the 27 PMTERs had a focus on Primary but between them they generated 61 responses in total, with 17 of the PMTERs declaring to also have a focus on EYS, for example. The percentages shown are of the total responses, in a like-for-like comparison with other age phase data.

From this chart, the major difference between the two profiles, is in those declaring a focus on secondary or FE as well. In the PMTER sample these are 4.9% and 1.6% respectively, compared with 28.1% and 6.3% for the whole survey population.

A Chi-Squared test was carried out to compare these two profiles: the result showed that there is a highly significant difference between the profiles ($p = 0.00009$; Chi-squared value $= 23.72$, with 4 df).

Therefore, overall, in terms of the Demographics collected, there are no significant differences between the two groups, other than the ones to be expected, given the explicit selection of Primary MTERs for the sample, and the analysis of the survey data in Chapter 4. While PMTERs held marginally fewer doctorates, the split between Maths and Maths-Ed was roughly similar. Proportionately fewer of the

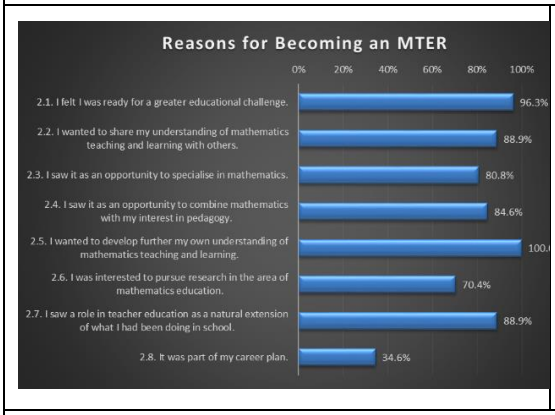
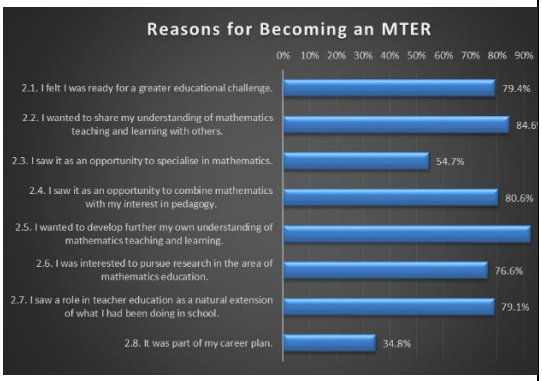
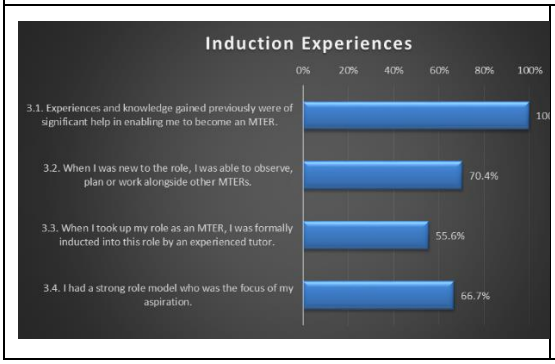
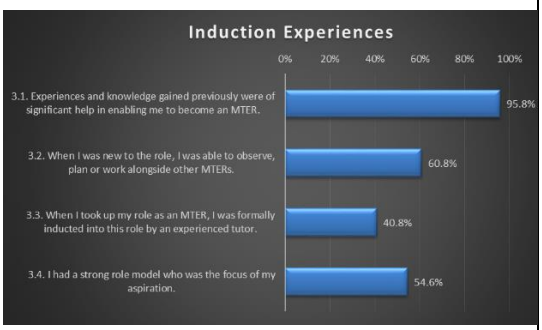
PMTERs had a mathematics A-level, but this is what we should expect, given the survey data in Chart 4.14. Previously, validity issues with the "age-phase" construct have prevented me from explicitly claiming that lower numbers of EYS and Primary MTERs possessed 'A' Level mathematics. Perhaps here is the first piece of evidence indicating that lower numbers of those teaching in the Primary age-phase (and possibly EYS as well), have studied 'A' level mathematics. Given what was noted earlier about the fact that to have studied 'A' level at least signifies that the respondent has had a relationship with mathematics to a greater or lesser extent from their school-days, this poses an interesting question about the career stage at which those with different phase foci might enter the MTER profession.

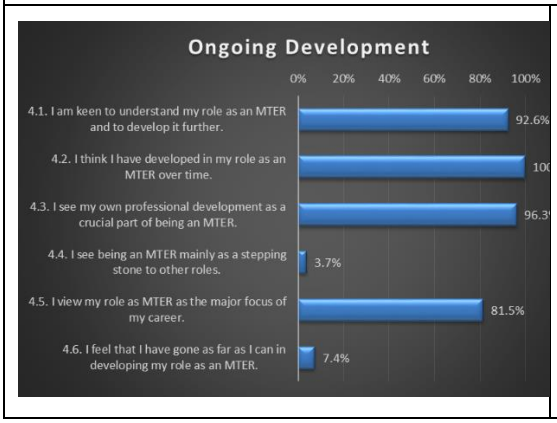
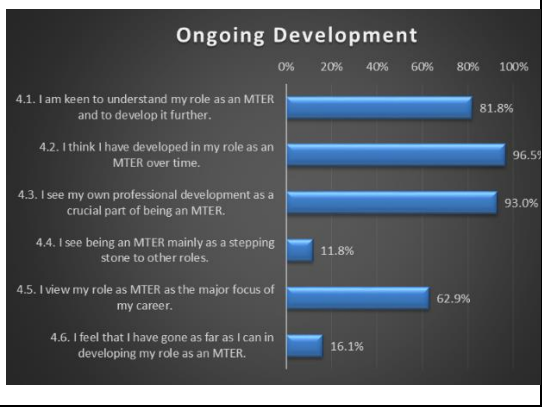
However, this is possibly reading too much into a small amount of data: the only difference of note here is that 14 out of the 27 PMTERs possessed an A level in Mathematics, compared to the 20 which might have been expected if the sample were representative. While this figure is lower than might be expected, with $p=0.01$, in a Chi-squared test, this really only just achieves significance. Given the very low numbers involved I will be cautious about drawing over-ambitious conclusions on the basis of these figures.

The important conclusion from this analysis is that the sample appears to have achieved its goal, of identifying a sample of those with a specific PMTER focus. In every other regard, as far as the demographic data is concerned, apart from the 'A' level issue, the PMTER sample appears to be broadly representative of the whole survey, and there are no inherent biases due to higher qualifications or career phase. However, that does not mean that the responses that this group will be typical of the whole survey group. In exploring this question below, I compare the set of 27 PMTER responses to the questionnaire items to the responses from all 144 respondents, and assess the similarities and differences using two different criteria:

(1) Is the overall pattern of responses within each block similar? A Chi-squared test is used to measure this.
(2) Are there similar levels of agreement on each item? A z-test of proportions is used to measure this.

H1.3 The *Becoming* Lens:

Interview Sample	All Respondents
QS2: Motivations	
	
QS3: Induction and Aspirations	
	

Interview Sample	All Respondents
QS4: Ongoing Development	
	

Commentary on potential differences in the *Becoming* Lens

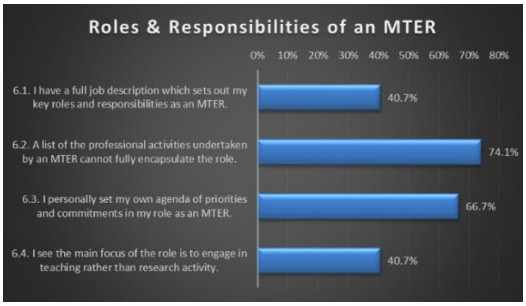
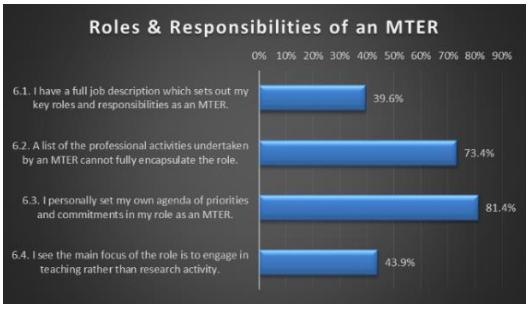
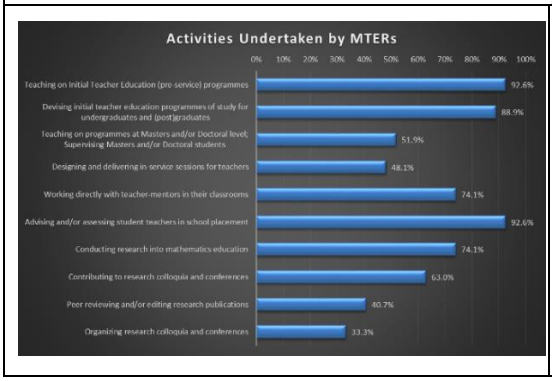
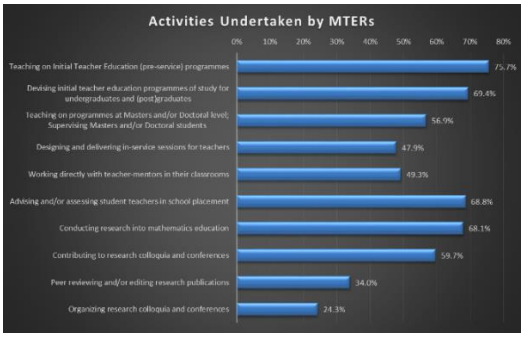
There are actually very few overall differences of note in any of the three blocks. The patterns of agreement within each of the three blocks is visually similar, and there are no significant differences using Chi-squared tests:

- For QS2, p = 0.6526 (Chi^2 = 5.0607, 7 d.f.);
- For QS3, p = 0.4518 (Chi^2 = 2.6325, 3 d.f.);
- For QS4, p = 0.4527 (Chi^2 = 4.7065, 5 d.f.).

All are therefore within what might be regarded as “natural statistical variation” such as might be expected in any subset of size 27 from the original 144. It could be argued, however that the one possible exception to this is in the “motivation” set. Far more of the sample of PMTERS said they were “ready for a greater challenge” (96.3% against 79.4%) however, this difference is not statistically significant (p = 0.0266: z= 1.9334, 2-tailed). Similarly, more saw becoming an MTER as “an opportunity to specialise” (80.8% against 54.7%. Here the difference is significant (p= 0.0057, z=2.5311, 2-tailed).

Chart A2 in the main text has already noted that there appear to be differences in motivation between those with different age-phase foci, where it was noted that the "opportunity to specialise" could be abduced into a model where those in the Primary phase are generalist teachers, who hold a desire to concentrate on their specialist subject, and becoming an MTER provides the opportunity to do just that.

H1.4 The Doing Lens:

Interview Sample	All Respondents
QS6: Roles & Responsibilities	
	
QS7: Elements of the MTER Role	
	

Commentary on potential differences in the *Doing* Lens

Here also there are very few overall differences of note in the two blocks. The patterns of agreement within both blocks is visually similar, and there are no significant differences using Chi-squared tests:

- For QS6, p = 0.8647 (Chi^2 = 0.7631, 3 d.f.).
- For QS7, p = 0.3790 (Chi^2 = 9.6567, 9 d.f.).

The only difference of any note in the first set, QS6, is the ability to set one's own agenda (66.7% versus 88.4%); however, this difference is not significant (p=0.0431, z=-1.7158, 2-tailed).

While QS7 overall shows no significant differences between the PMTER sample and the whole survey group, three of the items do however exhibit differences which are statistically significant at an individual level. These are:

- "Devising ITE programmes": p= 0.0232, z=1.9990, 2-tailed;
- "Working with teacher-mentors": p= 0.0085, z=2.3851, 2-tailed;
- "Advising and/or assessing student teachers": p= 0.0069, z=2.4615, 2-tailed.

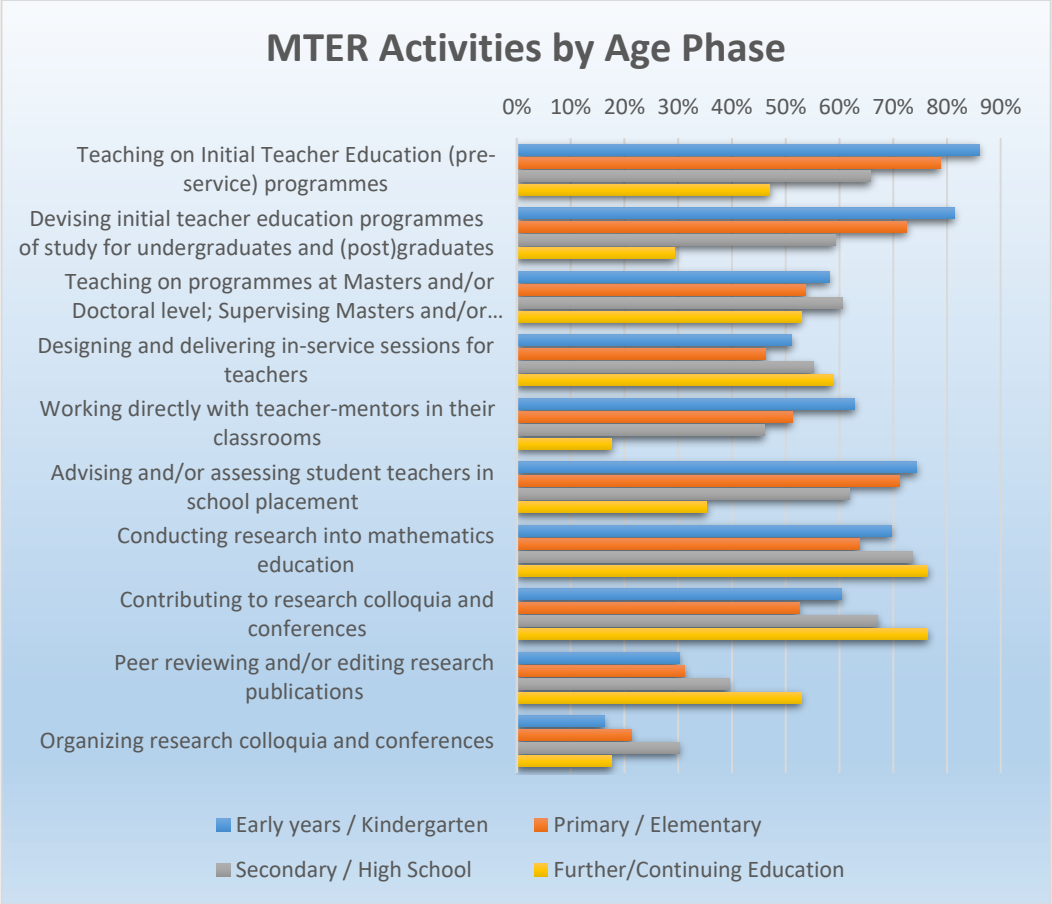
Before examining these further, it is worth noting that QS7 was a multiple-choice item and not a Likert-scaled item, and that respondents were able to select as many or as few items as they wished. Furthermore, while the differences are statistically significant at the 5% level, none is highly significant at the 1% level; consequently, perhaps it is worth issuing a note of caution here not to over-interpret these differences.

An issue of somewhat more importance might be the observation that in all but one of the items in QS7, proportionately more PMTERs reported undertaking the named activity than did the whole survey group, and that for the three items above, this represented a statistically significant increase. It is therefore worth spending a few moments to consider whether this effect may be more than a statistical artefact, and have a deeper explanation, such as an identifiable difference between Primary phase MTERs and other MTERs.

The section of the survey which analysed QS7 according to age-phase was omitted in the main text, simply because of difficulties with construct validity, since both of the variables ('age-phase' and 'activities included in current role') consist of groupings from multiple choice items. The previously omitted chart is shown

below, and notwithstanding its validity issues it does appear to indicate some differences between the phases – for example, that those with a focus on Primary and Early Years tend to concentrate more on ITE programmes, than those in Secondary and FE, and conversely those in Secondary and FE are comparatively more involved with conferences and research. Given the validity issues noted above, none of these observations can be claimed to be a result of this research, nor even a serious hypothesis, however, this does now provide an interesting backdrop for the sample of 27 PMTERs, and a baseline for comparison.

Chart H1.1 QS7 Data – MTER Activities by Age Phase.



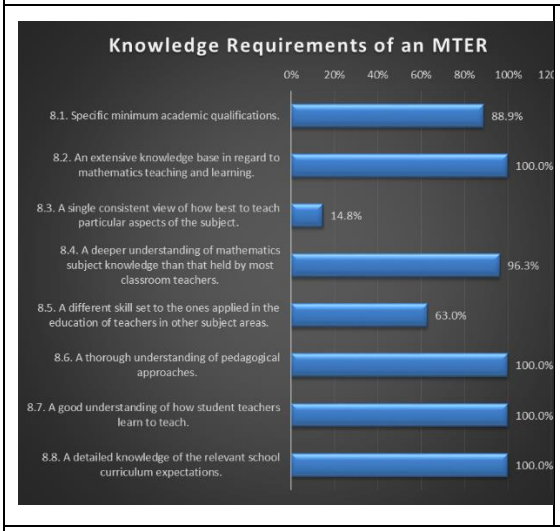
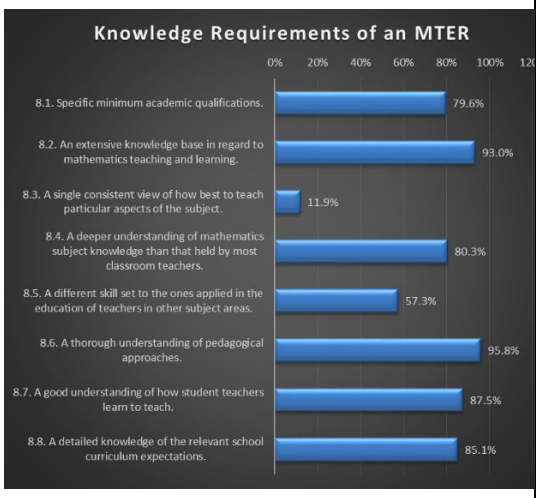
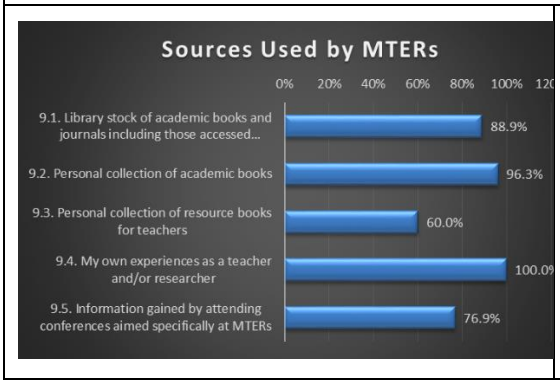
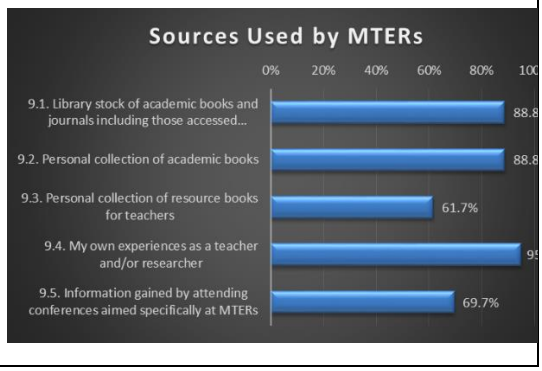
When we examine the responses to QS7 from the sample of PMTERs, there appears to be the same relative emphasis on ITE, and school-based placement activities, as with those declaring a primary phase focus in the entire survey. Thus, perhaps it is

therefore not surprising to find that these and other related activities as showing as significantly higher for this group.

However, in the main survey, the proportions of those with a primary focus who undertook activities related to research, attending conferences, etc., were systematically lower than those with a secondary or FE focus. In the PMTER sample, these activities all record as somewhat higher than the overall figures for the entire survey. This is less understandable, and while none of these figures, on its own is significant, the fact that we have four related categories, all showing a small to moderate increase in activity for this sample of PMTERs, together with the fact that this seems to run counter to what we might have expected using the breakdown above, indicates that perhaps those selected for this sample – in this particular regard - are not representative of all those who declared a primary focus, and for these particular PMTERs, there is marginally more emphasis on research-type activity than we might expect from a "typical" PMTER.

The above is merely a note of caution, since some of the construct validity on which such a conclusion is based, is highly questionable. Nonetheless this alerts us to the potential for a subtle bias in the sample which might need to be considered when drawing conclusions about the level or commitment to research activity if such generalisations were to be made on the basis of the sample alone.

H1.5 The *Knowing* Lens

Interview Sample	All Respondents
QS8: Knowledge Requirement	
	
QS9: Sources of Information	
	

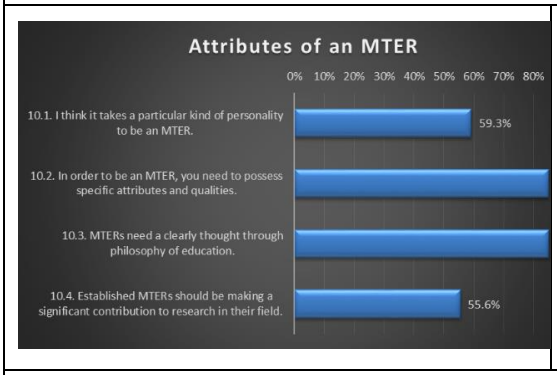
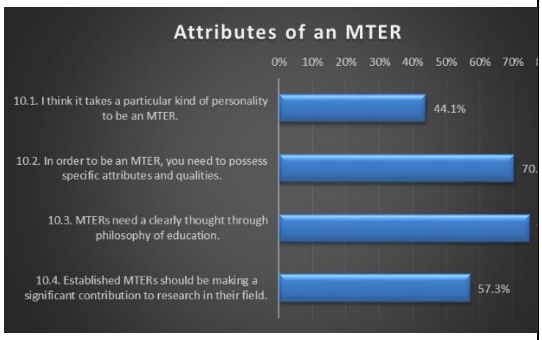
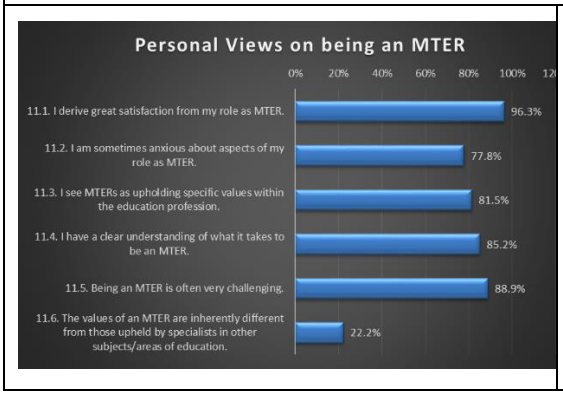
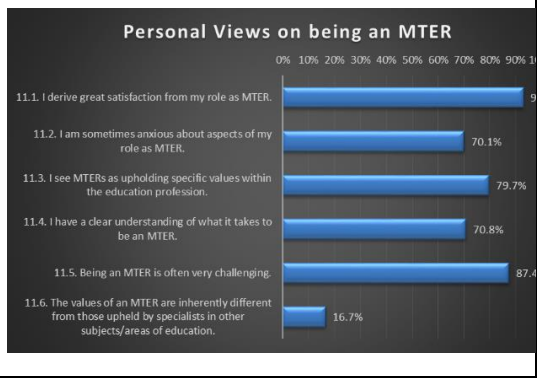
Commentary on potential differences in the *Knowing* Lens

Here, once again, the profiles of agreements on the items, for both the sample and full survey groups are very similar. All differences between the sample group and the whole survey are quite small, with only two showing over 10% difference. Unsurprisingly, there are no significant differences using Chi-squared tests:

- For QS8, $p = 0.8962$ ($Chi^2 = 2.8765$, 5 d.f.).
- For QS9, $p = 0.9779$ ($Chi^2 = 0.4527$, 4 d.f.).

Even the largest difference, that of item QS8.8, whether MTERs are required to have a "detailed knowledge of school curriculum expectations", represents an expected number of agreements in the sample of 23, whereas all 27 PMTERs in the sample agreed. However, what needs to be noted here, is while the differences are small, in almost every case they are in the same direction; the PMTERs are rating each category higher than the scores from the full survey. This is somewhat similar to the issue noted in the previous section, and will be commented on in the discussion at the end.

H1.6 The *Being* Lens

Interview Sample	All Respondents
QS10: Attributes of an MTER	
	
QS11: Personal Views on Being an MTER	
	

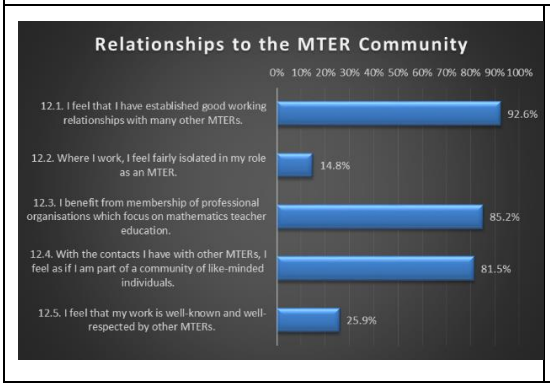
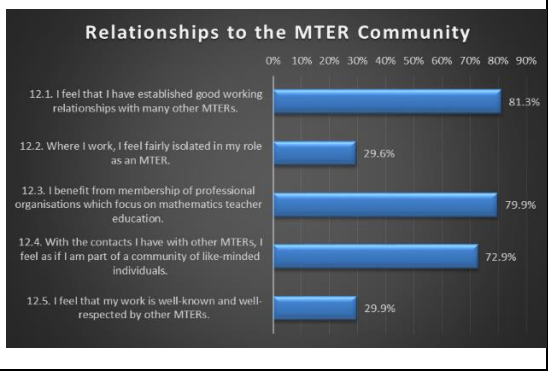
Commentary on the *Being* Lens

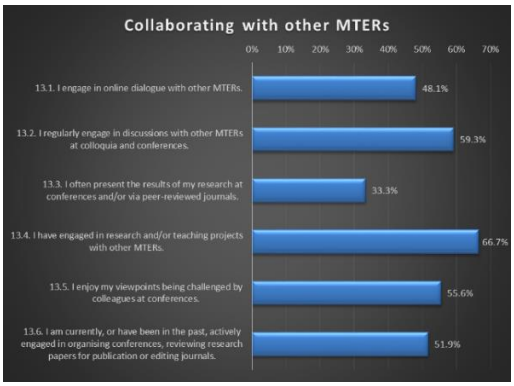
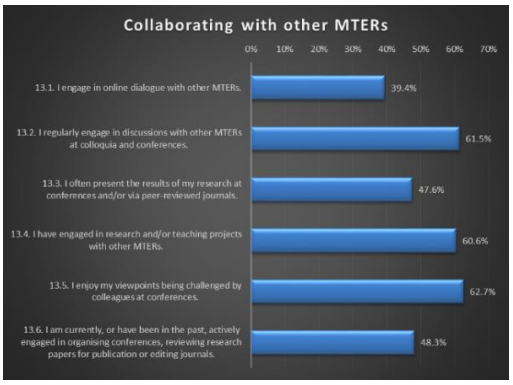
Once again here, the profile of scores for the PMTER sample matches almost perfectly that for the full survey, and the majority of the differences are quite small, and there are no significant differences using Chi-squared tests:

- For QS10, p = 0.4500 (Chi^2 = 2.6427, 3 d.f.).
- For QS11, p = 0.9065 (Chi^2 = 1.5559, 5 d.f.).

The only difference of note is the score on QS11.4, "*I have a clear understanding of what it takes to be an MTER*", on which 85.2% of PMTERs agreed, compared with 70.8% in the full survey. If the sample were fully representative, we might expect 19 of the sample to agree, compared with the 23 who actually did. This number is well within sampling error limits (p=0.0758, z=1.4340, 2-tailed). However, once again here the same effect is noted: while the differences are small, all the differences are in the same direction – proportionately more sample PMTERs are agreeing with statements than the whole of the MTERs in the full survey.

H1.7 The "Belonging" Lens

Interview Sample	All Respondents
QS12: Relationships to the MTER Community	
	

Interview Sample	All Respondents
QS13: Collaborating with other MTERs	
	

Commentary on *Belonging*:

Here too, the profiles of agreement match remarkably between the sample of PMTERs and the full survey, with only minor differences, with no significant differences using Chi-squared tests:

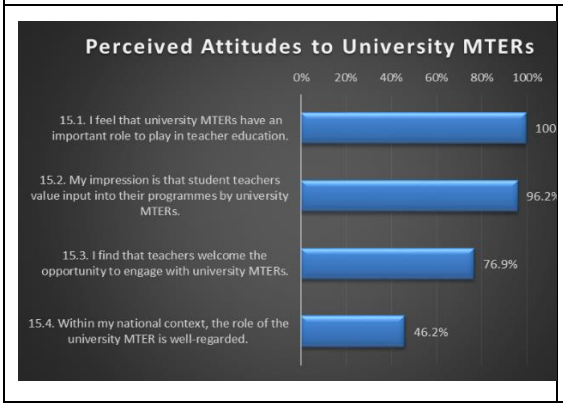
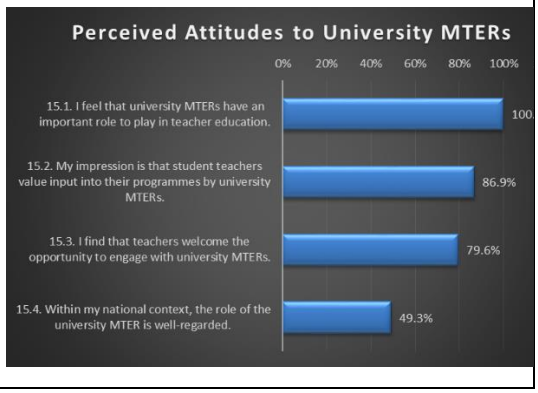
- For QS12, p = 0.5687 (Chi^2 = 2.9354, 4 d.f.).
- For QS13, p = 0.8273 (Chi^2 = 2.1552, 5 d.f.)

The only item which appears to change the profile is QS13.3, “engaging in research and/or teaching projects with other MTERs”. The 6% difference is minimal, representing only one or two MTERs, and does not even approach statistical significance (p=0.3257, z=0.4517, 2-tailed). In fact, QS13.3 is the only category which comes close to being significant (p=0.0976, z=1.2591, 2-tailed).

The effects noted earlier, however, occur again here. The sample of PMTERs consistently appear to be more positive in their agreements with categories showing commitment to the role, than the entire survey group. This is reinforced by QS12.2, which is negatively worded: “I feel fairly isolated”, and on the face of it, the difference appears quite large: only 14.8% of PMTERs agreed with this, compared with 29.6% overall. While this is only half the percentage which might be

expected for a representative sample, the numbers involved are low – 4 compared with an expectation of 8, and is not statistically significant (p=0.0703, z=-1.4739, 2-tailed).

H1.8 "*Being Valued*"

Interview Sample	All Respondents
QS15: Perceived attitudes towards MTERs	
	

Commentary on "*Being Valued*"

Once again, the profiles of agreement are very close, and in no case do the differences approach significance (p=0.9499, Chi^2 = 0.3522, d.f. =3). The effects noted earlier are not present, as in two cases out of the four, the level of agreement from the PMTER sample is lower than that in the full survey.

H1.9 Conclusions

I have noted above some minor differences between this sample of 27 PMTERs, and the full group. There are no significant differences in the demographic data, except in the age-phase category and the matter of 'A' levels, and these were to be expected, because it was on this basis of the first that the sample was selected, and the second had already been noted as a feature of those MTERs with a focus on the

Primary phase. Additionally, there are one or two isolated instances where responses to Likert scaled items appear to alter the profiles of agreement, but in none of these cases is there a statistically significant difference in the profiles as measured by the Chi-squared test.

In four instances noted, individual items show statistically significant differences between the responses of the PMTER sample and those of the entire survey. However, given the fact that we have conducted 70 such z-tests, at the 5% level, it is to be expected that 5% of these 70 tests, i.e. 3 or 4, will turn out to be statistically significant, simply on the basis of normal random variability and sampling error. None of the tests demonstrated significance at the more stringent level of 1% error.

Thus, in terms of generalisability from this sample of 27 PMTERs, i.e. whether the interviews can validly concur with or challenge the questionnaire results, there is no reason to suggest that the sample selection of those with a specific Primary phase focus would bias outcomes in any manner.

However, as the analysis has proceeded, it has become clear that there are systematic differences in some of the responses, specifically those concerned with commitment to the role, and while none of these differences individually approaches statistical significance, nonetheless together they add up to a picture in which this group appears to have an overall enhanced commitment to the role, undertake more research and have a higher attendance rate at conferences. The differences in many cases seem marginal, but given the purpose of this activity was to uncover potential biases in the sample, I now need to consider two things:

Why might this sample of PMTERs exhibit such features, and,

What are the implications for this study if this is correct?

It may be that the “enhanced commitment level” is due to sample selection processes. As explained above, the recruitment procedure targeted the responses as they came in, looking for likely PMTER interviewees. However, in doing this, I may potentially have subjected the sample to selection bias, in that those who responded early, may have been those more interested in research, more

interested in the role, and therefore more committed to it. It is hard to determine whether or not this is the case, but if it is, it serves as an object lesson: I undertook this analysis in an attempt to determine whether the choice of Primary MTERs might potentially bias the results: it has turned out that there are few, if any differences between those with a specifically Primary focus, and the results from the overall survey. However, in prioritising those who answered the survey first, I may have inadvertently introduced an element of bias into the sample, and this has manifested itself as a subgroup of those who seem to have greater commitment to the role, and to research.

In fact, the differences on these items related to "commitment" are relatively small. In the majority of cases where this is relevant, the differences amount to no more than a few percentage points. Even in the case of the largest difference (item QS4.5 "I view my role as the major focus of my career"), where the difference of 19%, represents a deviation of 5 from an expected figure of 17, this is still within the borderlines of statistical variation ($p=0.0358$, $z=1.8015$, 2-tailed). In none of these cases therefore does any of this amount to statistical significance, and so technically any deviation on any particular issue is within what might be considered as normal sampling error. It is only when global issues such as a "deepening commitment", where several items are considered together that this might conceivably emerge as a factor. It must be remembered, however that the purpose of these interviews was not to elicit data and draw conclusions from it on their own, but that they were developed as a way of triangulating the results from the survey, and producing illumination on some of the issues.

On most of the issues, the study is looking at comparisons between themes within the same lens, or cognate lenses. Any potential bias from the sample would not affect any of that. The only possible way that a potential sample bias would manifest itself in the overall results, is if I were to attempt to extrapolate from the interview data alone, and draw conclusions about the commitment levels of all PMTERs, or try to make comparisons about the commitment levels of PMTERs versus those of other age-phases. That was never my intention; the intention was to use the PMTER data to explore hypotheses that had emerged from the earlier

part of the study, to undertake respondent validation, and to provide deeper understandings of how MTERs saw themselves. None of these would be affected even if the potential bias identified in the sample were shown to be an actual bias. Furthermore, because of the validity issues with the 'age-phase" construct, no hypotheses related to this construct have been considered nor put forward for further investigation.

On this basis therefore, the exploration of hypotheses, the respondent validation, and the elicitation of "thick" data from the PMTER group can proceed without any clearly identifiable threats to validity or reliability.

Appendix I1: A Summary of the Findings from the Research

This appendix presents a summary of all the research findings, gathered together for ease of reference. While this listing contains only the more important results taken from each of the relevant chapters, it is a more extensive list than the one found in Chapter 7. For justification of the findings, the reader is referred back to the summaries of the relevant chapter sections.

I1.1: Findings from the Demographic Data

The results below are from Chapter 4:

I1.1.1 Age-phase focus

- Less than half of all MTERs in the sample focus on one age phase only.
- The work of most MTERs (54%) covered at least two age-phases. Of the 46% who did focus on a single phase, around half of these were secondary, and one-third were Primary; very few were single-focus EYS or FE. Of those with multiple focus, around one third were Primary, and one-fifth each were EYS or Secondary. The consequence of this is that there seems to be considerable overlap between EYS and Primary: 98% of those who declared a focus for EYS also covered the Primary age-phase as well. Of those with a Primary focus, just over half covered EYS.

I1.1.3 Time in Post

- Around a third of MTERs in the sample had been in the role for over 15 years, and around a third had been in post less than 5 years. Modelling of the data suggests a year-on-year attrition rate of around 10-12%, which reduces over time. The net effect is that those still in post after 5 years tend to remain in post throughout their careers.

I1.1.4 Mathematics Qualifications

- At least three-quarters of the sample had an 'A' level in mathematics. This rose to 92% for those who declared a focus on the secondary phase, dropping to just over half for those focusing on EYS.
- Almost two-thirds of respondents claimed to have studied a degree at undergraduate level with significant mathematics or mathematics education content.

- Just over 70% had a PGCE qualification or equivalent, with the majority stating that their studies were either maths or maths-Education related.
- 83% of the sample possessed a Master's degree; over three-quarters of these were said to be maths or maths-education related.
- Just under half of the sample (46.5%) possessed a doctorate, over half of these were claimed to be Maths Education related.
- In terms of highest relevant qualifications for the role of MTER, 73% of the sample had a Doctorate or a Master's degree in either mathematics or Mathematics Education.
- Data analysis suggests that the proportion of MTERs possessing relevant higher degrees increases with time in post, either by gaining a Master's degree or by gaining doctorates in addition to a Master's. Nonetheless there is still around 20% of MTERs who have been in the profession for over 15 years who have no higher degree.

I1. 2 Findings from the Survey:

The results below are from Chapter 5.

I1.2.1 Looking through the *Becoming* lens:

- MTERs have a diversity of different motivations for becoming MTERs, and come to the role in many different ways.
- Motivations for becoming an MTER included personal development combined with a deep interest in maths teaching and learning, the desire to make a difference, to share understandings, to pursue research and even to join a community of "like-minded" others.
- For the vast majority, becoming an MTER for many was never part of any career plan but contrastingly very few viewed the MTER role simply as a stepping stone to other roles.
- Previous experience and knowledge are almost uniformly (96%) seen as crucial in the early stages of becoming an MTER; fewer MTERs cited the idea of a role model (55%). Instead, many cited working alongside other, more experienced MTERs, as an important factor in the early stages of the role.
- The MTERs overall reported a relatively low incidence (41%) of formalised induction processes, and this might even have been lower in the past 5 years.

- Many MTERs reported the importance to a developing MTER of positive influences from others in the profession. These influences included mentors, peer support and collaborative working – this latter either involving colleagues within the same organisation or from elsewhere.
- Almost all MTERs are driven towards professional development, both to deepen their understanding and to maintain their progress in the role, and the overwhelming majority (97%) claim that they have developed as professionals during their time in post.
- There are very few variations in commitment to professional development across age-phases, but there are some differences in terms of career stage – with, for example, early career stage MTER focusing on understand the role itself, and trying to develop it.
- Only a minority of MTERs (16%) thought that they had gone as far as they could in developing their role; this was true of MTERs at all career stages, with only 23% of MTERs who had been in the role 15 or more years agreeing. Contrastingly, 73% of this group said that they are still keen to develop their role further.
- Respondents cited as significant contributing factors for professional development: collaborative working with others; courses and conferences; research activity, and self-study.
- Barriers to professional development cited were time and organisational constraints, often resulting in restricted opportunities, with many MTERs citing workload-related pressures.

I1.2.2 Looking through the Doing lens:

- Most MTERs (81%) appear to be relatively autonomous, setting their own agendas and priorities, with only a minority having a formal job description, and most MTERs (73%) in the sample thought that it was not even possible to encapsulate the role in that manner**.**
- There are some indications that while this picture is a good description of many MTERs with a Secondary and/or FE focus, that it applies to fewer MTERs with an EYS or Primary focus. The picture also better describes the experiences of MTERs later, rather than earlier in their careers.
- The tension between teaching and researching provides an interesting window through which to view the role: only about one-third of MTERs said that their main focus was on mathematical education of Teachers and PSTs, with only a minority (7%) focusing on research. The majority (60%) had roles which combined both teaching and research.

- Again here, those MTERs whose main focus is on research, tend to have been in the role longer.

I1.2.3 Looking through the Knowing lens:

- MTERs almost uniformly agree (93%) that an extensive knowledge and skill base about teaching and learning is required in order to undertake the role.
- The open-ended responses showed this base to be diverse, covering mathematical content, how learners learn, knowledge of school curricula, empathy with learners, as well an ability to make connections.
- Knowledge of curricula seem to be regarded as less important by those with a later phase-focus, and by those with more experience in the role.
- Those focusing on earlier age-phases consider it important to have a deeper understanding of mathematics subject knowledge than that held by classroom teachers.
- Those who have been in post longer tended to agree that the skill set required of MTERs is different from that required in other subject areas.
- Only a small minority (12%) consider that there was a single consistent view of how to teach the subject, and this reduces with age phase and somewhat with career stage.
- The open response items confirmed the complexity of the knowledge and skill base, showing the diversity of knowledge and skills needed.
- MTERs consider the most important sources of information to be their own experiences as teachers and researchers, but draw heavily on books and journals, both from their own personal stock, and the library.
- Other sources of information cited include the research literature and including attending conferences, networking with other MTERs, and internet sources.
- Almost all MTERs (95.1%) claim to draw on their personal experiences of teaching and research, but this seems to be somewhat less important for those longer in post, it is unclear from the research whether this is related to the currency of their teaching experience or the relevance of their research.

I1.2.4 Looking through the Being lens

- The majority of respondents (75%) thought MTERs should have a well thought through philosophy of education, and that being an MTER requires specific skills and attributes (70%).

- In the open-response items attributes were cited such as: *empathy, a supportive nature, a positive attitude, a clear enthusiasm and passion for the subject, flexibility, a willingness to learn, an ability to listen and diplomacy*.
- Over half of the sample (57%) thought that well-established MTERs should be making a significant contribution to research in the field. It may be the value laden phrasing here precluded more respondents from agreeing with it.
- There was overwhelming agreement (93%) that MTERs derived satisfaction from their role, but that it could be very challenging at times (87%).
- The vast majority (71%) had a clear understanding of their role, but often felt anxious about aspects of it (70%), especially those with an EYS (72%) or Primary (74%) focus, and those in the earlier stages of their career (as high as 87%).
- The majority of respondents (80%) felt that MTERs are upholding specific values within the profession, but very few (17%) thought these were specifically mathematics-related values.
- Open response items highlighted a range of possible values, but these were diverse and fairly generalised, such as *adopting ethical stances, holding specific beliefs, upholding social justice, respecting the views of others and demonstrating passion, commitment* and *enjoyment*.
- The majority of MTERs (87%) think that students value the contributions of University MTERs, and that teachers welcome the opportunity to engage with them (80%).
- Only a minority however, (49%) thought that University MTERs were well-regarded in a national context.

I1.2.5 Looking through the Belonging lens:

- These results portray a large majority of MTERs (73%) as feeling that they are part of an MTER community, and that they have good working relationships with other MTERs (81%), that they are benefitting from membership of professional organisations (80%), and feeling that they are part of a community of like-minded individuals (73%).
- Most do not feel isolated (70%), even if in their place of work they are the sole MTER.
- However, only a minority of MTERs feel that their work is known by other MTERs (30%), especially those in EYS and Primary, and those who are in the first 10 years of their role

- Three main ways in which collaboration can occur were highlighted by respondents as being of particular importance: discussions with colleagues at conferences (62%), engaging in joint research projects (61%), and receiving challenges to existing viewpoints (63%), these are also well-supported in the open responses.

I1.3 Findings from the Interviews

The results below are from Chapter 6.

The Research hypotheses are merely focusing issues, a way to draw material together, and allow an examination of the evidence for it. In two cases (RH1 & RH2) the hypothesis seems largely correct, and in two cases (RH4 & RH5) the hypothesis seems only partially correct. For RH3, while it is apparently correct, the rationale for proposing it was not.

I1.3.1 Investigating Research Hypothesis 1:

Research Hypothesis 1: The process of "becoming" an MTER is not limited to the initial time in post, but is part of a career long commitment.

Interview data revealed that:

- In order to carry out the role effectively there are pressures concerning credibility and currency which necessitate an MTER's involvement in an ever-widening range of activities simply in order to do the job.
- To do the job fully therefore requires that an MTER changes, develops and grows.
- For Hypothesis 1 not to be the case, this would require an MTER already to possess a doctorate, possess the skills of teaching adults, and be familiar with Higher Education procedures and to be a member of mathematical organisations with a good range of contacts.

I1.3.2 Investigating Research Hypothesis 2:

Research Hypothesis 2: There is a deepening commitment to the MTER community over time.

Interview data revealed that:

- What might be described as a "deepening commitment", encompasses a whole range of other, more detailed effects, such as the widening sphere of influence as an MTER, the strengthening of identity and status, and even a

greater sense of belonging, a “having found a home”. Each of these processes also might involve multiple *becomings*.-

- While it might be admitted that it is certainly possible for MTERs to become and remain an MTERs without engaging in the wider MTER community, or collaborating with colleagues, such individuals will be in a very small minority.
- The interview data revealed and illustrated why, for most MTERs, these things are important, and why, although not every MTER will engage with each element with the same intensity, some combination of these elements is a necessary feature of the identity of a successful MTER, who finds satisfaction in their role.

I1.3.3 Investigating Research Hypothesis 3:

Research Hypothesis 3: For many MTERs there is a tension in the role between the day to day demands of educating teachers and pursuing research.

Interview data revealed that:

- This issue here is complex. While there is evidence that Hypothesis 3 is largely correct for many MTERs, it is context-dependent and for some MTERs whose University values their research, conflicts are minimised.
- The tensions where they exist, are not between the research and the teaching per se, but on their competing demands for time and priorities.

I1.3.4 Investigating Research Hypothesis 4:

Research Hypothesis 4: MTERs tend to supplant the currency of their classroom experience with more recent project or research-related experiences as their career progresses.

Interview data revealed that:

- The Hypothesis was not fully correct; while there is certainly a “currency” issue, MTERs can maintain their currency in many ways: research, working with teachers, and by school-based supervisory and moderating activities.
- Furthermore, over time as an MTER becomes more experienced, they bring a depth of knowledge to the role as well as a strong commitment to staying current in regard to classroom practices.
- An experienced MTER will acquire over time, a sense of the history of mathematics education having seen various incarnations of curriculum, and

having had the time to reflect and undertake research contributing to the MTER knowledge-base.

I1.3.5 Investigating Research Hypothesis 5:

Research Hypothesis 5: The values of MTERs, and their perceived sense of being valued by others, differ between newer and more well-established MTERs.

Interview data revealed that:

- Hypothesis 5 is not fully correct: the values of MTERs themselves seem remarkably similar between newer MTERs and those having been in post a long time.
- However, longer serving MTERs appear to have somewhat different perspectives than more recent recruits.
- This might be explained by their having experienced changes to the profession first hand.

Appendix I2 Research Contribution and Dissemination Plans

I2.1 What has the research contributed to the study of MTER identity?

1. A systematic review of the literature in the field, complete with tables and summaries of the type of literature, research approach and a critical review of findings.
2. A description of a large group of MTERs in the UK, in terms of their academic backgrounds, their qualifications, teaching focus, their information sources and their day to day activities.
3. Attitudinal and other data gathered from a large group of MTERs in the UK, which examines various aspects of MTER identity, including amongst other things, their motivations, aspirations, views on self and others, knowledge base, day to day activities, values and relationships to others and the wider community of MTERs.
4. Analyses and summary data arising from an extensive set of written material, provided by MTERs elaborating their views within "open response" items in the survey. This material offers, in many cases, detailed personal testimony both interesting to, and of value to others.
5. A set of interviews carried out with a group of Primary MTERs, revealing details of their professional life, their attitudes and aspects of identity formation. This is a rich seam of data, which the current study has only mined selectively.
6. The derivation and testing of a set of research hypotheses which were inferred from survey material, then tested against interview data in order to challenge them. Various "critical realist" methods were used to do this, including different forms of retroduction such as case comparisons, thought experiments concerning counterfactuals, and counter-cases.
7. A set of conclusions from the research about the role of MTERs with some policy recommendations.
8. An attempt to apply and test a framework proposed in the literature, which described aspects of Teacher Educator identity. This framework was applied

within a systematic literature review to categorise and evaluate research papers, and formed the underlying basis for an extensive questionnaire, as well as the focusing structure for a series of in-depth interviews. The framework was evaluated by a range of methods, including factor analysis and the internal coherence of the items, and the analysis of responses provided by participants both in the interviews and the survey.

9. An overall understanding of what constitutes the core of MTER identity, and the processes by which identity is acquired. This understanding is encapsulated within a revised model for the Davey Framework, and offers "ways of seeing" which suggest possible future research questions.
10. An attempt to apply the principles of critical realism within an Educational Research setting,

I2.2 What are the potential papers and conference presentations arising from this research?

A. A paper based on (1) above. This is clearly a paper in itself, but might be split into two, offering the results in a paper, and the method used for systematic review in a different paper offering insights into the methodology of a systematic review.
B. A paper based on (2) above. This is probably best presented initially as a conference paper giving highlights, and getting some feedback from peers about which parts are important, and which are less crucial, and followed up by a detailed research paper.
C. A paper based on (3) above, possibly incorporating some of (4). There is enough material in (3) and (4) for these to be a conference papers in their own right. However, they probably need to be combined within one research paper.
D. A series of papers based on (5). There is so much material in these interviews that this could yield several papers, certainly several conference presentations on different aspects.
E. A paper outlining how critical realism was used in this context, in terms of its methodology. This would combine (6) and (10), and would be published in a journal dedicated to critical realism.
F. A paper on the Davey Framework, how it was used, how it was evaluated, and presenting the revised Model. This will probably require contacting and working with Davey, or at the very least, obtaining her input and/or permissions for such a paper to be produced which uses then criticises her work. She may also have deeper insights into the reformulated model.

I2.3 How will the results of the research be disseminated?

Overall Strategy

Table I2.1 overleaf gives an indication of intended presentations and publications, with some potential timescales.

My strategy underpinning the dissemination plan, is to present material to my immediate colleagues first, not just to other MTERs, but also colleagues whose roles include preparing students for various professions – in education, police, health etc. This will provide me with essential feedback on the extent to which the ideas surrounding professional identity within the study might be generalised to other MTERs, to other teacher-educators and to other professionals. Following these initial sessions, I intend to offer papers at several conferences, to determine which aspects of the study people find the most valuable; this will then lead to the writing and publication of journal articles drawing on different aspects of the study, and which will address different target audiences.

Table I2.1 Dissemination Plan – Proposal for the 3-18 months following completion of doctoral thesis

Product	**Location or Proposed Journal** **NB Presentations are likely to be online for the next 12 months at least**	**Target timeline** **(in months post EdD completion)**	**Target Audience**	**Key purpose**	**Additional Note(s) (where applicable)**
Presentation	University Centre 1	3	Fellow academic colleagues based at the Centre	Provide an overview of the research drawing particularly on some of the background information about Professional Identity of teacher educators and key findings re MTERs. Discussion - Consider implications of understanding of Professional Identity given the proposals to further develop this professional centre.	Until recently I was Deputy Provost (Academic) at the Centre where I set up a Research Seminar Series. I can now contribute to a seminar rather than chair and organise the sessions.
Presentation	University Centre 2	5	Fellow colleagues based at this second Centre from professional areas (health, police and education)	Provide an overview of the research with a focus on the features of Professional Identity. As above, consider parallels across professions and implications for developing this second professional centre.	This activity may be viewed more as professional development for colleagues drawing on some of the background material on professional identity rather than detail specifically focused on MTERs.
Presentation	University colleagues	5	Fellow colleagues based at the central location from professional areas (health and education)	Provide an overview of the research and key features of Professional Identity. Consider implications for colleagues who work on professional programmes.	This activity may be viewed more as professional development for colleagues drawing on some of the background material on professional identity rather than detail specifically focused on MTERs.

Presentation	Society for Research in Higher Education (SRHE)	6	International audience of predominantly university-based colleagues.	Raise awareness of the research undertaken. Provide an overview of the research and findings. Link with other research SRHE seminars which are currently planned, e.g. 03/02/21 seminar includes presentations on 'The policy context: the increasing importance of the blended professional in Higher Education.' Dr Emily McIntosh, Middlesex University, London, and 'Transitions in Higher Education: professionalism and professional identity'. Dr Julia Hope, University of Kent.	I regularly attend the meetings of SRHE and arranging to give a presentation would be straight-forward.
Series of Presentations	AMET (Association of Mathematics Education Teachers)	6 - 18	MTERs from across the UK	A sequence of presentations over 6-18 month period, for example: 1. Demographics of MTERs – who are we? [Gain feedback from peers about which elements are important, and which are less crucial to guide publication activity.] 2. What was learnt from the Literature Review on MTER Professional Identity? 3. Attitudinal data responses - motivations, aspirations, views on self and others, knowledge base, day to day activities, values and relationships to others and the wider community of MTERs. NB There are opportunities to negotiate what the group would like to focus on. [See also Appendix I2.2 for further possibilities.]	This is a key group to feed back to as it comprises the focus group of the research, namely MTERs. Several members contributed to the research by responding to the questionnaire and some also participated in the interviews.

Academic Paper	Proposed Journal: Mathematics Education Research Journal	9-18	MTERs and mathematics teachers – international reach	Paper(s) which build on presentations to AMET colleagues. See list above in Appendix I2.1 and I2.2	
Academic Paper	Proposed Journal: Teaching and Teacher Education	12-18	Teacher Educators and teachers – international reach	Overview of the research – signposting focused publications for MTERs specifically.	N/A
Presentation	UCET (Universities Council for the Education of Teachers)	12-18	Initial Teacher Education Managers	Overview of the research with a focus on the becoming and belonging aspects of professional identity and the implication for recruitment, induction and professional development of MTERs.	N/A
Presentation	BSRLM (British Society for Research into Learning Mathematics)	12-18	MTERs, mathematics teachers	Utilising a critical realism approach to analysing Professional Identity in MTERs.	N/A

Appendix J1: Glossary

CoI	Community of Inquiry
CoP	Community of Practice
CPD	Continuing Professional Development
DfE	Department for Education, UK
DfEE	Department for Education and Employment
DfES	Department for Education and Skills
IST	In-service teacher (one already qualified)
ITE	Initial Teacher Education
JISC	Joint Information Systems Committee
MT	Mathematics Teacher
MTEE	Mathematics Teacher Educators' Educator
MTER	Mathematics Teacher Educator-Researcher(s)
NCETM	National Excellence for Excellence in the Teaching of Mathematics
PGCLTHE	Post Graduate Certificate in Learning and Teaching in Higher Education
PST	Pre-service teacher (unqualified teacher also known as student teacher / intending teacher /prospective teacher)
PMTER	Primary Mathematics Teacher Educator-Researcher(s)
Practicum	School experience period for pre-service teachers
RQ	Research Question
QS	Questionnaire Section
UCAS	The Universities and Colleges Admissions Service