Perspectives on teachers’ numeracy, investigated via examination of comment and conversation.

Thesis submitted in partial fulfilment of the requirements of the University of Bolton for the degree of Doctor of Philosophy

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July 2016
Abstract

For those training to teach in England, numeracy is required to fulfil the remit of a complete teacher education qualification. Trainee teachers in the post-compulsory sector must address their own level and depth of numerical comprehension whilst also examining the factors that surround the acquisition of this knowledge for their own learners in the classroom. For those training to teach in the compulsory sectors of primary or secondary education, a GCSE graded C or above and the completion of an additional numeracy professional skills test is required.

Anecdotal evidence suggested prior to the initiation of research that numeracy within teacher education programs was not favourably received or welcomed by either trainee teachers or more established teachers. This research investigates in the first phase teachers’ and trainee teachers’ opinion and perception of numeracy using data collected from educational forums, prospectuses from teacher education providers, a critical review of resources available to support learning of numeracy for trainee teachers. In the second phase research utilises the observation of the delivery of a functional skills mathematics programme for teachers in the post-compulsory sector, recording information from participant observation, an online bulletin board and focus groups. Each successive method, through two distinct phases of research, focusses on comments and conversation, examining what teachers’ say to better understand their perceptions and opinions about the subject of numeracy.

The findings indicate that teachers in the post-compulsory sector are reluctant to undertake any form of numeracy learning and those taking the training for the compulsory sector experience a lot of anxiety about the numeracy professional skills test in particular. The depth of negativity found to be present is extremely high with teachers’ words being collected and examined for their positive or negative direction and being overwhelming in their negative attitudes and opinions. Negative past experiences of teachers’ inform the development of negative perceptions of their own abilities and add to the anxiety they experience in relation to numeracy learning. Those teaching or training to teach are likely to be qualified to a university level but still demonstrate very high levels of negativity towards numeracy learning.

The second research finding of conflict was present within the data not only from teachers’ words but also in the wording of prospectuses aimed at providing information for prospective trainees. The conflict was clear where prospectuses demonstrated avoidance of the mention of
numeracy as a course requirement for teaching, appearing to prefer not to stir up feelings of anxiety and negativity that are related to numeracy and mathematics. Teachers experienced conflicts between the need to maintain levels of professionalism, the traits expected of a teacher and their own feelings surrounding the subject. The findings of the research have been distilled down into the two main areas of negativity and conflict in relation to the perceptions and opinions of numeracy learning for teachers’.

A naturalistic method has been used throughout to capture information that is not solicited and is not volunteered specifically for the purposes of research. The methods throughout analyse comments and conversation, however many of these take the form of online conversation or postings leading to a development in the innovative methodology which utilises the internet and electronic forms of communication.

All of the research data is brought together for analysis to inform and support future practice in teachers’ numeracy through the development of a more positive attitude towards learning in numeracy for teachers. The development of a model for delivery is proposed which incorporates the findings and uses an acknowledgement of the inherent negativity surrounding the subject as a starting point for teachers’ numeracy learning to be more effective.
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1 Chapter One - Introduction
1.1 Introduction

This introductory chapter provides an orientation into the research process completed and the analysis, findings and conclusions that follow. The main area of research relates to teacher education in the English system. The English system is not the same as the UK wide system since this would include the devolved and semi-devolved systems of Wales, Northern Ireland and Scotland which do not operate in a fashion identical to that in England. Specifically the research centres on numeracy and mathematics, as an element of teacher education. Here, the sectors of education in England are briefly explained followed by a clarification of the need for research relating to the implementation of numeracy as part of teacher education and examining numeracy learning for teachers. The main research aim, research questions and objectives are presented to establish clear parameters for research.

Context is provided with background information on teacher training reform in England and the need for teachers' numerical thinking. The methodological choices are acknowledged with brief outlines of methods employed to address the research questions and the resulting aims.

The contribution to the current body of knowledge in the subject area and acknowledgement of the stance of the researcher follows on from this to ensure that the reasoning (underpinning decision making) is clear from the outset. Within this chapter the parameters for research are clearly presented and the nature of the research is explored with the provision of a justification. A chapter summary is provided with an indication of the focus for following chapters.

1.2 Sectors in the English education system

This research is focussed on teachers and trainee teachers in England. The post-compulsory sector is the main focus whilst the compulsory schools sector is used as a comparative measure. The post-compulsory sector encompasses further and higher education in further education (FE) colleges and higher education Universities (HE) (whilst the compulsory sector of education comprises primary and secondary schools) The compulsory schools sector requires specific qualifications of trainees on entry to teacher training courses. These entry qualifications
include a minimum of a GCSE grade C in mathematics and the completion of a numeracy skills test.

Within the post-compulsory sector, there are no such mandatory numeracy entry criteria for trainee teachers; however student teachers must evidence completion of a minimum core of literacy, language and numeracy to gain their ‘licence to teach’ or ‘qualified teacher, learning and skills’ (QTLS) status. This requirement has changed through the period of the research process and has passed from the obsolete Institute for Learning (IFL) to the Foundation for Education and Training, administered through the Society for Education and Training (SET). To gain QTLS teachers must invest in their professionalism by completing professional formation which is a fee paying process and involves the compilation of an electronic portfolio of evidence.

Gaining QTLS is similar to the gaining of ‘qualified teacher status’ (QTS)¹ in the compulsory school sector where trainee teachers must pass competence tests in literacy and numeracy, despite having GCSEs in the same subjects at grade C or above. In an examination of the minimum core in the post-compulsory sector, the concentration will be exclusively on numeracy; anecdotal the subject that student teachers and more established teachers struggle with the most, the research here supports that anecdotal assumption.

1.3 Justification of research into trainee teachers numeracy

Research can often be seen as a way of separating science and real life, the researcher as a separate entity to their research and participants, standing on the outside: in this instance, the aim from the outset is to acknowledge the underlying judgements of the researcher at every stage and the intrinsic involvement that accompanies this. The action research approach coupled with the research being almost purely qualitative supports an evolving relationship between the researcher and their collaborators (Berg, 2001) Here, experience in different roles, shared with colleagues through pilot research and critical professional discussion, coupled with a specific set of values and anecdotal observations formed the initiators of research.

¹ QTS is conferred by the Teaching Agency - an executive agency of the Department for Education (DFE) formerly one of the powers of the general teaching council (GTC) which ceased operation in April 2012.
Testing and evidencing teachers numeracy skills is described by the department for education in the compulsory school sector and by the professional bodies (now the Society for Education and Training) in the post compulsory further and higher education sector.

The professional skills tests (Including the numeracy test) which require completion to be awarded QTS status for those training to teach in the compulsory sector, are described by the department of education as ‘core skills’ and are presented as essential to ‘fulfil their professional role in schools’. The skills tests for QTS are described online by the Department for Education (DFE, 2015 P.1) as:

- Are in addition to the GCSE grade C equivalence entry requirement
- Are set in the context of the professional role of a teacher
- Assess the use of real data and information which teachers are likely to encounter
- Are computerised and can be taken at learn direct skills test approved test centres throughout the UK
- Go through a stringent quality assurance procedure
- Are extensively piloted and the performance of each test is regularly monitored

Within the post-compulsory sector, the minimum core of numeracy was introduced fully in 2004 by the now obsolete: Further Education National Training Organisation’ (FENTO) as part of national standards which then developed to become part of a strategy to re-professionalise the teacher workforce through the reform of teacher education in the tertiary sector. There are so many problems associated with numeracy that this focus is likely to be justified, work to implement numeracy learning has been limited, discussion on numeracy within teacher education is rare, with resources to support delivery: poor and scarce.

Research here has explored this area more thoroughly: ascertaining initially whether the interaction described is typical within the post compulsory sector, appearing to be substantiated (from this research) that this is the case, a negative situation is apparent in terms of perception.

The introduction of FENTO and the development of the Institute for Learning (IFL) (2002)\(^2\) has required a type of management that may not have been fully accepted by those responsible.

\(^2\) The IFL was developed by 2002 but did not accept the first members until 2007
Management of changes within institutions and organisations requires ‘buy in’ from those responsible for that implementation, managers in turn, require ‘buy in’ from the individuals at the next level: and so on, permeating through the organisational hierarchy.

According to Kotter (1996) 75% of managers need to be convinced of the need for change for that change to be implemented swiftly. This was one part of an eight step strategy for leading change within an organisation, which ends with new approaches being institutionalised. With student teachers still confused as to the nature of the numeracy and how it applies to them, with Ofsted (2010) observing that 80% of providers are falling short in their provision, a high proportion of teacher trainers and their managers clearly remain unconvinced of the need for numeracy, years after initial introduction of this initiative to the sector.

A truly substantial change in curriculum, such as the inclusion of numeracy, requires support and change drivers for implementation. Pilots, resources, discussion, consultation and agreement are essential elements for change to be effective. If very little is available for teacher educators to work with, the likelihood of curriculum change being effective is low, and achievement of change being institutionalised, described by Kotter will be highly unlikely.

Dunne and Zandstra (2011) for instance, whilst examining the management of change for curriculum via LSIS, document the process of curriculum change with a ‘micro’ approach, outlining the main contributory factors to successful implementation. The process is not an easy one and is not prescribed as the same for every type of curriculum change that may need to take place. This provides the possibility for procrastination by those individuals within institutions responsible for the implementation of the minimum core of numeracy. For post-compulsory provision in teacher education to change to accommodate numeracy there appears to have been resistance and apathy which is compounded by the lack of a supporting ‘prescription’.

Ofsted (2009) examined the initial training of further education teachers during inspection. The poor entry level numeracy skills of many trainees’ was highlighted as a concern, although some positive developments were noted on the previous year. Trainees described as ‘better’ were confident in working to support their own students’ numeracy skills, Ofsted observed, where trainees with poorer numeracy development were flagging behind they did not access the available support for their own lack of numeracy skills.
In comparison, Frankel, Morison and Sheil (2009) writing on qualified teacher status (QTS) numeracy tests for the compulsory schools sector, proffered the message that although trainee teachers found it difficult to pass the numeracy test, it provided evidence of skills that would ‘come in handy’ during a professional career in teaching and that the test was a necessary hurdle. It appears that the numeracy professional skills test for QTS in the compulsory school sector is very unpopular, although all trainees are aware of the requirements for this, whilst in the post-compulsory further and higher education sector the minimum core of numeracy remains an area of seemingly limited importance with trainees demonstrating a much lower level of awareness.

1.4 Research aim

The overarching aim of this research is to effect a positive change in the situation relating to teaching and learning of numeracy for those training to teach and those teaching in the English education system. The situation that has been observed, presents a huge cost in terms of a poverty of educational provision, especially in further education colleges, with students being taught by student teachers and teachers in classrooms that were not only inexperienced but underprepared for effective teaching and learning to take place (Gregson, 2011).

A positive step is needed to redress this imbalance. However, to be effective in making a positive step, some clarity is required through research to establish how negative is the situation and how can this be addressed effectively to provide a positive result.

1.5 Research questions

To provide a baseline or starting point, to define the research parameters, and to frame the research in context, three research questions have been formulated as follows:

What are the perceptions and opinions (positive, negative or indifferent) of numeracy held by trainee teachers?
What support mechanisms and resources are available to facilitate the implementation of curriculum and learning in numeracy for trainee teachers?

How can the delivery of numeracy for trainee teachers be supported, improved and modelled for effectiveness?

In an attempt to address these research questions and define the possible methods and products of inquiry, research objectives have been formulated, each reliant on its predecessor. These have been constructed to build up a body of knowledge in a logical and progressive manner (Vasquez, 1997) with room for manoeuvre at each stage, dependent on the data gathered. The research objectives cover the following areas:

Phase one of research investigates attitude and perception towards numeracy from teachers’ and trainee teachers and establishes the positive or negative direction of attitude from trainee teachers towards numeracy and examines the situation in terms of resources and support available for delivery of numeracy in teacher education.

Phase two of research presents a naturalistic case study within a programme of continuing professional development for teachers. This utilises the information gathered and analysed through the research process to produce a model for the delivery of teachers’ numeracy that provides the opportunity to cross check the negative perceptions of the participants between actions and expressions of opinion and feeling. The objectives have been broken down further:

Use online resource repositories and forums in the public domain to assist in data collection, evaluation and publication of materials (phase one of research)

Produce a critical review of scholarly literature, resources, and support documents currently available to facilitate teaching and learning of numeracy in teacher education (phase one of research)

Examine how the subject of numeracy is presented to trainee teachers (phase one of research)
Provide support materials for use by teacher educators following direct use as part of classroom practice and the implementation of curriculum development for numeracy within teacher education (phase two of research)

Evaluate the effectiveness of delivery of functional skills for trainee teachers including resources and support materials, with evaluative evidence provided by staff development participants in functional skills mathematics (phase two of research)

Develop a model of implementation for numeracy in programmes of initial teacher education. Model completion will utilise the evidence gained through investigation, analysis and evaluation (phase two of research)

Always at the forefront of these objectives is the overarching requirement (aim) to affect positive change for the better, benefitting teacher educators and trainee teachers and in turn benefitting their learners in classrooms.

This research has established a baseline by investigating perceptions of numeracy for teachers and is followed by a review of resources already available and an investigation of the presentation of numeracy.

The production of materials to raise awareness and promote positive strategies to affect a change in practice (as a negative situation is apparent) led on to an evaluation of functional skill mathematics delivery for teachers through a participant observation completed, relating to involvement with a Continuing Professional Development (CPD) programme of functional skills mathematics for teachers completed as a case study during phase two of the research and a model for delivery evaluated and developed further.

1.6 Background information - teacher training reform

Teacher training in England in both the compulsory schools sector and the post-compulsory further and higher education sectors has been subject to significant reform in the latter half of the twentieth and the start of the twenty first centuries.

Teacher training in the post-compulsory sector has been subject to varying reforms in recent
years, especially with reference to numeracy requirements for trainee teachers. Reform has included the creation of the Institute for Learning (IfL) incorporated as an independent professional body on 2 January 2002, first registrations by members would not happen until August 2007 however, and acceptance as a yardstick with which to measure professionalism has arguably never been accepted by those not willing to embrace the institute individually. The development of ‘professional formation’ has become a voluntary process for members of the IFL (2012/13) and the SET (2014/15) for newly qualified teachers in the post-compulsory sector. Over time ‘QTLS’ may have come to be seen as a hoop jumping measure, rather than an effective demonstration of professionalism, requiring evidence of level 2 functional mathematics and English³ equivalency qualifications as the minimum standard and the payment of a fee for completion.

This view of professionalism related to the IFL and QTLS may change considerably with the transfer of IFL functions and legacy to the Education and Training Foundation (ETF). As this is a reasonably new initiative, the outcome cannot be clearly identified. Further measures of reform in relatively recent history for the post-compulsory teaching profession in England included legislation that integrated numeracy skills into the regulations governing standard requirements for trainee teachers in the sector. The further education teachers’ qualifications (England) regulations (2007) stated that a person must demonstrate the necessary numeracy skills to teach (No. 2264 statutory instruments).

From the 1990s teacher training through all sectors has been subject to the implementation of competence based instruction, requiring that teachers demonstrate a set of observable and assessable outcomes. The inclusion of numeracy within programmes of post-compulsory teacher education can be seen as a shift in line with the move towards a competence based style of curriculum design (Lea, 2003) especially since numeracy is not the more academic subject: mathematics.

Numeracy as a subject is viewed more in line with the primary curriculum, with a clear link between the adult numeracy curriculum and the primary numeracy strategy. The education reform act (1988) saw the implementation of a national curriculum and standardised testing in

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³ From 2012, functional mathematics and English replaced the former adult literacy and numeracy qualifications.
the compulsory sector for numeracy (Lea 2003). The adult numeracy core curriculum was
developed and made available for use later, along similar lines, followed by the development of
minimum core numeracy criteria for teacher education in the post-compulsory sector.

The inclusion of numeracy in teacher training could be seen as a ‘dumbing down’ of
requirements due to the inherent link with an elementary level. Adult numeracy had no
requirement for the learner to master the more involved areas of mathematics, no trigonometry;
limited geometry and very little algebra are included in the specification. Functional skills
qualifications in mathematics4 focus on problem solving, also containing very little of the
traditionally more ‘difficult’ (the level of difficulty is subjective and is perceived rather than actual)
or abstract elements contained in GCSE mathematics. Regardless of the change from adult
numeracy to functional mathematics, the perception of a ‘lower’ standard than GCSE
mathematics is not only maintained but justified, as the functional skills curriculum has been
written along the same lines as adult numeracy and with the remit of being a preparation or
stepping stone for GCSE level study.

The level of the actual mathematical skills involved in functional skills level two examinations is
equated with primary level, however the problem solving requirement is at GCSE level. Inclusion
of primary level numeracy skills can also be seen as a move in line with the competence
professional skills tests required for completion of teacher training in the compulsory sector. The
professional skills tests themselves have been subject to legislative changes from 2012
onwards. They have not however been removed as a requirement for qualification as a teaching
professional in the compulsory sector and have taken on a larger role as an ‘entry test’ rather
than a summative assessment, as a direct result of the former secretary of state for education
(Michael Gove in the UK between 2010 and 2014) insisting on bringing the English education
system into line with reportedly world class successful (in terms of the Programme for
International Student Assessment or PISA index) examples like Finland.

Changes in the English system of Education, especially in the compulsory sector, echo some of
the values and ideology surrounding the Finnish educational system in terms of teacher training
in England. In Finland, teaching is seen as a high status profession and candidates for teacher

4 Functional skills qualifications replaced the obsolete adult numeracy and key skills
qualifications in 2012
education are required to be well qualified. The Ministry of education and culture in Finland (2012) explain that only ten percent of all applicants are accepted for teacher training, the most common pre-service requirement for teacher education is a master’s degree and teachers are required to have such a high level of education because their level of autonomy within the education system itself is so high. Many countries are envious of the Finnish system because it produces one of the highest scores in the PISA index of educational attainment in mathematics consistently without the use of formative stage testing.

In England we can see movement towards emulating the Finnish system with many universities now offering the ‘master’s degree in education’ which is actually an addition to the teaching qualification. Trainee teachers complete an additional unit within their qualification and are assessed at a higher level for further units completed, providing them with a ‘Masters’ degree as well as their teaching degree. There are also echoes of Finland’s autonomy for teachers with the newest inspection framework from Ofsted indicating that they will not be providing graded lesson observations in the classroom, will not require session plans or schemes of work when conducting inspections and have very recently (2015) cut their team of inspectors significantly (Lagden et al, 2015) indicating that teachers and schools are expected to be more autonomous.

1.7 Background information - The need for numerical thinking

There is more to the mastery of the numerical requirement for teachers than evidencing a set of competencies. Numerical skills can be seen as vital to the cognitive development that is required to teach. Tammet (2009) from his own unique perspective on the autistic continuum examines the usefulness of numerical thinking for everyday life, as well as looking at the need for people to be more mathematical in their thoughts, using mathematics as a language, (mathematics can be seen by some as a language, rather than similar to a language) similar to the use of semiotics. A lack of mathematical understanding is very harmful to individuals, not only because it affects their practical financial decisions for instance, but because it can stop them from being able to reason effectively. Mathematical or numerical thinking is linked to other, transferable cognitive skills. Tammet links numbers to everyday life in a seamless fashion
and to the development of logic which is an essential element of deduction, induction and reasoning.

Teachers of all subjects require well developed numerical skills, not because they use mathematics daily (although this is likely) and not because they suddenly have to teach long division (although that's also possible) but because numeracy, as a way of mastering the manipulation of abstract concepts, underpins so many other skills sets and competencies required of an effective teacher. Examples include:

- Ability to conceptualise
- Ability to think logically
- Ability to think critically and question
- Ability to think sequentially
- Organisational skills
- Confidence in teaching skills
- Confidence in subject knowledge
- Ability to follow a procedure or process
- Ability to solve a problem
- The ability to simplify complex instructions
- The ability to support students in developing their own numerical skills sets
- Ability to plan effectively
- Ability to be on time
- Ability to be cognitively agile
- Ability to dissect a subject area
All of these descriptions of teacher skills and abilities rely on abstraction. These are not concrete elements, although you can demonstrate a skill or ability, you cannot pick it up and hurl it across the room. These particular skills and abilities are numerically based, they are cognitive, thinking skills and processes that rely on several different factors (familiarity of task or experience for instance) but essential to the development of these skills and abilities is a foundation in numeracy.

Numeracy is needed for the development of reasoning skills, sequencing skills, organisational skills, and problem solving skills. Teachers are likely to find it difficult to ‘think on their feet’ if the cerebral cortex is not capable of (or practiced at) processing abstract concepts, which is one of the things that we practice when using or learning the skills involved in numeracy.

Numeracy can be viewed as the general foundation for many aspects of critical thinking and reasoning. Without it, individuals are ill equipped to face the modern world in many contexts and clearly not in the context of being an effective teacher.

The main characteristics of mathematics and numeracy as subjects is missed by many students and some teachers: the pleasure of knowing, of understanding and of being able to work things out is missed in favour of trying to pass a test or tick a box to achieve. For instance, Sudoku puzzles have enjoyed worldwide popularity, now contained in many UK daily newspapers (La Monica, 2005) even in the face of a universally perceived hatred of maths (this hatred being an anecdotal rather than a proven fact) Is it the nature of the arithmetic involved in numeracy that causes people to shy away? Sudoku is based on logic and problem solving, not arithmetic. The real nature of the subject is the real nature of learning, to help us find an answer, to work out the solution to a problem, to know, to develop understanding and to build ‘knowledge’ building confidence and self-esteem in the process, by providing a sense of achievement.

Numeracy teaching is fundamentally, intrinsically important. It supports literacy learning from a conceptual standpoint, assisting the formulation of logical sequential ideas and leading to self-expression of a more accurate nature. Numeracy teaching must be seen to be separate from mathematics teaching (Coben, 2003) although no learning of consequence can take place in mathematics without the required foundation of numeracy. Mathematics and numeracy may

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5 Sudoku puzzles originated in Japan, utilising a 9x9 grid of numbers where logic dictates the placement of each digit.
overlap but are essentially different. Numeracy can be seen as the tools needed to successfully learn in mathematics. The distinction between mathematics and numeracy is exemplified by the controversy over the introduction of the functional skills curricula in mathematics (Smith, 2004).

The complaint has been voiced by employers, educators and successive governments, that pupils are leaving secondary school in some instances without the required (GCSE) standard in mathematics, but also that those who achieve the standard of C or above cannot apply the knowledge and skills to any real life scenarios or use it in any real life context. Hence they have not learned any transferable skills, essential for the successful completion of a functional skills qualification. Numeracy then can be seen as the application of transferable skills.

1.8 Outline of the methodological approach to research

Any modern, twenty first century study needs to address technological advance. This research utilises a method of data collection that is growing in prominence, using the internet and more specifically: internet forums, as a source of data. The forums have been used to collect written postings as parts of a conversation on a particular topic and have been analysed in a similar fashion to transcripts of conversation. Use of the internet as a resource for collecting data has been continued in every stage of research here with an examination of online prospectuses from Higher Education Institutions (HEIs) including universities or further education colleges delivering higher education through a franchise arrangement, examining their portrayal of numeracy in the information provided for prospective trainee teachers. An analysis of comments taken from an e-bulletin board from teachers undertaking functional skills continuing professional development in numeracy in phase two of the research is another method of collecting and collating comments from teachers in online conversation.

Changes in the physical classroom makeup and the changes in learning environments and media for the twenty first century, where ‘Google’ and ‘you-tube’ are now used in conjunction with electronic whiteboards, learning portals and Virtual Learning Environments (VLEs) mean that teachers now need broader knowledge bases than ever before to facilitate meaningful

Google is an example of a search engine, you tube is an example of an application
learning for their students. Teachers must interact with technology both in and out of the classroom. Where the teacher and the researcher overlap this interaction with technology becomes essential.

Research methodology is also a changing landscape in the context of technology – books can now be read without print or paper, and conversations are had without a sound being made through multi-media messaging, which leaves a lasting record of that conversation. Varying types of study have examined the use of internet data and utilised similar methodologies. Gavin and Rodham (2006) examined the ethics of using the internet to collect qualitative research data presenting their findings in the ‘Research ethics review’. Here the researchers were concerned with the ethical implications of using data ‘found’ on the internet and the issue of informed consent their findings were vague as the practice was in its infancy. Lee (2000) claimed simply that the internet lends itself to data collection that is unobtrusive as it doesn’t require the researcher to be present, Flick (2009) agreed with this principle, that data could be collected for qualitative or quantitative analysis with little difficulty or bias and no physical presence.

Project Implicit from the USA is one example of the internet being used to collect data from all over the globe, with the whole process of collecting the research data, completing the analysis and producing the results completed in real time via the internet. Online learning has seen a rise in popularity which may then affect the use of the internet for research. Virtual learning platforms or environments include ‘Its learning’ ‘Blackboard’ ‘Moodle’ and ‘Eliademy’ are all being used, often linked directly to social media through the internet giving direct access to course content for students.

1.9 Addressing research question one

The first research question was as follows:

What are the perceptions and opinions (positive, negative or indifferent) of numeracy held by trainee teachers?
The first corresponding research aim was to examine educational forum postings to collect unsolicited, opinionative data. Higher education prospectus documents (online versions) were also analysed for their mention of numeracy or mathematics with the aim of establishing a baseline for further enquiry. Specific search terms were used within different educational forums to ensure the data collected had been gathered with a uniform approach to each forum.

Evidence has been gathered, collated and analysed for directionality. Information available and research conducted, related to perception and the experiences of trainee teachers is particularly limited (Wallace, 2005). As this information is scarce, this in itself can be an indication that numeracy is an element not discussed by trainee teachers or teacher educators through the course of teacher training, especially in the post-compulsory sector and therefore one possible explanation for this lack of a trace element would be that the subject is accorded little or no importance. The lack of a trace element (Bernard, 1994) could be as important as its presence. Information for those training to be teachers in the compulsory sector is more readily available but is very concise in nature, with few mentions of the words numeracy and mathematics.

The consensus observed: is that numeracy is an unpopular subject and is enough to make some trainee teachers in the post-compulsory sector believe that they are taking the wrong course when they have to address this area, it evokes the same fears as school mathematics and for those who have been unsuccessful in this subject already, there is no desire to repeat this failure again especially with so much at stake (future career) at this high level and in front of their peers. In this respect, trainee teachers are similar in their attitude and approach to the subject as more traditional adult numeracy learners.

These fears surrounding mathematics and numeracy stem from the perceived difficulty of the subject and the lack of understanding as to why this subject is important and must be studied again at this later point in life. Teachers and trainee teachers are, after all, reviewing the numerical skills that they would have been learning at primary school if they are completing a level two equivalency in adult numeracy or functional skills mathematics.

Teacher educators and trainee teachers may display resentment towards elements which are “forced” into programmes (Schloglmann, 2006), including minimum core numeracy or QTS

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7 The ‘later point in life’ refers to trainees in the post-compulsory sector being over school age.
numeracy tests. This can be interpreted and described as part of the prevailing pedagogy, transmitted through a cyclical process, initiated by teacher educators (Swartz, 2004) and mirrored by trainee teachers as attitudes and perceptions towards numeracy and further: towards numerical learning in its entirety. If teacher educators display a certain positive or negative attitude towards numerical learning it follows that in some instances this will transmit to the trainee teachers that they have a responsibility to educate. Conversely a positive attitude displayed is likely to develop a more positive outlook for trainees.

The first research question also led to a collection of information from prospectuses, analysed for their content relating to numeracy entry requirements for teacher education courses. This work clarified the negative direction of opinion in relation to trainees’ numeracy with limited mentions of numeracy requirements in the post-compulsory sector.

1.10 Addressing research question two

The second research question was as follows:

What support mechanisms and resources are available to facilitate the implementation of curriculum and learning in numeracy for trainee teachers?

This research question led to the development of the research aim to complete a critical review of resources and supporting information available to deliver and study (teach and learn) in numeracy for teacher education, with different types of text and online resources being explored.

One type of text appraised is the 'self-help' type of book, those written to support trainee teachers with numeracy. These can be very useful to refresh concepts previously learned, but concentrate on actual numerical skills required to pass a test, with no hint of how these skills are embedded into the life trainee teachers lead as teaching professionals. Any wider ranging or covert numeracy skills are ignored completely in favour of remembering how to do calculations or mathematics and numerical practice. These texts are only useful for learners who already
have the tools to be able to use them, the tools that are obtained from having a reasonably sound numeracy knowledge foundation in the first place. Adults cannot use them without already having a limited amount of comprehension, so they can only really be used by individuals who are already capable and simply need to revise. This is likely to be the intended audience, making these texts effective in their aim.

Other text resources reviewed include the minimum core guidelines for numeracy learning in the post-compulsory sector which provided a syllabus type document for teacher educators to use at the outset of the implementation of minimum core numeracy standards in post-compulsory teacher education. A supporting document is also available which outlines the expectation of competencies to be completed by trainee teachers. Teaching textbooks have also been examined, these are standard texts, often revised and reprinted regularly and accepted as mainstays in reading lists in teacher training courses.

The texts give a generalised overview and explain that literacy and numeracy are required, in some cases with vague details on how this can be interpreted and included in sessions delivered by trainee teachers to evidence their own skills in numeracy. Resources available specifically for the delivery of teachers’ numeracy were researched over a period of several years using a constant comparative method. This examined changes over time in terms of the amount and type of resources available.

The highest level of resources available related to websites and online content or downloadable content that related to numeracy and mathematical learning specifically and very little aimed at that type of learning for teachers as students in the subjects. Those teacher educators who are very adept would be able to create and adapt the more generic materials for use in the classroom with trainees but this would clearly be the delivery of a maths lesson rather than a session focussed on the needs of trainee teachers in any sector.

1.11 Addressing research question three

The third research question was as follows:
How can the delivery of numeracy for trainee teachers be supported, improved and modelled for effectiveness?

The approach to delivery that has been noted (anecdotally)\(^8\) from three institutions responsible for teacher education in the post compulsory sector has been the ‘tick box’ approach (Connell, Edwards and Hammond 2007) to provide a demonstration of competence for elements of numeracy from the trainee teacher. The tick box approach to competence proof that is inherent for instance in the National Vocational Qualification (NVQ) structure can be counteracted, removing the need for ticking the skill off a given list and then moving on to the next skill, as tangible proof that the numeracy is completed. The ‘tick box’ approach perpetuates the idea that the numerical components required of the trainees are finite and limited in their definition, in reality effective demonstration of numeracy skills is more far reaching and holistic. Numerical skills rely on abstract conceptualism being developed as a skill, difficult to define and tick off a list as completed.

Without appropriate numeracy skills the rest of a trainee teachers’ course is limited in relevance. Every trainee teacher who struggles with numerical learning will ultimately struggle with every other aspect of their course, because numeracy underpins many of the other skills that are required. If someone said they were a teacher and could not read and write there would be an obvious problem. When a teacher or trainee teacher says they are not good at maths or their numeracy skills are not strong the problem is not quite as clear.

A trainee teacher or qualified teacher cannot communicate effectively without numerical skills that are appropriately developed. At best they have difficulty being able to communicate effectively in the variety of situations that they may find themselves in, at worst they will struggle with every aspect of their work role. This poverty of teacher skills happens for a variety of reasons but poorly equipped teachers include those without a good foundation in numeracy.

A functional skills mathematics staff development programme in one English Further Education College has been observed in practice and evaluated to provide further data on perception and

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\(^8\) Anecdotal evidence has been gained through mentoring trainee teachers in the post-compulsory sector as part of FE franchise arrangements with three universities in England.
opinion but also to allow piloting of contextual and embedded teaching materials and observe the implementation of a mixed model of delivery.

1.12 Contributions to knowledge

The contribution to knowledge that this research makes is a positive shift in the teaching and learning of numeracy and mathematics, benefitting teacher educators, teachers and trainee teachers in the post-compulsory sector especially, with extended positive outcomes for learners in classrooms. ‘Raising awareness’ generally developed through the research stages completed in phase one, becoming a clearer part of the overall aim. Numeracy having negative connotations for people is not a new development but the discovery of the pervasiveness of this negativity going far enough to affect teachers to a significant degree does represent a development in this area. Teachers are severely affected by negative self-perceptions which may produce avoidance, discomfort and conflict between the need to be professional and the need to complete numeracy learning.

The imposition of numeracy learning on trainees and on practicing teachers causes resentment as teachers are forced to interact with a subject they despise to maintain their working credentials or embark on training in the first instance. These feelings cut across educational sectors, affecting teachers of different disciplines’ and at different levels.

The completed products of the research provide the clearest contributions to the current body of knowledge related to numeracy within teacher education and the expectation is that these will have the most practically useful impact.

The tangible products of research include a critical review of resources available to support delivery of numeracy for teachers (see appendix XI volume one P.52) concrete contextual and embedded resources to support the delivery of numeracy (see appendices XII – XXVI volume two P.3 – 30) and articles to raise awareness of teachers’ numeracy skills (see appendices XXVIII and XXIX volume two P.84-87) as part of the teacher training and numeracy educational agendas. The final contribution to this subject area is the development of delivery methods advocating the assessment of and addressing of the inherent negativity surrounding the subject
areas of numeracy and mathematics. This is presented as essential to success for teachers and trainee teachers learning in these subjects.

The development of the methodology implemented in this investigation, using technology reliant on the twenty first century, utilising forums, discussion boards and the internet is also a contribution to a new and emerging body of knowledge. Researchers are beginning to examine technology as a method not only of categorising data (as a facilitator to research) but also as a focus of research and a source or generator of raw data.

1.13 Acknowledgement of the stance of the researcher

Acknowledging the stance of the researcher at the outset of research is vital to maintain transparency. This research was initiated through experience as a numeracy and mathematics trainee teacher, followed by lengthy experience as a numeracy teacher for adults in the further education sector. This was followed by a significantly lengthy spell as head of department and head of area, followed by curriculum management for mathematics, and numeracy, basic skills and nineteen plus (adult) education. Further experience as a teacher educator and through mentoring trainee teachers in the post-compulsory sector plus the experience of researching in further and higher education as a post-graduate student all contributed to the formulation of research questions of differing types over time.

Whatever we decide to investigate or reflect upon is rooted in our own historical knowledge-power network in which our experiences, values and biases are embedded (Mezirow and Associates (2000)). The way that we approach a problem or research work, as a researcher, is an indication of our approach overall, made up of our value laden choices (Anderson and Arsenault, 2000). Here, this research is based on observations, influenced by value and belief systems, which include the meritocratic nature of education and the intrinsic value of numeracy education.

Within a meritocracy those who expound effort are rewarded on their merits. Applying meritocratic principles to education is not a new or idiosyncratic phenomena, many other practicing teachers view the education system in this way. There is a moral implication in terms
of effort being rewarded and therefore being ‘good’ with the opposite situation being ‘bad’. This conforms to an almost Wesleyan work ethic where work and effort are seen as virtuous and effort expounded is proportionate to reward.

The intrinsic value of numeracy education is a strongly held belief in this instance. Numerical skills are practically useful and mathematics qualifications can be life changing. For example one adult student had the ambition to be a nurse. This seemed an impossible journey starting with a few GCSEs that didn’t include mathematics. To gain the GCSE the student started an Access to HE course and functional skills in her first academic year in further education and then completed the Access to Higher Education (HE) and GCSE mathematics in her second academic year. Four years later the student e-mailed her graduation photo to her teacher and two years after that was spotted in the college car park, wearing her nurse’s uniform\(^9\). This student took a lengthy journey from functional skills mathematics to a nursing degree. This is a good news story but it is not as isolated an occurrence as we may think. Numeracy and mathematics qualifications allow people to progress, to gain employment and to reach their goals.

Although experience may not be a wholly reliable basis for the formulation of research work, it often proves to be valid. ‘Experience’ encompasses the value judgements of the researcher, and these biases and opinions cannot be ignored, since they are inherent in ‘experience’ as a form of knowledge, and ignoring them, will simply leave them as ‘implicit’ (Dey, 1998). A similar view of bias and experience is that presented by Hall (1999) who described value judgements as essential in the formulation of research since values can shape and determine the conduct of inquiry.

In this instance, the involvement of values, prior learning and assumptions as the researcher are not only acknowledged, but made clear as the foundation for research questions. Lather (1991) whilst using an observational method to record data in research noted that the researcher must acknowledge their own part in the research work with the recognition that it’s impossible to stand on the outside of the process.

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\(^9\) This is a genuine story of a student who started her study in 2006.
To be able to clarify the research questions and in making the decisions on inception of the research, experience and reflection on that experience were the main motivators. Self-evaluation is a vehicle to allow us to judge whether or not objectives are being achieved (Huddleston and Unwin, 2002). Being self-critical was important whilst self-reflective enquiry developed the aim of integrating action with reflection (Reason, 1994). Here the main influence was the difficulty faced initially by trainees approaching minimum core numeracy in the post-compulsory sector. Further investigation revealed colleagues in teacher education were also struggling with the implementation of numeracy and colleagues in other departments struggling with their own numeracy skills and the embedded numeracy of their learners. These observations though lacked substance and could not be universally generalised being dependent on context (Mezirow, 2000).

This experience led to initial questions: is this situation repeated elsewhere? What are the perceptions of numeracy from trainee teachers and other teacher educators? Evidence was important to be able to examine the initial observations and answer the first questions posed with as much clarity as possible. Evidence is vitally important since beliefs direct our action, and action based on valid (true) beliefs is more likely to be effective and successful (Craig, 2002). A positive change cannot be effected if it is unnecessary or the motivation for change is not founded in fact.

To be of any practical application, theory alone is not sufficient for research, theory and research must connect directly with practice (Coben, 2000). Teachers use ever more sophisticated methods to develop their own practice and pedagogy informed by research, to produce what Robertson (2000) P.324 describes as a ‘practice enhancing process’ which is inclusive in nature.

1.14 Chapter summary

This chapter formed an introduction to the subject area for research, outlining areas relevant to teacher education in broad terms relating more specifically to teachers numeracy or mathematics. The need for research in this area has been examined and research questions
formulated and presented for clarity, followed by research aims which demonstrate the approaches used to answer the research questions.

Context was provided with background information on teacher training reform and the need for teachers’ numerical thinking. Methodological choices were outlined and contributions to the current body of knowledge in the subject area (including the development in research methods) have been explored briefly with full acknowledgement of the stance of the researcher, providing an insight into the reasoning behind the formulation of research in the first instance.

The chapters which follow include a literature review which anchors the research more fully within the wider arena of education in England and within the specific subject area of numeracy and mathematics. The methodology chapter, which explains in more depth the methods used to complete research, is followed by chapters on the findings emergent from investigation. A discussion, which examines the research findings in relation to the anchoring subject area, an examination of phase two of research and the development of a model for delivery precedes the conclusive chapter. The conclusion examines all of the research findings as a homogeneous whole with recommendations drawn from the results and analysis for future practice.

One of the main elements of this process are the ‘products’ of the research, the documents and resources created to promote awareness and support a more positive and effective implementation of numeracy in programmes of initial teacher education and staff development for practicing teachers where required.

Although examining both numeracy and mathematics through the course of the research the focus is on numeracy throughout. Mathematics implies a higher level skill and knowledge set which is not the focus of attention however it cannot be discounted because so many people use the two terms interchangeably and use both words to indicate the same meaning.

The research here also examines both the compulsory schools sector of English education and the post-compulsory further and higher sector of the English system. The focus here is on the post-compulsory sector whilst the compulsory sector remains as a comparable element to further scrutinise in more depth the results obtained through both research phases. The focus on numeracy and on the post-compulsory sector has developed through the successive stages
of research through phase one, leading into phase two as it became apparent that this focus was justified.
Chapter Two - Literature review
2.1 Introduction

The area surrounding teachers' numeracy contains several different aspects including the training of new teachers, the perceptions of numerical skills and the differences between the compulsory schools sector and the post-compulsory further and higher education sector. Here, the research and literature which is available within this field will be examined in context to identify current thinking and the areas that are lacking in information.

A review of the literature surrounding teachers' numeracy forms a backdrop and a foundation to the research work completed. An examination of policy landmarks with reference to numeracy learning and the lifelong learning sector with an examination of the developments in curriculum, economic effects and the effects on the individual is provided as the first part of this chapter. These important aspects provide some context in which the research and its findings can be viewed more accurately. Following on from this the minimum core of numeracy (as originally formulated by the Further Education National Training Organisation or FENTO) is described with an overview of the implementation of the core and teacher skills in professional skills numeracy tests for the compulsory sector. Comparisons are made between the compulsory sector and the post-compulsory sectors of education in terms of trainee teachers learning numeracy as part of their teacher training.

The perception of mathematics and numeracy is a central aspect of the original research questions formulated and is developed here more theoretically, examining both the individual and wider societal perceptions. Teacher training forms another aspect of the research and this is viewed from several perspectives in this chapter, including an outline of the process of initial teacher education (ITT) the application of numeracy in training teachers and the underpinning pedagogy in teacher education.

2.2 Policy and professionalism landmarks

The historical underpinning and policy measures within the English education system which have led to the formulation and the implementation of numeracy for teachers and the
requirement for evidencing level 2 mathematics as part of QTLS, and the skills tests for compulsory sector trainees to complete QTS provides a clear context and backdrop to the research conducted. All the individuals who learn numeracy as trainee teachers or undertake this subject as CPD for qualified teachers are adult learners; they are part of the tertiary education system because they are all over the age of 19.

This work is anchored in lifelong or adult learning, which has an established place in British history, with strong roots in the perception of a meritocratic system geared towards either leisure learning, academic achievement or learning aimed at improvement within work and industry, through a notion of vocational learning. Vocational learning refers to the achievement of qualifications that are vocation specific, for example hairdressing or construction, often delivered using diploma, National Vocational Qualifications (NVQs) or apprenticeship models.

The development in the post compulsory sector of the lifelong learning agenda proffers several landmarks, which include the start of the Open University (1971) the setting up of Technical Education Councils or TECs (1990) and the development of the Further Education Funding Council (FEFC) in 1992 (Hillage et al. 2000). The Skills for Life Strategy, the embedding agenda, and the development of the adult basic skills and functional skills curricula\footnote{The skills for life strategy, embedding agenda and development of numeracy/functional curricula relate to further education sector developments related to numeracy learning, rather than being directly related to teacher education.} are relatively recent developments within the further education (post compulsory) sector. This is strongly related to the perceived need to provide a workforce which is more suited to the changes in the nature of employment and the economic base of the nation, which has undergone transformation from a rural to industrial and finally to a service driven base within the nineteenth and twentieth centuries (Hoyles et al, 2002).

The concentration on the development of skills to address economic or social disparity is a recurrent theme in English educational policy. Education policy as part of a response to the need for welfare reform addressing social movement, upheaval or influential events, for example disease epidemics, urbanism and industrialisation (Ross, 1991) or want, disease, ignorance, idleness and squalor described by the Beveridge report in 1944, has helped to give rise to education being part of the perceived moral obligation of mainstream society embodied
within socio-economic policy (O'Donnell, 1987). Therefore education is a benefit provided for English people individually as part of their citizenship but is also beneficial to the nation as a whole.

Essential, basic or functional skills are seen as fundamental to achieving national economic ambitions, individually, within families and within communities followed by a national and international level. The Department for Education and Skills (DFES) (2003) reported a strong suggestion of a link between poor skills and poor income. Skills and knowledge create wealth, outlined as a priority in the DFES skills whitepaper (2005) ‘Getting on in business, getting on at work’ was the requirement for the achievement of a more skilled and educated British workforce. This view of basic skill levels being high impacting on a wealthy and successful economy can be seen more as ideology and rhetoric than a statement of fact. There may be other reasons for the requirement of a numerate workforce, promotion of the ideology underpinning the need to educate the workforce is just one (Apple, 1990).

Political movement is connected to education and the formulation of programmes for the transformation of institutional and organisational practice, ultimately impacting economically on the market forces which contributed to the formulation of political rhetoric initially (Rose, 1992). Each element is seen as interconnecting or symbiotic, the education system impacting on an individual’s ability to contribute economically to the prosperity of the nation as a whole. This creates a spiral or cycle where communities are developed through a combination of education, market forces (embedded through economics) and central government interventionist policies, leading to those developed communities making a larger contribution to the development of other smaller or poorer communities which could be described a smaller or poorer in terms of size, economics or power relations.

Key to the economic development cycle is transferable skills (those skills which can be transferred within and between contexts) which are seen as providing in part a resolution to economic disparity. Leitch (2005) reported on skill requirements for industry, examining the lack of skills demonstrated by individuals, and the impact of essential skills gaps, identifying a lack of appropriately qualified individuals in the wider society, negatively affecting the nation at a ‘macro-economic’ level. The DFEE (2000) identified possible effects on the wider industrial society in the UK (prior to the recommendations of the Leitch report) stating that a demand can
be identified for individuals in the labour market with minimum or higher skills levels in the essential bracket, the skills outlined included numeracy.

The policies of successive UK governments have meant that the economic movement from an industrial to a service driven base provides fewer and fewer unskilled jobs in the labour market. Essential transferable skills (including numeracy) allow individuals to move between different forms of employment in the modern UK economic landscape. More and higher qualifications provide more choice for the individual and more opportunity for employers to grow and expand, responding to market forces. Adaptation to change and the ability to diversify has been presented as a driver for national economic prosperity.

Evolution and implementation of numeracy in programmes of initial teacher education is directly related to social and economic policy developments. The “Lisbon Agenda” (2000) defined plans to create a European Union with a strong and competitive financial economy. One pivotal aspect of the plans for the Euro-economy centred on: the ‘development of skills in the lifelong learning sector’ (DFES, 2005). Using an integrated approach to education through economic policy development, allows rationality in a political sense, to be applied to govern problematic aspects of social and economic existence (Rose 1992).

The importance of central government (and so of national policy) as opposed to local authority and individual teachers, was enshrined in England through the Education Reform Act (1988) ensuring universal notions of numerical learning through state control and prescription (Johnson et al, 2007). The 1988 Education Reform Act formed part of a sequence of acts that enforced centralised nationally dictated curriculum for numeracy within the compulsory school sector. This dictated the national numeracy strategy implemented in schools for more than twenty years in England. This has been reinforced with legislative reform in national curriculum never losing the universal notion or the notion of central government control of the curriculum.

Part of the central control of the curriculum exerted by successive governments includes continuing professional development (CPD) programmes for teachers which have become an accepted part of practice in all strata of the education system in England. Successive research has focussed on the gains for teachers that result from CPD (Timperley and Phillips, 2003) This came to the forefront for those working in the further education sector especially through
the requirement to evidence thirty hours of CPD for compulsory membership of the IFL and to allow conference of QTLS status through professional formation requiring evidence of a mathematics qualification at level two. To be able to evidence that their teachers were suitably qualified further education colleges attempted to ensure that all of their teaching staff had followed the appropriate guidelines and evidenced their CPD requirements yearly.

The requirements have become significantly ‘looser’ over time and were not particularly restrictive for colleges initially. No penalties were specifically in place for those colleges or teachers that did not conform to the CPD requirements of the IFL. There may have been a lasting legacy for colleges though, keen to be ‘investors’ in their staff and reap the possible financial gains of training their own staff members on accredited and funded courses. Adult numeracy followed by functional skills represents a course of study that is funded (with ten percent funding uplift for disadvantage for several years) and should represent a high success rate if delivered to staff members who are already well qualified (level three and above) and therefore likely to pass the qualification in less than the recommended guided learning hours.

Prior to 2004 when the reform of teacher education started to gather momentum, colleges provided varied CPD opportunities for teaching staff, including allowing them access to courses viewed as ‘adult leisure learning’.

With the IFL requirement to evidence CPD for teachers and swathes of funding cuts in the adult leisure learning budget, colleges began to dictate the type of learning that staff member’s accessed, making this a stronger part of appraisal targets, taking some level of control out of the hands of the individual. Nash (2012) advocates control over CPD being firmly held by the teachers themselves and sees self-regulation of the sector as being key to an effective development of professionalism within the further education sector. Nash also claimed that prior to 2004 there had been an under-investment in the area of professionalism within the further education sector.

The 2012 review of further education chaired by Lord Lingfield proposed more autonomy for those lecturing in the further education sector and more autonomy for their employers especially if they achieved self-efficacy in the self-assessment process allowing them freedom from inspection cycles and entry into a possible charter recognition scheme for the sector. The impact on professionalism as a concept within this sector was examined and as part of a
plethora of reforms and changes proposed, professionalism was seen as one aspect being 
impacted fundamentally by freedom being created in the governance and implementation of 
teaching and learning in further education. Higher education was presented as an effective 
model but one that should not be fully replicated within the further education arena, as the 
requirements for staff and students would be different. Although no hard and fast definitions can 
be provided, Lingfield et al proposed a list of criteria which would be evident within a 
professional role and therefore underpin professionalism:

‘Mastery of a complex discipline;
Continuous enhancement of expertise;
Acceptance that the field of expertise is a vocation to be pursued selflessly for the benefit of 
others;
Public accountability for high standards of capability and conduct;
Membership of a group earning and deserving the respect of the community;
Membership of a defined group with similar skills, transcending local loyalties to achieve 
national and international recognition;
Acceptance of responsibility for the competence and good conduct of other members of the 
professional group;
Membership of a group which accepts responsibility for planning succession by future 
generations;
Membership of a group which seeks continuously to extend and improve its field of knowledge;
Membership of a group deserving an above-average standard of living.’

Lingfield et al (2012) P.22

According to Diaz-Maggioloi (2004) professional development does require a suitable 
framework for delivery and does have the ‘noble intention’ of improving student gains but also 
requires some ownership from those undertaking the development. Professional development is 
often completed in a fashion that involves top down decision making which muffles the teacher 
voice in the process. The culture of ‘professionalism’ the reflective or evaluative teacher as 
practitioner and the drive for continuously higher student gains has become a pervasive culture 
within institutional discourse as the norm.

Adams and Tulasiewicz (1995) pointed to a predominant political and cultural ideology 
influencing teachers and the way that they teach, transmitting the same ideology to students 
ensuring that notions of equality, egalitarianism and inclusion were not fully explored due to the 
limited discourse in these areas and the lack of preparation for teachers to do so.

Professionalism then would be measured by how much a teacher can conform to the practical
requirements of their teaching post which in turn rests on the predominant political values of stakeholders and central government dictates’.

The underlying philosophy and value structure for teachers becomes entangled with market forces (due to further education college incorporation for instance) and the Ofsted inspection framework rather than personal development or the ‘rounding’ of a professional identity. This is diametrically opposed to the ethos of the lifelong learning agenda in the UK, promoting target driven industry standards for teachers rather than taking a holistic approach to the development of professionalism. Whitty (2006) describes the previous labour government as providing managerialist reforms which failed to create the conditions required for ‘informed professionalism’ for teachers.

The notion of professionalism has been studied and researched in academia beginning with the concept being outlined by researchers such as Millerson (1964) who provided a definition based on core requirements for a profession which included skills based on knowledge, certified skills acquisition, a code of conduct for professionals and conduct based guidelines based on actions seen to be for the ‘public good’. This research was representative of its time and considered to be related to traditionalist notions of professionalism related to Law and medicine.

Defining professionalism via a pre-set value system or list of qualities, especially with reference to using older conceptions of professionalism leads to exclusivity and elitism rather than development of the individual and the profession itself (Whitty, 2006) Intervention by the state via imposition of technical requirements for teaching rather than teachers making choices may perpetuate elitist models of professionalism.

The national numeracy strategy within the primary sector of education is an example of intervention by the state on a grand scale. The strategy demanded greater coherence and standardisation across the primary phase, indicating what and how to teach for these subjects specifically. Prescribed teaching approaches, indicative content and increased testing has removed control of curriculum from teachers and placed it firmly in the hands of central government for these subjects. Teacher professionalism then is measured on adherence to the prescribed structures rather than the needs of students and teachers, transforming teachers into technicians (Whitty, 2006). The primary numeracy strategy impacted on the curriculum for secondary teaching at GCSE level or key stage four. The numeracy strategy and
secondary curriculum then informed other qualifications in mathematics including the development of the adult numeracy core curriculum.

The development of teacher standards to replace teacher competencies may help to examine the concept of professionalism in more depth. In both the compulsory and post-compulsory sectors of education in England teacher standards of practice have been introduced and may prove more appropriate for the twenty first century concept of professionalism for teachers than a tick list, technical approach.

2.3 Effects on the individual

Parsons and Bynner (2005) concentrated on the individual person as a part of society more directly, finding that poor essential skills related to employment chances for the individual and then has an effect on their immediate community followed by an effect on the nation they are a part of. A lack of essential skills and a lack of education in general can impact not only on social mobility\(^{11}\) for an individual, but can deprive a person of the opportunity to escape from poverty (DFID, 2005) or from a life dependant on welfare benefits provided by the state. Secondary problems can occur (other than those problems which have a financial impact for the individual) these include problems that may lead to social exclusion, a lack of access to services and support and may even include issues of physical and mental health or wellbeing (DFEs, 2003).

Although a clear causal relationship cannot strictly be identified, a web of interconnected factors surrounding an individual can be viewed. When a person cannot fully participate in the wider society they can restrict themselves and withdraw from participation. Kubzansky et al, (1999) further supported this proposition in the USA, examining the effects of a lack of high school (secondary school) education affecting health and psychological wellbeing adversely. Feinstein, (2002) Schuller et al (2002) and Parsons and Bynner (2005) all reported that an interplay of factors are affected by educational attainment, supporting the social-ecological model as described by Belsky (1980) and Holahan and Spearly (1980), where individuals do not develop

\(^{11}\)Social mobility is used as a term to indicate a positive upward or forward movement for an individual, with reference to their financial or economic status.
or exist in an isolated vortex, but co-exist within a matrix of interacting environments, having a wholesale effect on the life chances of an individual within a societal context.

Feinstein, Duckworth and Sabates (2004) went further in the creation of a conceptual model identifying proximal and distant factors in child development set in a familial context. Those factors identified included the educational attainment of parents impacting on the educational attainment of a further generation. Cummings et al (1994) in examining similar factors to those described by Feinstein, Duckworth and Sabates, concluded that mediation through an external agency, for instance a stratified education system, can positively influence outcomes for the individual, mediating the negative effects of proximal factors in some instances.

People can be made poor by an ever-increasing cycle of deprivation (DFID, 2005). The different elements of health, employment, social contact, and education coupled with socio-economic determinants conspire to create lives which have unfortunate conclusions which are predictable from the interplay of factors that contribute to them (Feinstein, 2004). The function of social systems designed to counteract negative influences on the individual or specific communities and groups is to ensure that people are fit for the working environment. Being fit for work implies a person is physically healthy but in addition to this a person requires the intellectual tools to function effectively in the workplace.

The qualifications informed by the numeracy curriculum, which included adult numeracy certificates and key skills or equivalency certificates (now obsolete) and functional skills qualifications do make people fit for work – but only at limited levels: they do not bring learners up to the level of their counterparts who hold the mathematics GCSE. When someone presents an ‘equivalent’ qualification it says something about them in a subliminal way: they couldn’t get a GCSE at the grade C ‘average’ level or complete key stage four, they did badly at school, or didn’t attend, they are somehow less than their counterparts holding a GCSE C grade. Conversely the equivalent qualifications should indicate that a person has gained new skills, more confidence, worked hard and achieved.

Unfortunately these qualifications can demonstrate the lack of a GCSE, re-affirming the academic, vocational divide, since these qualifications are often accepted for entrance to vocational courses in FE but are not universally accepted for entrance to higher level three (A-Level) or access to university courses. The qualifications fall down further since the GCSE is the
next level above the functional or adult equivalency qualifications demonstrating clearly the lack of parity and the lack of genuine clear progression routes. Functional skills are a stepping stone on the way to achieving a GCSE.

The Skills White paper part 1, (DFES 2005), examined the progression of learners to level 3 courses, where the impact of qualifications in terms of earnings potential, productivity or remuneration is positive and high, finding that there needs to be a clear progression ladder from basic skills to higher level courses (DFES, 2005). This was not apparent in 2005 and even with the re-development of curriculum to become functional skills, this progression route was not in place in 2012 and 2013. By 2015 some clarity was introduced with funding regulation changes relating to GCSE mathematics.

Students in post-sixteen education or further education with a D grade GCSE in mathematics gained in school are required to undertake the GCSE to gain a C grade with functional skills qualifications being described in curriculum and funding guidance as ‘stepping stones’ towards this ultimate goal. This does make it clearer in terms of attainment levels, however it also points to the adult numeracy and functional skills mathematics curricula having failed to provide a suitable alternative to the GCSE curriculum for mathematics.

2.4 Curriculum development

Teachers have been forced to relinquish their wholesale authority over the curriculum, (this action was embodied in the 1988 Education Reform Act) providing a platform for policy development on a macro scale, where central government can manipulate the curriculum to meet the needs of differing sectors of society or form part of a balance redress for disparities within society (Machin and Vignoles, 2006). Major elements in the English system related to numeracy learning include the development of ‘core skills’ followed by ‘key skills’ to integrate the essential skill of numeracy into vocational disciplines through apprenticeship and diploma frame-works, now replaced by functional skills or GCSEs in these frameworks.

Tomlinson (2004) proposed curriculum reform with the intention of making the system of qualifications comprehensive, providing a new diploma framework, clarifying progression routes, aimed at providing a coherent model for the 14-18 student in the further education sector.
Followed by the 14-19 (DFEs 2004) and skills white papers (DFEs 2005) proposing the further development of the functional skills curricula, embedding of this new functional curricula within vocational diplomas and its inclusion within GCSE specifications. The original proposal for the development of functional skills in GCSE provision was to integrate a functional skills examination within the GCSE structure, ensuring that a student could not gain a GCSE in mathematics without the corresponding functional skill. This proposal was later altered in favour of writing functional skills elements into the GCSE specifications with the addition of wordy ‘problem solving’ and ‘skills application’ questions.

These reforms to the mathematics curriculum have gained momentum over time with a revised GCSE structure for 2016 delivery and a nine point grading system replacing the A* to G grades. More functional aspects have been included within GCSE mathematics and the functional skills curriculum has been re-developed to be more rigorous. Changes surrounding the qualification structure have included a change to funding which requires all those at age sixteen who have achieved a D grade rather than a C grade in mathematics must continue to study mathematics until the age of eighteen if necessary. Further measures include clarification that the functional skills qualifications are lower in value and provide a marker towards achievement in GCSE rather than forming any kind of equivalent or alternative qualification for students under nineteen. For those over the age of nineteen the curriculum choices remain the same as they have been previously, a choice between functional skills mathematics, GCSE mathematics or individual units of numeracy study which can be combined to create a mathematics certificate. Entry levels are still available for adults but the de-valuing of the level one and two has a knock on effect for these qualifications which are now seen as very low down on the qualifications framework.

The intention of the functional skills curriculum to bridge a reported gap in skills and to compensate for the lack of functional skills exhibited by learners who lack a GCSE, presents a view of curricula tied to vocation or described as a curricula designed to improve employment chances and to up-skill the workforce (Newby, 2005). Vocational educational routes traditionally in England command a lower status than academic curricula, relating to the level of cognitive functioning required for the manipulation of abstract conceptualism over mastery of skills (Torff and Sternberg 1998). This leads to the implication of a devalued curriculum and the associated qualification, due to its inherent functionality. Curricula geared to industry and improvement in
the skills base having a lower status than its academic counterparts, including the original basic skills curricula and the functional skills curricula.

The perception of both institutions involved in higher education and employers, takes account of this association and predisposed the level one and two adult qualifications to fail in their aim of leading to progression routes in either education or employment. Adversely, these qualifications have led to a maintenance of the status quo and equipped the workforce for their current or initial levels of endeavour, rather than offering a route for further or higher levels of work (Smith, 2004)

Using the word numeracy to describe adult numerical learning gives the subject a lower status.

Coben, (2003) identified the subject of numeracy as equated with primary, lower level or elementary mathematics due to an association with childhood. This approach is difficult to change (even if it is just a matter of perception) and is enshrined in the naming of the National Numeracy Strategy (NNS) which is primary level. The adult numeracy core curriculum (Steed 2001) is based in part on its predecessor, the NNS developed and implemented nationally as the primary provision in schools (up to year six or the age of eleven years) (Macrae 2003)

Although the national numeracy strategy extends to secondary provision, the association with school means that the word numeracy is always associated with a low level or school level of learning.

The inherent similarities with the National Numeracy (primary) Strategy, rather than the GCSE, of the skills for life strategy for numeracy, gives the message to teachers, learners and others that the qualification is more likely to equate with the primary level of education than with secondary or ‘higher’ mathematics. The skills for life strategy also enshrines this rhetoric by using the word ‘basic’ to describe the numeracy delivered to adults. Hudson (2006) highlighted these concerns by claiming that adult numeracy qualifications were ‘child centred.’

Several governments commissioned reports\textsuperscript{12} (Smith 2004, DFEs 2005, Tomlinson 2004) place emphasis on ‘functional mathematics’. Hudson (2006) highlighted the concern that functionality introduced to mathematics generally may become identified with lower status pathways, reaffirming a vocational-academic divide, also stating categorically that the functional skills

\textsuperscript{12} Reports commissioned at or around the time of minimum core development and initial implementation.
curriculum will be equated with low achievements and will become the curriculum that marks out low achievement in these areas.

The further education (FE) sector strives towards what is seen as “high status” work (McGinty and Fish, 1993) including higher education delivery. Placing basic numerical learning (lower status work) into programmes of initial teacher training (ITT) could be seen as tying teacher training to vocationalism and low achievement rather than academia, de-valuing the provision in the eyes of educationalists and employers (Smith, 2004). The curriculum for initial teacher training within the post-compulsory sector is then further de-valued, with anchorage to a “primary” level of education due to the numeracy core curriculum being linked with the National Numeracy Strategy (Oughton, 2007).

It is possible that the process of change within the areas of mathematics and numeracy at levels leading up to and including level two, will be mirrored or filter through at level three and higher, demonstrated by the current reform of the A-level curriculum. Movements in one sector of education are likely to promote movements and shifts in another sector.

Functional skills implementation (replacing adult numeracy) brought a slight positive change in perceptions. Functional curricula are presented as mathematics and English, rather than numeracy and literacy. Many adult learners (anecdotally) referred to their numeracy class as their maths class and if this subject perception could be reinforced, it may be possible to remove or erode the association with primary levels of education. The numeracy qualifications for adults have been removed from the national qualifications framework (especially with reference to funding) and replaced with functional skills qualifications in mathematics.

2.5 The minimum core of numeracy and professional skills tests

The minimum core of numeracy refers to the aspects of numeracy which are required to be integrated into teacher education for the post-compulsory sector. Professional skills tests are the tests which trainee teachers must pass in order to start their teacher training in the compulsory school sector of teacher training. The two things are different but are underpinned by the same remit, the requirement to include numeracy in training for teachers.
QTS tests have been re-named the Professional Skills Tests. These tests are completed at the start of teacher education, although previously trainees were able to book their tests at any point in their training and could then re-book as many resits of the tests as required. The tests have a limit of three attempts and without success at this point trainees must reapply for training after twenty four months and go through the process of the professional skills tests again. The tests are taken online and are marked by the electronic system with the results then being available for both the trainee and their training provider to access.

The numeracy professional skills test has twenty eight questions split into sixteen written arithmetic and data questions and twelve mental arithmetic questions which are delivered via audio for the candidates. The audio section of the skills test is seen as the most difficult for trainees as each question is repeated twice but they have a time limit of eighteen seconds for each question to be answered. Each question is worth one mark, regardless of the amount of work, knowledge or skill required to find the answer. The questions in the test have been calibrated against a benchmark test and so although each test is made up of different questions, all will equate to the same levels.

The skills tests have significant time limits and these are likely to impact on a trainee’s ability to take up their place for teacher training as they cannot begin their course at all until evidence is available that their test has been completed and passed, the department for education (DFE 2015) outlines the requirements on their website:

“The numeracy skills test is divided into 2 areas:

- mental arithmetic section
- written section (written arithmetic and written data)

You will not be tested on your knowledge of the mathematics national curriculum or on how to teach it…..

Each test contains 28 questions made up of 12 mental arithmetic questions and 16 written questions (written arithmetic and written data), plus a practice question that is not scored. All questions carry 1 mark regardless of the number of required responses.

All the numeracy skills tests have been calibrated statistically against a benchmark test. As with any multiple set of tests, the tests are not identical to each other. This is because each test has different questions, but they are all of an equivalent standard. A test with slightly harder questions will have a slightly lower pass mark and a test with slightly easier questions will have a slightly higher pass mark.”

(DFE 2015 P.1)
The number of trainee teachers who pass the tests has changed significantly, varying negatively with the change in regulations over time. In 2010 the percentage of trainees passing the test for numeracy was 97.41 percent taking all their attempts into account. In 2014, after full implementation of the new regulations this figure had fallen to 79.36 percent (DFE 2015) this may demonstrate that the test regulations have been successful in identifying those trainees who lack the required skills prior to training, or it may be that the test is flawed in its newest format, or that it has become progressively more challenging over time. What is likely to have caused the turndown in results is the cap on the number of attempts at the test, meaning that trainees cannot keep taking the test until they pass.

The core of numeracy in programmes of initial teacher training for the post-compulsory sector forms part of the larger minimum core which includes literacy and language and as part of the professional formation process to be awarded QTLS, there is a requirement of trainees to present a level two mathematics or numeracy qualification. This is only a requirement for those undertaking the professional formation process, a voluntary process rather than a necessary process for teacher training and resulting in an elective conferring of status rather than an industry or sector specific dictate.

Introduced into initial teacher training programmes in August 2004 the specific competencies to be evidenced by trainee teachers were outlined by The Further Education National Training Organization, FENTO (2004) in conjunction with the department for education and skills (DES) and the qualifications curriculum authority (QCA). Minimum core numeracy is divided for classroom delivery into the two distinct sections of personal and social factors. Personal factors include the actual numerical skills needed to function effectively (Newby, 2005) and represent those skills which underpin extended cognition. This is an outline of the actual mathematics required of the trainee teachers and can be clearly evidenced by providing a certificate. Social factors are those (including socio-economic, demographic or behavioural) which may contribute to the impediment of learning for students, providing barriers to learning in mathematics and numeracy. Social factors are essentially a topographical map of students which will affect how they learn any subject, not limited to numeracy alone. Developing an understanding of these factors is beneficial to understanding how students learn in any subject.
Trainee teachers can be encouraged to explore these areas with special reference to the overlap of features with vocational areas. To achieve an appropriate level of understanding trainee teachers are required to be able to reflect on their own and learners attitudes and attainment relating to personal levels of basic or essential skills use and to new learning that involves these skills (FENTO (b) 2004). Examining how social and personal factors can impact on essential skills learning in particular also creates a wider awareness of how these factors impact on learning in a broader sense. Further to this trainee teachers are encouraged to identify the underlying elements of numeracy which are occurring within their own classes, which is by far the most difficult aspect to address, this process having evaded many fully qualified and experienced teachers. This has been described clearly by Callingham et al (2015):

‘A challenge hence exists to raise teachers’ awareness of the nature and importance of numeracy, and to encourage their engagement with numeracy aspects of subjects outside mathematics.’ P.551. Callingham et al examined the feelings of practicing teachers finding a negative situation resulting in avoidance of the subject:

‘For teachers who actively avoid mathematical ideas, or are simply unaware of the numeracy possibilities, the expectation that all teachers are teachers of numeracy makes an increased demand on their professional knowledge.’ P.552.

Mathematics is a specific skill which has been in short supply in the UK, leading to criticisms that teachers are not sufficiently numerate or qualified to be able to support their learners (Hudson, 2006). With reference to those teachers who teach mathematics and numeracy as their specific subject and those teachers who teach another subject but need to support numerical skills development for their learners. The development of numerical skills can be encouraged through both continuing professional development (CPD) for established teachers and through the implementation of the minimum core for trainee teachers in the post-compulsory sector and completion of the QTS tests in the compulsory sector depending on the role of the individual (Tout, 2005).

2.6 Implementation of teachers’ numeracy learning
Implementation and development of teachers’ numeracy may have proved to be an arduous task for some institutions. SVUK (2005) identified that institutional adjustments may be necessary in some instances, not only for the minimum core to be delivered fully in the post-compulsory sector of training, but for it to be effective, implementation in this sector especially has been sluggish and unsatisfactory. The need for positive intervention involving practitioners in this area was clearly stated by the Office for Standards in Education or Ofsted (2010) P.4: “Four fifths of the providers visited had made too little progress in ensuring that all teachers met the minimum levels of skill in literacy and numeracy.” Four fifths (80%) of providers falling short on numeracy skills for trainee teachers is a signal for teacher education in the post-compulsory sector to examine the delivery of numeracy for teachers in more depth. Within the compulsory schools sector, the implications for delivery are much clearer due to the recent reforms relating to the professional skills test. Teachers must reach the expected level, there is no room for manoeuvre and the trainees must evidence their achievement clearly. Everything rests clearly on the shoulders of the trainee with no requirements of the training institution at all apart from checking successful completion and therefore eligibility to embark on training. A lack of knowledge which could help to redress the situation is apparent.

There is a lack of concrete information in terms of theoretical constructs, scholarly literature and practice based information available surrounding teachers’ numeracy as a subject area. Callingham et al (2015) concentrate on the feelings and reported views of teachers on numeracy from an Australian viewpoint but in England this subject is not a popular one for study. Where literature is available, and the subject area has been discussed, the point appears to be missed or misinterpreted. Duckworth and Tummons (2010) for example provide examples and case studies relating to numeracy embedded into teaching sessions within different vocational and academic subjects.

The embedded numeracy examples provided are actually overt numeracy examples, concentrating on calculation skills, not on wholly embedded underpinning numeracy skills. The example provided is clearly demonstrating how numerical work can be ‘inserted’ into a history session (contextualised numeracy), but the statement is made that: “level 2 numeracy is not ‘naturally’ embedded into history, which is to say it does not occur through the general disciplines history promotes, such as critical analysis” (P.55).
Critical analysis is a clear example of exactly where the numeracy in history naturally occurs. Critical analysis is the embedded element of numeracy within that subject, and the amount of sequencing and chronological work involved in historical study is vast – also the mainstay of embedded numeracy in the separate subject of ‘history’ - but there isn’t any mention of this. This provides us with a clear example of how numeracy as an underpinning foundation has been misinterpreted at a conceptual level even by those who are really attempting to address the subject in a practical and positive way. A focus on numeracy is essential, since this subject is often perceived to be the most difficult of the four core elements of language, literacy, numeracy and ICT (Handley 2003) with reference to teaching and learning in post-compulsory teacher training.

2.7 Teachers’ numeracy skills

Lucas et al (2004) examined the characteristics of teachers participating in core curriculum training for adult literacy and numeracy over the years 2001 to 2003. This training was seen as essential within the skills for life arena, for those teaching literacy or numeracy to adults. The sample contained 1004 teachers taken from both literacy and numeracy backgrounds (current subjects being taught by them in the classroom). Of all those involved in the study, 19% of the respondents held mathematics qualifications below level 2 (GCSE grade C) whilst 52% held a mathematics qualification at level 2 only, leaving just 21% holding mathematics qualifications at level 3 (A level) or above. This does point to numeracy teachers being underqualified within the sample examined, not generally but within their own actual teaching area subject specialisms specifically. This does lend support to Tomlinson’s report recommendations (2004) that within the further education sector teachers needed to be better qualified and professionalised.

Teacher training guidelines for mathematics (numeracy) teachers at level five include the requirement for teachers to demonstrate an understanding of different types of skill. These include; ‘hypothesising, exploring, testing’ and ‘interpreting’ (Sector skills council, 2007). This skill emphasis is a substantial alteration to the subject specialist criteria at level four developed by FENTO (2002) previously and points to the underpinning areas of cognition developed by numerical or mathematical learning which enhance and underpin learning in other subjects.
FENTO’s guidelines (2004) on teachers’ knowledge related to minimum core numeracy also has an expectation that teachers will be able to further develop elements of ‘process’ knowledge, which includes decision making in terms of seeking advice from area specialists, addressing the needs of learners with specific difficulties impacting their learning and interpreting information gleaned from assessment practices (FENTO (b) 2004) all of which are generic teaching skills, and the underlying expectation is that these skills are to be applied with learners who exhibit difficulties or deficits in essential or basic skills. All trainee teachers within the post compulsory sector should have a raised level of awareness provided by the minimum core, including seemingly simple elements, for example the level of language skills required to complete functional numerical exercises should not be overlooked (FENTO (b) 2004).

Trainee teachers are not a breed apart from other human beings. These individuals will suffer proportionately within the population from the same anxieties and struggle with the same difficulties in numeracy as any other adult learner\textsuperscript{13}. Trainee teachers in the post-compulsory sector are required to evidence their skills at level 2 in numeracy\textsuperscript{14} which is significantly below the requirements of those training to teach in the compulsory (schools) education sector\textsuperscript{15} who must evidence their skills in addition to having mathematics GCSE C grade or above mathematics on entry to their teacher education course. Although the disparity appears to rest on the completion of a professional skills test, the attitude with which regulations are enforced makes the difference more acute with limited urgency or reliance on completion in the post-compulsory sector.

2.8 Comparisons between numeracy and mathematics

Concerned with the ideological and political functions of education within the restricted school environment, Apple (1990) pointed to the ideological function of education being circular and self-fulfilling or self-justifying, in terms of removing conflict. Pointing to the way science is taught as an example of a set of technical knowledge, divorced from true application. From this

\textsuperscript{13} Adult learners are those learners over the age of nineteen years.

\textsuperscript{14} Evidencing of skills at level 2 is required for completion of QTLS status from the IFL, and is required within the first year on completion of initial teacher training.

\textsuperscript{15} Although level 2 functional mathematics is seen as an equivalent level of qualification, it does not contain the more abstract elements of GCSE at A*-C grade.
standpoint it would be possible to see that the overlaps in the requirements at different levels for numeracy teaching and learning simply justify the need for the teaching of the subject. Apple (1990) expressed the currently popular viewpoint that a ‘normative’ and ‘legitimised’ curriculum adversely affects the development of creativity for instance. It is likely that Apple is able to argue from the position of someone who has an appropriately well-developed set of numeracy skills and therefore has the ability and the tools to develop creativity.

Creativity and the development of ‘free thinking’ are reliant in many instances on cognition and self-expression which requires the ability to manipulate abstract concepts. Without numeracy individuals are unlikely to develop realistic levels of cognition that would allow them to be creative, expressive or free thinking, basic numeracy being the most important tool to develop cognition through the manipulation of abstraction. Tammet (2009) and Newby (2005) both provide support for this proposition by stating that people actually need these numerical, reasoning and communication skills to function effectively, especially in the twenty first century environment.

The effect on teachers of the implementation of the older national strategies (for example the national numeracy strategy prior to its re-assessment in 2014) on teachers at primary level for literacy and numeracy was examined by Earl et al (2003) who found that the self-belief of teachers improved as they were empowered, believing their own learning had: ‘been positively affected’. Teachers who have attained a functional level of essential literacy, language, numeracy and ICT skills themselves (level 2 and above) are more likely to be able to foster and support the essential and transferable skills development required by their learners.

An increased use of ‘whole class teaching’ was also noted by studies such as those of Earl et al, these observations point to a greater depth being employed by teachers at primary level to interact and ‘reach’ pupils taking into account different levels of ability. A strong shift towards learner centred pedagogy (Chappell et al 2003) is implied by the methods expounded within the national strategy, which may also account in part for the observations of Earl et al, as teachers employ and become more confident with an ever expanding range of methods.

The national numeracy strategy has attempted to support teachers to start off the first experiences of mathematics and mathematical reasoning in the primary curriculum stage as a
non-threatening experience for the pupils, which they will then carry with them through the education system into adult life, possibly impacting positively on the learner histories of future mathematics students. Measures to place the student at the centre of the learning process may be beneficial to improve student perceptions of their ability and interest in mathematics and numeracy. So as teachers become more confident, pupil’s performance and attainment correspondingly may improve.

In 2004, the Tomlinson Report stated the need for adequately trained teachers for the subject area of numeracy for adults, but also emphasised that more professional recognition was required for them. This ‘professionalism’ was expected to be apparent through the training system, demanding a level 4 subject specialist qualification.\textsuperscript{16} The qualification, does not hold parity with higher mathematical qualifications of other types, for example a degree or higher diploma, and the view of numeracy teachers as being ‘less’ qualified as their mathematics teaching counterparts has been dominant (Cameron 2003). As yet, there is no degree in England specialising in the subject ‘numeracy’ relating to adult or more advanced learning (although this is available at Master’s degree level) extending this perceived discrepancy for the foreseeable future.

The experiences of trainees in the compulsory sectors can be used as a comparison measure with the experiences of those in the post-compulsory sector, to an extent since the subject matter is similar. There is a strong emphasis on numerical calculation within the professional skills test which only forms half of the numeracy minimum core, making very direct comparison more difficult, since a true comparison of value would require a direct like with like approach. No examination of social factors relating to numeracy skills acquisition is required for the compulsory sector.

Lessons learned in comparison of the compulsory and post-compulsory sectors, could be positive since the reported improvement in teacher confidence when supported at primary level in implementation of the national numeracy strategy and the learning of skills through a ‘hands on’ approach could be mirrored in numeracy within teacher training, for both the secondary and

\textsuperscript{16} The level 4 qualification has progressed to be a level 5 diploma in mathematics (numeracy) teaching diploma qualification and is provided as stand-alone continuing professional development or through integrated generic and subject specific teacher education for the post-compulsory sector.
further sectors. This would positively impact on teachers and students but may negatively impact on perceptions.

Numeracy is undervalued as a subject, whilst mathematics as a subject is given a high status that also negatively impacts on the learners’ perception. Public opinion and feelings about mathematics and numeracy as subjects and the real influence on society of these subjects do not correspond (Maasz 2005).

Learning elements in an area which requires abstract thought from the outset is more difficult than learning in an area resting on elements which are more concrete. Learning what numbers ‘are’ is a complex process. Counting out items relates to the numerical symbol for the number of items. Two buttons becomes the number ‘2’, the numerical symbol ‘2’ refers to the amount. Without strong guidance to the contrary, the number ‘2’ will easily and naturally be associated with buttons themselves as items and not the amount, as is a common mistake referred to in the primary level national numeracy strategy.

Mathematics (especially at any ‘higher’ level) is associated with occupations that require lengthy study and cognitive development, for example doctors, chemists, engineers and anything related to scientific occupations requires a higher level of mathematics qualification or knowledge base. Evidence for the perception of difficulty in this subject is provided by the fact that mathematics provision has declined at a higher level (Level 3 or ‘A’ Level) regardless of the expansion in lower level courses for mathematics and numeracy (French 2002).

Higher mathematics has become an unpopular study choice. In 2015 this decline is reported as having halted and started to reverse with Gov.uk (2015) reporting a rise in the number of traditionally unpopular subjects, including mathematics being taken as choice subjects for A-level by students in the UK. If the trend continues this may signify a change in public perception or simply a change in data analysis methods to highlight positive data trends and discount negative ones.

2.9 Learning in mathematics and numeracy
Thinking skills and abstract concepts are not easy to explain, teach or learn even at a foundational level. Illustrating an abstract concept can require substantial command of language and metaphor to be entirely clear. Unfortunately, this also requires the same level or similar level of comprehension from the student. Students are not encouraged to understand why accepted algorithms work, only how, technically to use them. When only the ‘how’ of mathematics has been learnt without the ‘why’, only technical proficiency can be achieved, rather than the thorough and clear comprehension required to use mathematics effectively. A model for conceptual teaching was provided by DeCecco and Crawford (1974) demonstrating that the more complex the concept, the more attributes it will have, and the more difficult it will be to communicate that concept.

Differences in how people learn, and the difficulties associated with learning can often be related to the different types of knowledge which have been identified. In examining transferable skills for mathematics, or those skills which can be applied through differing contexts, more complex cognitive processes allow students to make connections, and are promoted most when teaching and learning encompasses activities that involve more complex elements of cognition such as, analysis, evaluation and creation rather than description or calculation (Anderson et al 2001).

Kieren, Pirie and Gordon-Calvert (1999) examined mathematical understanding. They reported that this phenomenon is not something to be acquired and applied, but occurs through action in context, and is more organic than linear in its growth. Any attempt to understand the growth process must therefore take into account the different interactions that take place within different contexts, when using different materials and with different teachers or groups of students (Martin et al, 2005).

When faced with mathematical or numerical instruction, a student has two choices, controlled by cognition and emotional response. They can either; ‘control emotion and put effort into cognition’ (described as a learning intention) ‘or limit cognition and put effort into preventing “distortions of well-being” (described as a coping intention) (Boekaerts, 1995). The theory of social cognition (Bandura, 1997) examines achievement (in terms of successful task completion) as being made up of several inter-related factors within the individual. These factors include elements of an individual's behaviour, environment and personality, controlling the
emotional or cognitive response, which may not be an entirely conscious action on the part of the individual. Malmivuori (2000) stated that these factors created a 'filter' through which people create a 'self-system'. This 'system is ‘built up from new and past mathematical experiences (Hauk, 2005), exemplified by Swain et al (2005) who believed that learning mathematics is a change facilitator for individuals in terms of both how they view themselves as individuals and the world around them. For many learners this is negatively true, their mathematics lessons have left them with a negative perception of their abilities that does not correspond with their actual ability, or the reality of the situation.

“The belief of many people is that if they can successfully carry out a numerical operation then it can’t be ‘real’ maths, because maths is hard and they were never any good at it” (Milloy 2005 p 365)

The way that we learn mathematics, may be related to the feelings that are associated with mathematics (numeracy). At primary levels, methods for teaching mathematics are often hands on, practical, kinaesthetic and make full use of collaborative work or ‘circle time’ (Taylor 2003) and most pupils do not have the strong negative perception that will follow them later in life. In contrast, secondary methods are often characterised by ‘chalk and talk’ and textbook learning (Wadsworth, 1996). All the games, symbols, experimental learning and toys associated with primary levels are removed at this level, and at this point, individuals are likely to start experiencing failure and discomfort, as they can often be introduced to Wadsworth’s ‘textbook learning’, which provides a classroom experience that tends to be ‘boring and uncritical’ (Apple 2004) Past negative experiences partially explain a negative perception of the subject, as does an association with experiencing failure.

2.10 The wider perception of mathematics and numeracy

Wadsworth (1996) saw students in mathematics as passive and as recipients of knowledge rather than active participants in learning, a common view held by students themselves in relation to mathematical or numerical subjects. Pupil attainment is still the main indicator of success or failure, hence ‘passing the test’ is still the most important feature of learning and instruction (Papen (2004). A negative view commonly ascribed to mathematics and numeracy,
taking a mathematics test can lead to a huge amount of anxiety, which in small amounts is useful in a test situation, but for those who have failed several times previously in this subject, that anxiety is an expression of our knowledge of our own weaknesses and threatens the ego's autonomy for an individual (Jacoby, 1997).

Students often blame the teachers for their dislike of maths, (or conversely, attribute their liking for maths to the teacher) Ollerton (2003) described mathematics as ‘beautiful’ whilst Baker (2003) refers to the teaching of mathematics as ‘…boring and irrelevant’. There are many people who struggle, sometimes daily with even the simplest mathematical operations (including teachers) with more complex analysis or conceptual understanding evading many individuals for the whole of their lives (Parsons and Bynner 2006).

If adult learners, including some teachers and trainee teachers had already achieved in mathematics at the foundational level they would not be attending further education institutions to gain qualifications up to and including level 2 within the national qualifications framework. The collections of past experience which learners bring to the adult classroom have been termed ‘maths histories’ (Hauk, 2005) and ‘funds of knowledge’ (Baker, 2003) reflecting the past (historical) and cumulative nature of these experiences. In research conducted by Swain et al (2005) the voice of the learner relating their experience in the classroom is very clear and succinct:

“When I was at school it was written on the blackboard and if you hadn’t got it then, tough. The teacher just went on with something else” (‘Carla’ reported in Swain et al, 2005 P.67)

The collection of previous experiences in different types of mathematical and numerical contexts is experienced and then internalised by individuals, becoming part of their identity construct as mathematics students and informing their self-perception of their numerical ability. These usually include experiences from both primary and secondary mathematics classes, but for adults can extend to simple items that are numerically related, being confused by the percentage discount offered in a sale, not having enough money to pay for shopping at the supermarket till or never being on time without a ‘digital’ watch or mobile phone to tell the time. Although students may see themselves as being failures in mathematics, this perception is often unfounded. They have not been successful in the ‘formalised’ mathematics engaged in
during school years. In reality, students may be proficient or functional; “they may be doing mathematics with their hands and in their heads rather than on paper” (Coben, 2000).

Mathematics is often perceived as an area where the motivation of the learner is seen as clearly lacking (Lindenskov, 1996). This again, is often traced back to the learning in the school environment. School is described as the place where students start to fail, and those who do not, succeed despite the instruction they have received, rather than because of it (Wadsworth 1996). The result for those who cannot overcome the shortcomings of their learning in mathematics is that they become ‘lost’ to the entire subject, essentially failing at instrumental points in the process of learning.

Wadsworth (1996) P.164 described the process of ‘being lost’ to the subject of maths as having intellectual consequences, including simply ‘giving up’ to the whole area, concluding that these students are: “at risk of learning to hate maths.” Being ‘lost’ and ‘hating maths’ can create a fear of the subject which affects the ability to learn effectively, with a background fear ever present (Schloglmann, 2006) even when the individual is clearly capable of addressing the mathematical problems presented.

Misinterpreting even a small piece of essential information can have detrimental effects for the learner, where a fear of failing and of being ‘turned off’ is present. Due to the nature of learning in mathematics being hierarchical, and requiring foundational concepts to be thoroughly embedded into the schemata before more advanced concepts can be engaged with effectively (Kahn and Kyle, 2002) missing the foundations, or fatal errors in their execution (for example errors in the computation of standard algorithms) leads to a compounding of errors in any further processes. Attempting to calculate a mean average when the ability to divide has not been thoroughly mastered, for instance, sets the learner up to fail. Processes that promote mathematical understanding for learners’ must be preferable to processes that simply allow a learner to pass a test. Where teacher intervention in the classroom is appropriate and relates to the learner directly, rather than emphasising the need to complete the ‘correct answer’, learning outcomes can be ‘crucially’ positively affected (French, 2002).

This apparent universally perceived difficulty inherent within the subjects mathematics and/or numeracy promotes the concept that, it is almost socially acceptable to be bad at maths (Tout 2005) there is no particular social stigma attached to being bad at something difficult, for
instance making the statement ‘I am no good at quantum physics’ is unlikely to elicit the same response as ‘I cannot read or write’.\textsuperscript{17}

The ‘abstract’ nature of mathematics only supports the proposition that it is difficult to learn. Constructivists describe mathematics as a wholly abstract concept in its formulation (Telese, 1998) making even counting a difficult operation to perform successfully. Numbers in themselves may have no identity other than one which is entirely socially constructed, mathematics can be presented as a description of the abstract and conceptual, with Cole (2002) identifying that there is no corresponding reality that can be attributed directly to mathematical truths.

The underpinning mathematical principles of order or sequence and logic including the use of Arabic numerals and the system of place value is also completely abstract. Concepts of this nature rely on certain types of ‘thinking’ skills, which have to be fully established and practiced to be effective, accurate and transferable. August Comte (1798 – 1857) the founder of positivism in the social sciences, placed mathematics at the top of an abstract hierarchy of conceptual understanding, indicating this was the hardest possible subject, demonstrating its difficulty for the population at large (Gregory, 1987). Just because something is ‘hard’ doesn’t make it ‘hateful’. There must be other underlying reasons that contribute to the widespread reported ‘hatred’ of maths. Wadsworth (1996) believes that people experience a hatred of failure, which they have come to associate with mathematical and numerical learning, rather than hating the subject itself and Handley (2003) agrees with this belief.

\textbf{2.11 The process of initial teacher education}

The role of teachers now encompasses many varying aspects which were previously not accorded the same amount of importance as was the transference of knowledge within a restricted subject curriculum. The pastoral element of the teaching role ensures that teachers are working as facilitators in an effort to ‘aid learning’ (Fox, 2005) often in areas that are not related specifically to the subject that they teach, but are inter-related, through the tutorial

\textsuperscript{17} Adult learners in classrooms often use self-deprecation to cover their self-perception of very poor ability or lack of knowledge, it has almost become acceptable to be ‘rubbish at maths’ for instance.
process for instance, or as personal tutors. Equipping teachers adequately to address fully, as many elements of their professional roles as possible, includes the move towards ensuring teachers uphold and support minimum standards of content and process knowledge for the numeracy skills their learners need to acquire (FENTO, 2004).

The post compulsory sector provides different routes into teaching for trainee teachers. There are two main routes into teaching in the post-compulsory sector: the ‘full time’ route with work placement where trainees receive instruction prior to initially supported teaching in the classroom, or the ‘in service’ route (DFE, 2016). Following an ‘in service’ route, trainees could be placed in a classroom with no teaching experience, limited pedagogical knowledge and in some cases inadequate subject knowledge.

This route into teaching stems from the original practice of certifying individuals from industry as teachers, fuelled by the rise of vocational education, where successful individuals from the industry sector were encouraged to enter teaching so that colleges had lecturers from industry who could bring in a wealth of experience in vocational areas. However, it does not follow that these individuals bring in a wealth of knowledge or experience relating to teaching and learning within or around their subject areas, or that they already possess the appropriate level of numeracy skills required. The relaxation of formal entry requirements for FE teaching in particular in 2013 (DFE, 2016) has enabled many more individuals to be eligible for entry to teacher training in the post-compulsory sector.

The overhaul of the system of initial teacher training included the development of a post-compulsory regulatory body in England, the institute for learning (IFL) which required reporting procedures for continuing professional development (CPD) and conferred the ‘Licence to teach’ as qualified teacher learning and skills or ‘QTLS’ status for newly qualified lecturers. The past tense is appropriate here, as the IFL became (2012) a wholly voluntary body and had regulatory powers and functions transferred to the education and training foundation by the 2013/14 academic year, becoming entirely obsolete by 2014. These changes are directly related to the recommendations of Lord Lingfield et al (2012) in their review of further education, advising the removal of the IFL as a regulatory body and changes to the working definition of professionalism for those in the FE sector:
‘Revocation of the 2007 Regulations from 1 September 2012, with largely discretionary advice to employers on appropriate qualifications for staff and continuing professional development replacing compulsion.’ P. 6

The suite of teacher qualifications in the post-compulsory sector starts with the initial teaching course: ‘preparing to teach in the lifelong learning sector’ (PTLLS) course. The PTLLs qualification became a requirement for all those entering the profession, regardless of the route taken. This qualification requires no direct teaching practice or classroom interaction with learners, but allows those with prior qualifications to start on their journey into teacher training.

With the development of Free Schools (which can be in the post-compulsory sector) in England additional options have included the option of employing unqualified individuals to teach. ‘Unqualified’ refers to a lack of accepted teaching qualifications and also covers those individuals who are ‘working towards’ appropriate qualifications within the post-compulsory sector, where a small number of post 16 Free Schools have autonomy over their recruitment policies.

There have been moves to not only raise the attainment of teachers and lecturers professionally in terms of subject knowledge and pedagogical knowledge, but also to retain teachers once they are in the workplace. Measures to recruit teachers and once recruited and trained, keep them in the profession and reward their skills base have been attacked not only as ineffective, but as counterproductive. Cameron (2003) examined ‘fast track’ and ‘graduate’ training programmes in England, which relates to those trained for the compulsory education or schools sector in England, coupled with economic incentives like training bursaries and ‘golden hello’ payments, which are lump sum payments made to qualifying teachers in shortage subjects.

These may have compromised the intrinsic need for quality teachers, with individuals taking the economic incentive rather than appreciating the corresponding professionalism and responsibility expected of the profession. Cameron’s conclusion was that these measures ultimately, negatively impact on the status not only of teaching, but of the students’ learning taking place. This is set to continue as a trend with newer government initiatives (2013) to recruit mathematics graduates into the teaching profession offering a twenty thousand pound bursary for these individuals, for instance and fast track training for professionals from certain areas (the armed forces and finance sectors for example) to train ‘quickly’ as teachers, for the compulsory sector especially.
As previously described, numeracy represents one element in a plethora of factors surrounding the lifelong learning sector, and developments in curriculum for post-compulsory teacher education, incorporating new routes to teacher qualification through PTLLS (Preparing to Teach) certificate in teaching in the lifelong learning sector (CTLLS) and the diploma in teaching in the lifelong learning sector (DTLLS) plus subject specific level 5 diplomas for those training to teach literacy, numeracy and ESOL (LLUK, 2006). The development of the Institute for learning (IFL) in 2005 encouraged a strengthening of the concept of professionalism in teacher training programmes for those training in further education.

The minimum core of numeracy represented one policy element of a move towards this new professionalism in further education but has not experienced longevity or popularity. Similarly, the professional skills numeracy test has experienced longevity but not popularity. Subject to policy changes which mean trainees in the compulsory sector must now take QTS tests at the start of their training course and are limited to three attempts, after this unsuccessful student teachers must wait until another set of three tests are released for them, typically at least two years. QTS tests although changed in their delivery structure remain firmly in place and are likely to be a permanent feature of teacher training.

2.12 Application of numeracy

Numeracy is a relatively new construct in teacher education, especially for the further and higher post-compulsory sector. FENTO (2004) outlined the standards required of teachers in the post compulsory sector, claiming that although these teachers need not be specialists within adult basic education (ABE) in addition to their own subjects, they should have the content knowledge to a minimum standard and be able to implement some basic strategies to support those learners who demonstrate a lack of essential skills. Although teachers may teach within a wholly different main subject specialism, there are several additional elements of support that they can provide to ensure the success of their learners in foundational skills, such as numeracy (FENTO, 2004).

Where trainee teachers may find themselves at the most disadvantage is in the application of
standard algorithms, and their correction for learners. Error diagnosis requires teachers to be able to interpret difficulties in computation, errors of omission or misinterpretation of mathematical vocabulary. The process of providing embedded learning for the basic or essential skills in vocational or other subject areas can be seen as a shift towards a more integrated approach and a demonstration of the rise in the perceived value of these skills at a higher level. The term ‘embedded’ refers to the use of inherent numeracy skills contained within different subjects including those at level 3 and above. Essential skills represent the learning of transferable skills which can be utilised and applied in other areas, transferable skills being those which can be applied throughout different learning contexts (Kahn and Kyle 2002).

Askew, et al (1997) in a study of over 90 teachers and more than 2000 students identified teachers’ beliefs about numeracy teaching, and compared that to student gains in terms of achievement. They revealed that the most effective teachers held a set of coherent beliefs which acted as an underpinning for their work in the classroom with students. These included generic beliefs about teaching and learning and the importance of that not just in everyday life but for the future prospects of their students, and beliefs about the value of numeracy as a subject, what being numerate is represented by and the relationships between their different belief and value systems.

Mathematical skills in particular have a strong influence on the development of ‘other’ more generalised learning and cognition. Numerical learning provides the tools for analytical thought and can develop the ability to conceive quantitative descriptions of the world (RAND Mathematics study panel, 2003). Russell (1993) noted that there is a relationship between mathematics and logic which can be identified. Having an in depth understanding or even a more basic understanding of this relationship would benefit trainee teachers and teachers in the classroom, allowing them to work towards reaching their full potential.

Teachers need to be more aware of the history, the paradigms and the underlying principles that are beneath their teaching practice (Maasz, 2005). A teacher that has a fund of knowledge to draw upon is likely to be more successful than a teacher who does not. Earl et al (2003) pointed to gaps in both pedagogical knowledge or generic teaching and a lack of subject knowledge seriously limiting the extent to which teachers can make use of curriculum frameworks.
Sawyer (2000) observed and reported on 'Ellen' the teacher over a period of six years, and the results were presented on completion in three main stages. The first part of teaching was described as 'keeping above water', the second as 'seeing what works for the student' and finally the third as 'maturity'. Each of these parts described, was observed to have lasted for approximately two years, with the third being categorised by an experienced or even 'expert' approach to the work of teaching in the classroom (Sawyer, 2000). The investigation of the teacher 'Ellen' demonstrates how the teacher may first implement the predominant pedagogy, and even promote this in the initial phase described as 'keeping above water', but in some instances will then go on to ask questions and finally to develop their questions and answers into practice, which may then become an ever expanding process of evaluation and implementation. Without support, teachers may never achieve the 'expert' phase of teaching described by Sawyers investigation.

The way that teachers are trained has impacts on the way students are taught. Trained within a prevailing pedagogy, what they teach, and how they teach it, depends in part, on the point in time that they enter the profession. Swartz (2004) described the transmission of prevailing pedagogy as cyclical, starting within programmes of teacher education where ideas are perpetuated and supported.

Much of the work completed by student teachers undertaking teacher training is generic and theoretical, little emphasis is placed on how theories can be applied in the classroom effectively, demonstrated clearly by participants in Kirby and Sellers study in 2006, P.32:

“You need more about how to turn theory into practice – they don’t do that, and then when you’re thrown into a classroom at the beginning of your teaching career, you do what others do – so we all go down the textbook line. It's how you’re taught to teach.”

2.13 Teaching numeracy for trainee teachers

The way that numeracy is taught for teachers as part of their training course is important in terms of a 'cyclical transmission' of attitude and perception of their own students towards the subject. Teacher educator approaches to delivering the numeracy elements required for initial teacher training are important in terms of what information, values and pre-conceptions they
transmit and how. If ‘absolutist’ methods prevail numeracy will be difficult to digest and will become a hoop to jump.

Through teacher training a prevailing paradigm can be seen to be perpetually transmitted, however, there are indications that these paradigms are slowly altering to shift the focus of mathematics and numeracy teaching. This shift in focus which includes new teaching methods demonstrating a possible change in classroom pedagogy has been apparent in the forward movements of generic teaching skills.

Vorhaus (2006) examined teaching and learning in numeracy classrooms, through direct observations, finding that the quality of teaching was not always directly correlated with the standards of learning, in some instances, ‘poor’ teaching did not correlate with learners progress being poor and conversely noting within classroom observations that the opposite was also the case, where teaching was good this did not correlate with high gains for learners in every instance. Vorhaus concluded that the characteristics of the learners themselves may have a bigger part to play in their success than expected and ‘went on to recommend features which could be included within programmes of teacher training, especially useful for integration of subject specific knowledge, and the pedagogy of the teacher.

These recommendations were presented with the aim of promoting the involvement of learner characteristics within the classroom, and included: Improving teachers’ confidence and skills in classroom management (balance of whole group, small group and individual work) supporting teachers to become more skilled and flexible with different teaching approaches and involving learners more in the learning experience (Vorhaus 2006).

Hands on experiences in mathematics can aid the development of skills, by forming genuine experiential memory for learners. Locke (1632 – 1704) argued that ‘experience’ was the strongest form of knowledge and ultimately, learning through experience created the most enduring type of knowledge. Cole (2002 P.3) expounded the same principle, referring to Aristotle for support;

“Aristotle emphasised experience filtered through logic as the way to gain this abstract knowledge”.

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Swan and Swain (2007) provided a more up to date rationale for hands on teaching, resulting in experiential learning of significance in mathematics as the approaches were presented for mathematics teachers in particular by the Department for Education. Swan and Swain advocated a more experiential type of learning for both teachers and students that did not detract from the essential knowledge base, ensuring that this was key at all times.

The Cockcroft report (1982) proposed an ideal for mathematics teaching in terms of the structure of sessions, and the different methods which should be employed to aid learning for students. These did include the more traditionalist methods such as teacher exposition but also included practical work, problem solving and discussion.

Within the different methods described, there exists the opportunity to differentiate tasks to cater for different learning preferences, ‘discussion’ for instance aids the auditory learner, whilst ‘practical work’ will enhance the learning experience for the kinaesthetic learner in particular (if examining learning preferences using a VAK continuum). Ollerton (2003) disputes the idea that people can simply be classified in terms of their learning styles clearly, indicating that other factors affect the learning experience for the individual including context and stimuli, the only way to account for all of these elements is to use vastly different methods and resources in the classroom. Emphasis has often been placed on the ‘three part lesson’, but the recommendations for the amount of methods would indicate a lesson in an infinite number of parts, rather than limited to three distinct elements of beginning, middle, and end.

Development of teachers is a valuable tool for improving the experience of learners. Often, teacher development is based on administrative details and target driven collections of information. If the methods advised for learners in the classroom were applied to the trainee teachers learning, the results may prove to be intrinsically valuable, not only for the teachers but for their students.

The report of the Advisory Committee on Mathematics Education (ACME) in 2002, examined the CPD of mathematics and numeracy teachers. Several lengthy recommendations were made by ACME, including that CPD programmes aimed at teachers of the subject should take into account opportunities which would allow teachers to relate theory and practice to each other within the classroom environment, supported by Coben et al, (2003).
Kirby and Sellers (2006) examined the practical application of learning styles in the numeracy classroom. The most usual application of learning styles is to assess individual learners, and note down the result (paying a type of ‘lip service’ to the process). Kirby and Sellers went on to develop CPD training in the practical application of learning styles information, informing the pedagogical process in the classroom. The main aim being not just to pay ‘lip service’, but to allow learners to develop a ‘metacognitive awareness’ related to their own numerical skills, and through this to further develop the whole process of teaching and learning. It should be noted that although the subject of much study, learning styles is not considered to be scientific and has fallen out of favour with educationalists over time.

Rumelhart and Norman (1981) considered all learning to be defined by a set of schemas or schemata or blocks of knowledge. The process of learning includes ‘assimilation’ which has particular relevance to adult learners, who assimilate new learning to prior knowledge, regardless of whether their prior knowledge is accurate. Context is important to the process of assimilation for adult learners, a true contextual clue can hinge on to prior knowledge, building on foundations that are already present. The value of making mistakes should not be underestimated. Learners’ mistakes often lead to independent investigation, confusion and frustration, but in turn these can lead to the development of a re-constructed knowledge in a cyclical logical format developed through problem solving. Wadsworth (1996) saw intellectual and mathematical development as full of errors and making mistakes in mathematical and numerical learning as not only acceptable but desirable.

2.14 Chapter summary

The literature surrounding teachers’ numeracy has provided some context and background to be able to anchor the research clearly. Several areas have been identified as lacking in information in a general sense; very limited information is available relating to the implementation of minimum core numeracy in the post-compulsory sector. Teachers’ perception of numeracy and mathematics in this area has not been afforded a great deal of research time by the educational community. Some of the main policy landmarks with reference to numeracy...
learning within the lifelong learning sector and the compulsory schools sector have been examined.

Developments in curriculum, economic effects and the effects on the individual have been reviewed as part of the wider context of the research. Following on from this the minimum core of numeracy for the post-compulsory sector was described and the basic process of the professional skills tests for numeracy presented providing an overview of implementation and teacher skills in numeracy. Comparisons have been made between the compulsory schools sector and the post-compulsory sectors of education in terms of trainee teachers learning numeracy.

Over time, the same information relating to mathematical and numerical learning can be seen appearing again and again. From Locke (1632-1704) to Cole (2002) Swan and Swain (2007) experiential learning is seen as a method which is useful for learning in mathematics but not a method that is necessarily strongly advocated for trainee teachers.

The perception of mathematics and numeracy partially underpins the original research questions formulated and has been developed here more theoretically, examining both the individual and wider perceptions, examined in more detail in phase one of the research.

Training teachers forms a major part of the research and has been viewed from several perspectives in this chapter. An outline of the process of initial teacher education was included here with further exploration into the application of the minimum core of numeracy in training teachers in post-compulsory teacher education and generalised comparisons made with the compulsory schools sector. The process of learning in mathematics and numeracy and the subsequent effects on the individual have been briefly explored, examining the fear of failure and the experience of hatred described by many.

The process of research creates a ‘ripple effect’ between the research itself and its implementation (Robertson, 2000) or effect on practice and pedagogy. This ‘ripple’ is a desirable outcome here as numeracy in teacher education does not appear to be very well received. This needs to be addressed practically to have any real impact. The main purpose of research of any kind is always to develop and create knowledge (Coben, 2000). The lack of knowledge surrounding numeracy and numerical skills required by teachers necessitates the
research into this area to develop and support implementation to be more effective in practice and therefore more useful.
Chapter Three - Methodology
3.1 Introduction

This chapter describes the methodology employed to answer the research questions posed in the introductory chapter. Initially a generalised overview includes a comparison of qualitative and quantitative methods and examines the use of a research journal to support the work completed at every stage. This overview is followed by a more in depth account of the methods used in the different investigation phases and those methods which completed the research. The different methods employed are presented in a chronological sequence to aid clarity and include the use of a research journal throughout both phases one and two of the research.

The use of data collected from forum postings found via the internet is the first method outlined in the sequence, followed by a description of the methods used to gain data from online prospectuses relating to teacher training provision within higher education.

The next step in the methodology is the completion of a critical review of resources available to support the implementation of numeracy for trainee teachers. The sequence of methods used culminates in a case study of the delivery of a functional skill mathematics staff development program for teachers in a further education college, with data collected through participant observation, focus groups and a staff e-bulletin board. All the data collected and analysed conforms to the same typology, comments, text, discussion and conversation. This allows for all the findings to be presented together from each research method used and allows for the data to be cross analysed as like is being compared with like data.

An examination of relevant ethical principles for this research is presented and a chapter summary is provided.

3.2 Overview of the methodology employed

An overview of the research conducted examines the nature of the methods used with reasoning which relates to the research questions presented. Each method has been
formulated to address those questions in the most succinct fashion and keep the research on track. The applied nature of this research, infers an expectation that research products and outcomes will provide insight and resolution (Ritchie, 2003). Although the methods have been matched to the research questions, room for manoeuvre is essential to respond to the nature of the data collected at each stage, as it was not possible to anticipate with any strength of clarity either the problems and difficulties or the possibilities and opportunities which may take form during the process of research (Archer and Whitaker, 1994).

Within the methods devised for data collection, interpretive reasoning is applied since research questions and ensuing action are not wholly derivative of the data produced, as for instance in a “grounded theory” approach, described by Glaser and Strauss (1967) and advocated by Charmaz (2006) where data interpretation is responsible for the construction of some methodological aspects and subsequent theory with a literature review being written after the completion of research rather than before.

In this instance, the data gathered itself makes a contribution to following stages, being responsible in part for decisions made within each subsequent stage of research, creating a chain of events including limited collaboration with and participation of others within phase two of investigation, with the intention of leading to the construction of a model to support a positive change which is perceived as an improvement in an existing situation (Gergen, 2003).

3.3 Qualitative and quantitative research methods

Regardless of its association to numeracy and mathematics, the enquiry under taken here is not quantitative in nature: it does not involve numbers as primary research data. This research involves people, practices and experiences in the classroom. People’s opinions and attitudes are difficult to classify as a quantifiable element, in the sense that if we want results that are meaningful to people, or from people, we must break down what it is that people do and say and examine the elements that relate to them and their practices. The extent, to which knowledge that can be applied in practice derived from traditional quantitative research would
be useful in the situation where people and their actions, words, practices opinions or values are important, is an issue (Markless, 2003).

Overall, a qualitative approach is taken to attempt to provide results that are meaningful to practitioners and have some positive influence on practice. McNiff and Whitehead (2005) maintain that researchers value the possibilities of the application of their practical knowledge and view this as being as valuable as conceptual knowledge.

The difference between qualitative and quantitative methods has caused much debate in the past. It is now accepted that methods vary with their suitability for the type of data collected or required. There is still some imbalance between the two strands of methodology, especially with reference to academia (Berg, 2001). It is not necessary to view qualitative or quantitative research methods as diametrically opposed to each other (Parker, 2006) being strictly confined to quantification for instance may lead to ignorance of context or of indirectly conflicting variables.

Quantitative methods can be perceived as more scientific in nature, solid and reliable with an emphasis on facts and figures and the disassociation of the researcher from their research in most instances. Quantitative methods include: standardised questionnaires, examination of quantifiable data (statistics) and repeated trials or experimentation. These methods are viewed as reliable due often to their level of standardisation, and the possibility of replicating the methods in repeated trials (Churton, 2000).

Qualitative methods are often seen as being ‘practical’ in nature and are useful for examining the dynamics of how things work ‘on the ground’. These types of methods generally help to develop an understanding of research outcomes and can identify different contributory elements to successful delivery of programmes in terms of educational outcomes (Ritchie, 2003) as this research is anchored in educational practice and provision. Qualitative methods include more focus on individual aspects of phenomena in relation to people: methods that focus on experiences and opinions, values or beliefs. Focus groups, interviews, participant observation and individual accounts are all clear examples of qualitative methods.

Quantitative data (numerical) often has the advantage of appearing more robust than data collected through qualitative methods, and can be tested using a statistical approach. This type
of numerical data may not exhibit strong validity, in terms of the provision of a true representation of the subject under scrutiny (Churton, 2000) and cannot answer the criticism of not presenting the ‘human side’ of an argument. Qualitative methods can counteract this by presenting the type of data that a wholly quantitative study may miss altogether, or not take into account. Although a strong indication, numbers alone may not tell us the whole story in primary research (Dey, 1998) and are criticised for their tendency to ignore from the outset questions that do not necessarily benefit from a scientific style of enquiry (Charmaz, 2006).

**Qualitative methods**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Seeks to explore phenomena</td>
<td>Struggles to avoid preconceptions</td>
</tr>
<tr>
<td>Instruments use more flexible, iterative style of eliciting and categorizing responses to questions</td>
<td>The results are often seen as subjective and interpretive rather than clear and wholly objective</td>
</tr>
<tr>
<td>Some aspects of the study are flexible (for example, the addition, exclusion, or wording of particular focus group questions)</td>
<td>Flexibility can lead to disruption and the data produced may not have continuity throughout a research project or study</td>
</tr>
<tr>
<td>Study design is iterative, in that data collection and research questions are adjusted according to what is learned</td>
<td>The study is not fixed from beginning to end and may not trace a linear research path</td>
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<tr>
<td>Aims to describe and analyse variation, individual events and experiences, finding the human picture</td>
<td>Curtails the ability to generalise to a wider population or larger sample</td>
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(Fig 1 – qualitative research methods, advantages and disadvantages, adapted from Mack et al 2005, P. 3)

The research here into teachers’ numeracy, if categorised, is utilising a qualitative sequence of methods, including contextual analysis of online conversation, the use of a research journal and using evaluative data produced through focus groups. This allows unquantifiable facts about real people to be collected and observed though traces of conversation that they leave behind them, in forums for instance and in doing so, let us share in the understandings and perceptions of others, allowing this research to: ‘obtain a better, more substantive picture of reality’ (Berg, 2001).
3.4 Research journal

To help maintain an overview, whilst tracking and monitoring progress, a research journal has been used (initially as an experimental tool) this has become genuinely useful over time, helping to keep research on track and stay focussed on the main research elements. The journal goes everywhere with the researcher, making this research an integrated part of real life and educational practice. The use of a journal helps to review original research questions regularly and to keep track of the original time line set with deadlines. A journal method is common practice in programmes of teacher education, where trainees write their observations and reflections. Having been through this training, the use of a journal is a familiar method of recording information for research purposes. This has come to represent a reflective as well as wholly practical tool (Huddleston and Unwin 2002)

Cotner (2000) kept a log throughout her pilot study of teachers in a participant observation conducted in schools. This was very similar to the journals used for this research throughout both phases, recording everything from actual comments and conversations directly to dates and times of meetings and feelings about the research process.

Schon (1987) as part of his advocacy of the reflective practitioner insists that there was a need for a shift away from the type of educational research which appeared unconcerned with the realities of practice, towards research grounded in practice. Markless (2003) advocated the self-conscious systematic analysis of situations which can be completed via a journal method, as a way of making sense of the things that are happening around us, helping find solutions to complex problems. One of the advantages to thinking in terms of research questions is that it helps to maintain focus on formulating claims for the research. The research journal has kept these questions at the forefront of the research throughout the process.

Through the use of a research journal, the emphasis is on ‘emergent discoveries’ Charmaz (2006). Theories are constructed (according to Charmaz (2006) through interactions taking pace within interplay of perspectives, the actual people involved and the research practices they undertake. A journal helps to record these interactions in a ‘live’ environment, without the need
to wait until research databases can be accessed for instance. A journal has been used to record information in real time and represents a very personal account of reality or snapshots at specific points in the research process.

3.5 Case study

One of the purposes of research is to instigate a change or development. This change can be the main purpose of research (Robson, 2002) a purposeful investigation of phenomena that leads to ‘movement’ or development. Robson also identified that ‘improvement’ is central to research, so although a change in envisaged, not just any sort of change or development is appropriate, a purposeful positive change in practice or situation is the expected outcome of research. The use of qualitative methods can represent a movement from descriptive to explanatory accounts, (Spencer, Richie and O’conner, 2003) where researchers are no longer happy with describing phenomena, there is a need for explaining and understanding that phenomena more fully. Robson (2007) has described this shift from description to explanation as more evaluative in nature, albeit a more specific way to carry out evaluation.

The dominant ethos in research in the past has often been directed by the search for an ultimate answer or solution to an identifiable problem, affecting the decision on what to research (McNiff and Whitehead 2005). Deciding what to do does not necessarily mean looking for an ultimate answer, because: although solutions to problems may exist ultimate answers rarely do. Even where they do, answers tend to generate new questions, so any answer needs to be seen as provisional and containing new questions.

A naturalistic case study including participant observation places some emphasis on the involvement of the researcher in the research process (Robson, 2007) rather than standing on the outside of the process. This clear acknowledgement of the researcher as integral to the decision making process and the influence that these decisions have on the process and outcomes of the research conducted is welcome for those of us who conduct research precisely because we are a part of it. Parker (2006) stated that admitting to the subjective nature of the research situation allows the researcher to avoid any disingenuous claims that can be made to objectivity in the research process or in the findings that result.
From the outset the researcher influences the research and denying this, hints at an underlying flaw or some form of dishonesty by omission. Charmaz (2006 P.15) identified researcher influence clearly from the outset:

“How you collect data affects which phenomena you will see, how, where and when you will view them and what sense you will make of them.”

As part of this initial process, involving the adoption of a specific approach to the methods required collecting data, grounded theory was also considered, since grounded theory is the collection of qualitative data and its analysis: leading to the construction of theory grounded in the research data itself. So the data and its subsequent analysis ‘creates’ the theory, rather than starting with a theory to be tested or disputed (Charmaz, 2006). Construction of grounded theory does not take into account the elements of positive improvement that are present as a pre-requisite of this research. Grounded theory also denies any pre-supposition or prior knowledge on the part of the researcher in relation to the subject under investigation.

Data cannot present its own categories in the sense that the researcher must become arbiter, allocating categories to data collected, even if the data exhibits suggestions – as in the case here of data collected from internet forum exploration, this still does not constitute a fully grounded theory, some structure was initially present at the outset, and in analysis Wolcott (1994) insisted that structure was necessary and should be imposed on the data if it doesn’t already exist. The research questions did not formulate themselves or become apparent through research. They were formulated by the researcher examining experiences and through supporting others to work in the area of teachers’ numeracy specifically. The questions were imposed on the context rather than being wholly drawn from or created by the context.

3.6 Internet use, forums and perception

The investigation of teachers’ numeracy rests on a set of research aims, each aim having a research method or methods constructed to build up a body of knowledge and tools for development. The first aim was to investigate attitude and perception towards the numeracy in programmes of initial teacher education, establishing the positive or negative direction of
attitude towards this numeracy learning or teaching. The first research aim represents the first step in phase one of investigation, initially establishing a baseline or a starting point to ascertain any need for further investigation by attempting to first define a situation ‘as it is’ (McNiff and Whitehead (2005). This has been achieved using analysis of forum data posted by individuals working with teachers’ numeracy, representing an analysis of communication (Uwe Flick, 2009) in this case electronic conversation.

As this research uses data taken from online sources, it is important to distinguish clearly between the different types of information available on the internet. The nature of the internet can lead to confusion in terms of the originator of information and so a solid source that can be directly retrieved is preferable for the provision of reliability (Pears and Shields, 2009). Using naturalistic or unsolicited data allows for the neutralisation of reactivity, the process that occurs when subjects respond or react to the presence of an observer or researcher (Berg, 2001). The data here is collected rather than solicited and does exhibit some reliability in terms of the source or originator due to its naturalistic nature. Because the data was pre-existing to the research, removing any reactions to the researcher and ensuring that the information is unlikely to be manufactured in any way.

According to Lee (2000) the internet is giving us opportunities that we didn't previously have, to study behaviour, allowing us specifically to follow the discussion of a topic. Lee pointed towards e-mail communication as the way to follow discussion primarily, however this form of communication clearly identifies those participating. Flick (2009) argues that internet examination of discussion provides a greater amount of anonymity for individuals who may become ‘participants’ in research via the use of avatars18 as identifiers.

The rise of social networking sites including ‘Facebook’, ‘Twitter’, ‘Instagram’ and ‘snap chat’ has led to a myriad of conversations taking place simultaneously, world-wide. For any researcher this represents a huge amount of data that can be accessed and possibly analysed. There is also a synthesis of new emergent technologies within more traditional media, with texts for instance: Joshi and Routledge (2011) ‘Using Facebook’. The text gives technical details for

18 An ‘avatar’ is an online persona or identifying pseudonym rather than using a person’s real name to identify them.
the use of Facebook with clear examples on how to create individual pages or ‘walls’ where people follow different conversations or other people of interest to them.

Lightbody (2012) examined the differences in generational electronic media usage, using the terms generation X (teachers) generation Y (students) and generation Z (the future) generation Z being born post the year 2000, and never having known the world without mobile phones, personal computers and the internet. Further evidence that the internet has become a part of everyday life is provided by the associated functions of internet use: blogging, posting on forums, social networking, accessing e-books and using a search engine as well as the revolution that has occurred in peoples shopping habits, using the internet.

This notable change in generational use of electronic media is likely to have an effect on the academic use of the internet and possibly social media, resulting in the wider use of data collected from the internet. Using forums, as a method of gathering information, is currently a newer form of methodology. In the future this may become normative in terms of research methods applied to the analysis of different forms of human interaction. This utilisation of online ‘postings’ is gaining momentum as a method of enquiry. The Times Educational Supplement, for example has a regular report in its hard copy, dedicated to publishing opinions gathered via the online TES forums (Shaw, 2010).

Convery and Cox (2012) examined internet based research and the ethics involved for practitioners. Their research pointed to an upsurge in internet-based research over a ten year period from 2002 to 2012. They included research based on analysis of ‘e-conversations’ through social networking sites as an accepted method of internet research, the same method which has been employed for this research. Convery and Cox concentrated on ethics, finding that one of the most important aspects of internet research ethics was the determination of whether data was public or private. Even data that was in the public domain would have implications for use in terms of ethics if that data were in such an area that individuals would not expect their conversation to go further than a very select group (in a chat room for example).

Mason and Rennie (2008) claim that far from threatening traditional methods of research, communication or entertainment, social networking and development of the use of the internet in an everyday sphere represents a growth from previous practice and theory. They also go on to point out that ignoring social trends of this magnitude does not point the way forward for
today’s modern educators. Information technology has changed the way teachers and students can interact and has also changed the way that researchers conduct their research work, adding to the tools that researchers can utilise.

3.7 Studying online conversation

Words are seen as the most common form of qualitative data (Robson, 2002) which here are examined in an electronic form through both of phases one and two of research. These ‘electronic conversations’ represent a form of ‘trace measure’ or the physical and definite effects of interaction, the evidence or remains when the actual occurrence or usage is complete (Robson, 2002). This process is also known as the analysis of ‘accretion measures’ or the usage of something being a popular way of measurement, so in this instance, counting the responses provided to a question or statement over time could be used as a measure of interest in the subject. These unobtrusive observable indicators allow us to investigate information that may not be wholly accessible through other means but can be viewed through the trace elements people leave behind them whether they do this through intention or not (Berg, 2001).

There is also the possibility to consider that it is not just the traces that people leave behind, but the things they do not leave behind, the things they do not discuss without prompting that gives an indication of events occurring (or not occurring) or of the amount of interest generated in a particular subject. Unless participants are asked directly about their lack of conversation on a particular subject, the meaning of the absence of that conversation or comment can only be inferred, although the absence itself is a fact, the interpretation of it can only be an inference without direct justification from the source. Here direct justification would then require an individual to ascribe meaning where originally there may have been none.

The written word is subject to interpretation and inference of meaning that may not have been the intention of its originator and the interpretation can be misaligned with the original expression if the individual was not necessarily expressing their thoughts accurately in the first instance (Kridel 2010). Ascribing meaning to elements not previously accorded any thought leaves the data in a difficult state in terms of meaningful analysis.
Studying elements like speech or conversation strings in forums that have already been produced, avoids the desire of individuals to present themselves in a socially acceptable light, or to respond to what they think a researcher wants, the production of the ‘Hawthorn effect’. This relates very generally to the possible effects that arise when subjects within an experiment have an awareness of the experiment, any intervention on the part of the researcher or the possible results (Draper 2006). Within a forum where individuals are not face to face and have no expectation of research using their words, people are likely to be more direct.

The individuals’ idea of how they can speak using social networking sites or forums is interesting in this instance. What levels of control do people experience whilst using these forums? Do people say what they think is expected of them or do they reveal their more personal thoughts about a subject without fear of reprisal? Especially with reference to the idea that they are using an avatar, the avatar lending anonymity, possibly affecting the level to which individuals are willing to reveal genuine thoughts, feelings or responses. This may then lead to data which is more naturalistic in nature, unobtrusively obtained and self-disclosing (Lee, 2000). Collecting comments and conversation strings which are already present eliminates volunteer characteristics from participants. Characteristics were documented by Parker (2006) who investigated the phenomenon that those who volunteer have certain characteristics which will skew any data collected from the outset. This is avoided by using data that requires no permission, solicitation or volunteers.

It should be noted however that those who participate in online forum debate may also exhibit certain types of characteristic possibly similar to those of volunteers. In online conversation of this type, although enjoying popularity world-wide, not everyone has social media accounts or has access to forum debate areas online. The dynamics of these choices or circumstances mean that certain groups will be excluded from participation. One of the advantages of employing this method is that no interaction has to take place between the researcher and those participating in online forums, the researcher does not have to be present, or be part of the virtual group to observe any phenomena (Flick, 2009) and (Lee, 2000) thus leading to greater spontaneity. This also has the advantage of providing data that although self-disclosing in nature, is not subject to bias in the population studied through the desire to give favourable responses (Lee, 2000).
This method also has the advantage of providing data which doesn’t necessarily contain non-verbal semiotics or paralinguistic elements of communication. ‘Body language’ for instance, which is difficult to translate accurately in context (Flick, 2009). This may also be seen as a criticism of the research process as these aspects can lend a plethora of information to the basic communication involved in conversation between different people.

The important questions of: what constitutes text, or what constitutes conversation? Here are relevant, since the forum postings are treated as conversations and analysed as texts. Although analysis of conversation can also examine other elements, emphasis for instance or body language, this is for the most part absent from forum or e-bulletin board postings. This forms data similar to commercial media accounts which includes almost any media variation according to Berg (2001). This is seen as an advantage in this instance in terms of the research conducted. Inferences drawn from the data are not reliant on contextual clues although it should be noted that this does produce a situation where those aspects of speech may be important and cannot be judged or analysed. Sarcasm for instance or the intonation or emotional clues attached to speech through animated hand gestures will all be missing from the analysis conducted as part of this research. This is balanced by the face to face contact in real time used in participant observation and focus group methods in phase two of research.

3.8 Collecting data from forums

Collection of raw data from forum postings was initiated by using search terms and key words. This proved very difficult as a wealth of data was available, with lengthy conversation on the professional skills numeracy tests in the compulsory sector but not many examples of specific data on minimum core numeracy in the non-compulsory sector. This represents a measure of accretion, measuring the amount of something occurring (Lee, 2000) (and its content) indicates that the accumulation of forum postings is limited in relation to minimum core numeracy and teachers’ numeracy giving (generally) an indication of negative direction in itself, or the lack of a trace element.

The original aim was to ascertain opinion and the direction of opinion, through the content of the forum postings, rather than examine the instances of comment. It is interesting to note the
difference between the two sectors of education, with little comment in the post-compulsory sector and numerous comments in the compulsory sector.

The main forums examined for this research include those hosted by the Times Educational Supplement and the Guardian newspapers. ‘Twitter’, ‘Linked in’ and ‘Facebook’ were also searched externally for posted data on this subject. Social media of this type proved unsuitable for data collection since valid, clear data could not be retrieved without some form of solicitation. Externally available conversation strings or postings could not be clearly attributed to the subject area. The Times Educational Supplement and the Guardian newspapers were chosen as the main sources of forum data as these were entirely in the public domain and clearly accessible without passwords or security elements, ensuring that the rights of individuals in terms of public access to their generated data were not breached.

Searches of the forums used key words, as follows: ‘Minimum core’, ‘Minimum core numeracy’, ‘Numeracy in teacher education’ and ‘Trainee teachers’ maths’. Once the data was collected it was categorised into the main emergent themes that this data exhibited, which, through observation conformed to three main groups:

RS (related subjects)

MC (minimum core numeracy)

QTS (the QTS numeracy test)

These categories were then used initially to identify the strands of data. The conformity to the three groupings appeared from the data itself through collection, however the decision of the researcher is clearly a part of this process through a critical assessment of the different types of data and how they could be categorised, exemplified by Wolcott (1994) who advocated all the data collected in detail whilst examining for inclusion or exclusion should be stringently considered and judged critically and comprehensively. Silverman (2004) concurred with this but went one step further, indicating that even the facts or information we find are influenced by researcher judgement from the outset, rather than speaking for themselves they are ‘impregnated’ by the researchers assumptions in the field. Even the establishing of categories for data found in the online forums, is a simple form of content analysis (Silverman 2004).
The collated comments were made into a set of posters which although a simple technique made it very clear that context was vitally important to a thorough understanding of the perceptions and opinions of individuals. When all the comments were clustered together in a visual format, perceptions and directionality were clearly identifiable.

3.9 Collecting data from HEI prospectuses

Due to the lack of comment or low instance of comment relating to minimum core numeracy, further investigation centred more on this area. The discrepancy between the two sectors of compulsory and post-compulsory was interesting and so further action was focussed on this to find out more.

Ascertaining the direction of opinion again involved an internet research method, using an electronic document search, which is an unobtrusive method of content analysis (Babbie 2010). Each Higher Education Institution (HEI) and through franchise arrangements (where partnerships between universities and colleges allow higher education programmes to be delivered in further education colleges. Each website links to an online electronic prospectus. This research uses the prospectus information only and this allows for comparison of like with like in terms of the starting point for collecting data (where prospectuses were available). The data is accessible in large quantities and is non-reactive in the first instance to the researcher, (Berg, 2001).

The choice of the prospectus from each HEI and collaborating FE institutions as a source of information was made because a solid source was needed. Searching through the databases of websites from the HEIs may have yielded more or less information, however this means that like may not be being compared with like in every case. If the same type of document is being accessed each time then a genuine comparison can be made without exception, essential for the information gained and analysed to be valid. Using this type of data, according to Berg, (2001) is similar to the use of ‘archive’ material, since the information is in the public domain and forms a record in a similar fashion to hospital admittance records or computer accessed bulletin boards.
Via the collection and analysis of each prospectus, information relating to initial teacher education for the post-compulsory sector was examined for content relating to minimum core numeracy or trainee teachers’ numeracy. This follows the format of discourse analysis (Boeije, 2010). It is important to note here that this exploration of language is not concerned so much with language structure or semiotics but with meaning. It is an investigation of properties of naturally occurring language and interactions during dynamic socio-cognition, rather than one which applies ‘counting’ methods or other types of frequency examinations of words in text.

This research is studying social phenomena rather than the investigation of isolated linguistic units (Wodak and Meyer, 2009). Analysis formed an examination of latent content, rather than manifest content (Esterberg, 2002) searching for a positive or negative impression left by the information presented. The analysis of collocates and concordances (Lee, 2000) within the texts examined, formed a starting point for further analysis.

Criteria were required to assess in the first instance whether a piece of information is to be collected. If data includes certain simple words or phrases then it was selected as suitable for collection from HEI prospectuses:

- Minimum core
- Numeracy
- Mathematics
- QTS / QTLS (tests)

The context also has to be examined in a basic fashion to ascertain whether data is relevant to the research questions, so the general question being asked here was: is the information directly relevant to the entry criteria for teacher education or to the study of the minimum core numeracy and teachers’ numeracy or mathematical requirements?

Concordance lists the words in a text showing for each the immediate context in which it appears. This shows each word, usually centred on a page, surrounded by the words appearing immediately before and after it in the text. The analysis of collocates (that is co-located words) looks at how the words in a text are associated with one another. In specific terms the analyst looks at the range of words that appear within some specified distance of words having analytic interest (Lee, 2000).
A textual analysis has been completed using information from HEIs and supporting FE institutions, examining the information provided on numeracy or mathematics entry criteria. Here ‘concordance’ is used very loosely, as no set amount of text is collected, single sentences or whole paragraphs have been collected depending on the amount of text needed to ensure context is maintained, this varies between a few words, a simple or complex sentence and a paragraph. Initially a fixed number of words either side of key words was considered and tried but this led to a significant loss of context and therefore meaning, rendering the data useless because the meaning was the most important part of the information collected.

The sample used for HEIs in phase one of research is valid and reliable if repeated with the same conditions. However there are some aspects which are negative in terms of the sample used. The sampling was purposive and clustered (Weiss and Sosulski 2003) examining a specific clearly defined and limited group within a particular domain. The purposive nature of the sampling refers to the data being collected in response to the purpose of the research and clustered generally within a specific area.

In this instance the North West area of England was used as the basis for initial sampling as this conformed to the second phase of research where a North West college was used for the case study. This was then supplemented with samples from other areas to ascertain whether the same information was apparent and the sample was made up of both traditional HEIs and further education colleges delivering teacher education as higher education under franchise arrangements, also to ensure that a full range was covered. This desire to sample additional elements to promote validity and act as a checking or balancing measure means that the overall sample does not conform necessarily to normal conditions or accepted stratifications as described by Shuttleworth (2008) in terms of stratification or specific population sampling.

The sample was initially intended to be all of the institutions offering the appropriate courses, however as the search progressed through the websites for universities and colleges, a significant number of online prospectuses were not accessible and the list of institutions rendered the task significant in terms of being time consuming. The approach to sampling for this element of research was altered to take into account the difficulties encountered. A sample of colleges and universities from the north West of England was targeted as this conformed well to the case study in phase two of research. Additional institutions from other locations were
also included as a cross check measure, supporting the reliability of the sample. To maintain
the reliability and stability of the sample, online prospectuses rather than a search for website
information were the only sources of information used. The sample assumed the pattern of a
more random distribution as those institutions which could not be accessed immediately were
discarded.

Data was collected from UK higher education institutions electronic prospectus’s over a period
of time from the academic years 2011/12, 2012/13 and 2013/14. Only an online prospectus
document from each organisation was sampled to provide a measure of continuity within the
search for information. Rather than searching through VLEs, learning platforms or web pages
belonging to the institutions, this provided data that could be compared as a like source was
being compared with a like source only. Once the prospectuses were accessed the search for
information was narrowed down further by course provision. Only those higher education
providers were examined offering the following courses: Diploma in Teaching in the Lifelong
Learning Sector (DTLLS), Certificate in Teaching in the Lifelong Learning Sector (CTLLS),
Professional Diploma in Education (PDE), Post-Graduate Certificate in Education (PGCE) and
Certificate in Education (CertEd).

The PTLLS course was not included for instance as this course is: preparing to teach in the
lifelong learning sector and does not provide a ‘stand-alone’ teaching qualification. The search
for prospectus information was restricted to particular areas by searching for specific terms in
the text. This helped to eliminate spurious information that lacked relevance. The terms that
were used to complete the search through the documents were as follows: ‘Minimum core’,

The LIWC results (See Appendices IX and X, Volume 1 P. 47- 49) indicate that all the aspects
of language used in the prospectuses when combined to form a corpus of one thousand, four
hundred and sixty four words, conformed more to formal use rather than personal use. This
included self-references social words articles and cognitive words. No negative emotions were
recorded at all and larger words of six letters or more had a very high usage recorded. This is
almost exactly what could be expected from the type of data represented by the corpus. The
type of text in prospectuses of this type is aimed at individuals progressing from a level 3
standard of education to higher education and therefore the expectation of reading level of the
text presented is at level 3 and above. Formality of the text indicates that it is informative or instructional in nature rather than descriptive or persuasive. The four main types of text are persuasive, instructional, descriptive and informative. Each type of text has its own features and levels of formal or informal text and use of emotional or lengthy words.

The qualitative nature of the research does mean that data collection and analysis will not conform to the accepted scientific methods associated with quantitative methods including repeated trials and validity through replication. As Shuttleworth (2008) P.1 expressed; ‘any experiment that uses human judgement is always going to come under question’.

3.10 Completing a critical review of resources

A critical review of relevant information, resources and sources available to trainee teachers and teacher educators was completed concentrating initially on addressing the numeracy requirements for trainee teachers in England and the mechanisms by which it is supported as a legislative measure. This informed further stages of investigation, since clarity was provided as to the nature, breadth and scope of information already available. Completion of this critical review provides a reference and critique of current electronic and hard copy literature and resources available relating to minimum core numeracy (see Appendix XI, Volume 1, P.52).

Participants are involved through their contributions and evaluations which are taken into account and recognised as a catalyst for improvement or change in pedagogical representations and actions providing mechanisms directly for teacher trainers to aid their choices and development of the implementation of numeracy requirements. The methods involved to produce a critical review include literacy search and online searching, again establishing base lines for the subsequent research to follow on, determining the nature and type of information available. This is an accepted method of ‘raising awareness’ and provides a support mechanism for those working with teachers’ numeracy. Portner (2008) for instance, in the text ‘Mentoring New Teachers’ provides an annotated bibliography, described as ‘resource E’ where the author explains that the purpose of this is to provide the reader with support to read on further in the subject.
This stage of research was initiated with an internet search to collect up information relating to numeracy requirements including hard copy, electronic journal and posted internet resources. The search terms and Universal Resource Locators (URLs) have been recorded and dated, as internet sites have changed over time. Categories of the types of data available emerged from the data itself as the research progressed, for example books published to support trainee teachers, guidance documents for delivering the core of numeracy, sample planning documents or recording documents and sample delivery resources.

The original search for resources to support delivery of teachers’ numeracy and trainee teachers’ numeracy was conducted in 2011. Conforming to a constant comparative method and reviewing and re-visiting the work in 2013 led to significant changes. Originally very little information was available, especially to support teachers responsible for delivering learning around teachers’ numeracy in the post-compulsory sector. Nothing at all was available to support trainee teachers in that area. Institutions would have provided their own support and guidance but that information was not readily available in the public domain. Some texts were available to support those trainee teachers faced with the professional skills numeracy test in the compulsory sector, these texts were primarily aimed at passing the test, not necessarily increasing actual knowledge or understanding in the longer term.

The research in this area was reviewed in 2013 and 2015 resulting in an expansion of the critical review as more information and resources had been made available, especially with reference to the minimum core of numeracy being addressed in the post-compulsory sector.

3.11 Collecting data from an e-bulletin board

As part of the functional skills mathematics staff development program case study in phase two of the research the e-bulletin board, open to all participants and teachers to use was examined for information. For delivery staff this allows for manoeuvre by individuals forming a platform for mediation between experimentation in the classroom and pedagogy for delivery of trainee teachers’ numeracy. Comments were collected in full from the e-bulletin board, collated into one corpus with all elements of identifiers including names, dates and avatars removed and analysed as text in the same way as forum comments in phase one of the research. The e-
bulletin board is a microcosm of the wider institution in which it operates and represents a community of practice in miniature.

A community of practice allows individuals a collective conscience and the opportunity to review, explore and change reality. Working in isolation is not appropriate where evaluation of practice is required. This gives a poorer result, as it has no impact other than on the individual, which is not the aim. To gain the changes in practice that are being targeted, as researchers, we must:

"stand on each other's shoulders that serious progress can be made in our collective understanding of and action on institutions like schools"

(Apple, 1990 P.82)

The nature of knowledge itself and the extent to which it is determined by outside agencies rather than communities that actually require knowledge (or possess it) is an issue. By the use of an e-bulletin board for those involved directly in the process of working with teachers and student teachers and the delivery of functional skills mathematics qualifications, via the use of an educational forum, it can be established the extent to which knowledge is required by take up rate and from a repeat of the original analysis on perception from the start of the research. Using an 'e' method of communication to raise awareness and stimulate interest and change in the teachers' numeracy allows for change to occur where the researcher is 'absent' and not intervening in the traditional sense (Lee, 2000). Through the involvement of practitioners within the research itself a more realistic and practical means of facilitating change is provided (Robson, 2002).

The e-bulletin board is made up of an elective set of people who would participate by using materials provided if they thought them appropriate and useful and where possible providing feedback to inform progress and conclusions. Evaluative data and progress data can be collected, analysed and compared to the original perception data collected in the same way. This fluidity was important at the beginning of the research and remained so, less didactic methods than just providing information via one platform would (after some scrutiny) appear to support that fluidity and be more likely to produce the positive result expected from a qualitative research methodology such as this.
Involving other practitioners in research work, according to Robson (2002) provides a more obvious method of effecting change that will be effective and actually implemented. This change is desirable, it is the main expected outcome of this research and vital to the research questions presented at the outset. Bringing people into collaborative relations for the purpose of research transcends the completion of research for its own sake (Gergen, 2003). Creating mutual understanding, creating patterns of practice: vital to research and to a change in pedagogy. The research participants or members of the functional skills staff development programme in the case study phase of the research are supporting the construction of the research ‘reality’ with the researcher (Robson, 2002) through their participation in focus groups, an e-bulletin board and observed conversation as well as through their participation in the CPD programme.

3.12 Observation of functional skills delivery for teachers

Functional skills at levels one and two are qualifications based on problem solving, calculation and the application of numerical skills. Functional skills mathematics is equivalent in terms of difficulty, especially in relation to problem solving to a C grade at GCSE.

The functional skills staff development programme for mathematics completed as a case study in phase two of research was observed using a participant observation method from its conception to completion with comments and experiences collected through the process. The comments were collected and collated as with comments from forums and HEIs in the first stages of research with all themes and perceptions emerging from the data itself during analysis. This created a type of ongoing evaluative data set related to the functional skills staff development programme.

Within further education and training, evaluation and reflection are commonplace elements of the professional value base. To become a reflective and evaluative practitioner is an aspiration for trainee teachers as it forms such a large part of the more recent concept of professionalism. Evaluation informs Continuing Professional Development (CPD) for instance, the on-going process via which teachers in every sector up-date their subject knowledge and practice pedagogy. Within the educational community at all levels, evaluation is expected to be a common, everyday occurrence. The use of an evaluative method to gain data concerning
education is not new, however it is a method that has been previously under-utilised (Cranmer et al 2004). Evaluation can be described as assessing the value of something, not always linked to research, Robson (2007) ties evaluation to organisations or services, examining their end product or effect.

The process of evaluation has been described as having two distinct phases: the planning phase and the actual evaluation phase. These two phases inform each other in an ever-continuous cyclical procedure for improvement within a given situation (Trochim, 2006). Evaluation leads to implementation and analysis, which then leads to the formulation of new areas for evaluation, providing a continuum supporting practical improvement. Using a qualitative methodology, where the variables are not directly manipulated (as variables would be in an experimental design for instance) the ability of the researcher to determine simple cause and effect as part of the relationships exhibited by data is limited (Bryman and Cramer 2005). Evaluative methods can help to provide a stronger picture of impact, acting as a form of ‘impact assessment’.

The use of evaluation as a tool for research, in combination with other methods ensures a logical and systematic view where cause and effect can be inferred, becoming part of a chain of reasoning that can be described as inductive (Bailey, 1996) while Trochim’s (2006) description of evaluation is more explorative and concentrates on the systematic nature of evidence gathering leading to the provision of feedback that is useful.

Due to dependence on the previous research methods used and the data yielded by them, the design of the evaluation was clearly determined by the research questions first and foremost (Robson, 2007). The use of evaluation as a research tool in this instance centres on the need for limited involvement and participation by others, if any action or clear influence on practice is to be evident. The measurement of impact of the proceeding research aims is subjective and qualitative since many of the desired outcomes are so long term, that truly quantifiable measures may take years to fully assess impact effectively (James, 2003).

Qualitative data of the type provided by evaluation can be seen as having a high degree of validity, although sometimes suffering in terms of reliability. Alwin and Krosnick (1991) presented the idea of measuring elements more than once to assess any true changes as a form of evaluation which tends more towards repeated trials in quantitative methods to preserve
reliability. Within this research exactly the same conditions are not repeated in exactly the same way, which does not allow the data to be evaluated by measuring net change directly. This subjectivity in the data gathered must be taken into account at every stage to ensure that validity is maintained.

To ensure that evaluative data is gathered in a way that is effective and above all useful, several questions are important to keep at the forefront of the evaluation processes within the research, adapted from Robson (2007), these include:

- What is needed (in relation to the research questions)?
- Does what is provided meet the needs of those involved?
- Does it attain the goals or objectives?
- What are the outcomes?
- How can it be improved?

(Adapted from a fuller version provided by Robson, 2007 P.33)

To collect evaluative data, the e-bulletin board, focus groups and direct recording of conversation through observation was used. Via observation and the other methods used within both phases of the research process, the aim is to disseminate sample resources and complete evaluation, this process takes account of individual interactions in addition to conversation or evaluation provided by the other research methods involved.

Resources for teaching mathematics and numeracy have also been uploaded to the Times Educational Supplement resources section of their website, where resources can be viewed, downloaded and reviewed by others. This was completed as a pilot measure to reach a wider audience and examine the ‘traffic’ experienced by resources available on this site.

A total of seven basic and generalised numeracy resources to aid teaching and learning were uploaded. These received 32912 views, which led to 16213 downloads. From this, only nine reviews were provided by those downloading. Resources were clearly popular, and approximately 50% of those viewing the resources downloaded them for use, however this is not reflected in the level of feedback provided. Evaluations from those downloading the resources in this instance were entirely voluntary and unsolicited, evaluation could have been
prompted and requested to improve the response rate, but this would affect the nature of the research.

Using a 'pilot' can inform the research process and allows for mistakes or errors to be made, acknowledged and acted upon (Underwood, 2003). From the piloting of initial resources for mathematical and numerical learning it was clear, especially with the passage of time that there would simply not be enough evaluations to use within the research and gain any meaningful results unless these were specifically elicited. The pilot of making resources available via the TES and collecting review or evaluative information from this demonstrated that unless solicited in some way, there would not be enough information generated by relying on a naturally occurring phenomena. The most interesting response/review was the individual who had used the resources for the maths required in teacher training. This was completely spurious but demonstrates that individuals are looking for information, resources and support in this area, agreeing with the premises and the findings of this research.

It is important that any action taken by individuals within a group as part of reflection and evaluation belong to the individuals themselves and are not guided by the researcher (Brydon-Miller and Greenwood, 2006). In this instance evaluative data has not been directed or guided but emerges from the data, informing the production of resources to support teaching and learning in phase two of the research completed.

3.13 Conducting focus groups

The questions for the focus groups represented difficult choices. The focus through the research has been emergent themes, rather than elicited responses. Freedom for the participants in terms of the answers that they provided was very important to make the information produced conform to the naturalistic data format preferred from the outset. However, sitting in a room with a group of people without any prompting in terms of the subject matter they are expected to examine is not likely to be very productive, this produced a dichotomous juxtaposition for the researcher. Conducting focus groups in phase two of the research requires some guidance for participants, too much guidance would have produced invalid results and so some questions were required. The design of questions for
questionnaires, according to Meyburg and Metcalf (1996) is a similar process to that of designing questions for focus groups and involves considering the length of the questions, simple language, and the provision of instructions for both respondents and any administrators or researchers involved.

The more categories of response there are available to participants, the higher the probability of confusion, leading to discomfort in the completion of the focus group and low participation or actual speaking, coupled with an increased chance of ‘overly considered’ answers, rather than the more immediate response required. This possibility of these over considered answers can be addressed with the use of closed questions, improving reliability since the range of appropriate responses is defined (Dey, 1998) (Meyburg and Metcalf 1996). The use of closed questions will not produce naturalistic or in this instance, realistic or useful data for evaluation.

Focus groups can be used as an evaluative measure (Kreuger, 1988) through an organised structure, and are viewed in this way for the purpose of this research. Although focus groups are an example of a method in their own right, they ideally complement other methods since results can be limited, especially in terms of analysis of findings and attempts to generalise to a wider sample (Gibb, 1997) Responses of individual group members can be interpreted in as many ways as a person can interact, potentially posing difficulties in analysis of the data produced from this method (Hyden and Bulow, 2003).

Within focus groups, there is no anonymity during the actual ‘performance’ phase, due to the nature of group interaction (Gibb, 1997) and so where this method has been used it was paramount to include a measure that would indicate to participants that their responses would be recorded generally, in an anonymous form.

Ethically it is important that issues of confidentiality and anonymity are clear and that participants give informed consent for the data generated to be utilised for research purposes. Consent forms were constructed within accepted regulations and used with all participants for phase two of the research, where people other than the researcher contributed directly to the research data.
3.14 Participant observation

Participant observation has been utilised as a method to gather data in phase two of research within the case study. The case study data is similar to the patterns of data collection throughout the research process, gathering conversation, comment and discussion as data and analysing and examining those words. Participant observation though can provide more depth and allows us to concentrate on the experiences of the people involved in situ. This depth can counteract the basic nature of gathering and analysing data and give us a cross-check facility against the other methods of data collection and against the other sets of data generated or collected in this research through forum data or HEI data for instance. If what people say corresponds with what they do then we can be more confident in the validity of our findings.

There is a clear link between naturalistic methods and participant observation. The research that has been conducted here also brings these aspects together in an attempt to learn more about teachers numeracy, and how the observed situation can be improved. Naturalistic methods used include the capturing of unsolicited voices through online forums, an action research methodology through an influence exerted in the case study and the production of materials for use in classes where teachers’ are learning numeracy.

Observational methods have become common in educational research (Kawulich 2005) characterised by the use of immersion in the target sample community. In this instance the target community is the teaching body in a further education college which included newly qualified teachers, teachers in training and experienced teachers of differing subject areas. This is a difficult area of the research process, as in this instance the researcher is part of the community that is being observed. This led to very frank and honest exchanges with people willing to open up more with someone they had known for a long time possibly more than they may have done otherwise.

There would be the ethical consideration of possibly deceiving the people that you work with, however in this instance the researcher was upfront about the research, the aims and objectives, how the participant’s words would be recorded and analysed and ethical consent or agreement was sought before use of the collected material.
Observation can be used to support the building of theory (Kawulich 2005) and in this instance the research supports the building of a model for delivery of teachers’ numeracy. Researcher bias is one of the aspects of any study that includes observation methods that has led to the view that qualitative research is subjective, rather than objective. Bias must be acknowledged in this area more than in any other as the reliance on the researchers interpretation of the data collected in analysis could be seriously skewed by any inherent bias (Kawulich 2005).

With roots in ethnography, participant observation is now an accepted tool for data collection in qualitative research, used by researchers who are interested in both the occurrence of a phenomena and understanding that phenomena (Mack et al 2005).

Participant observation can provide rich detail of the context within which various actions take place as noted in the table:

**Participant observation as a method of enquiry**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allows for insight into contexts, relationships and behaviours</td>
<td>Time-consuming to complete data collection and analysis</td>
</tr>
<tr>
<td>Can provide information previously unknown to researchers that is crucial for interpretation of other data</td>
<td>Documentation relies on memory, personal discipline and diligence of the researcher</td>
</tr>
<tr>
<td>Provides ‘rich’ data that may not be available through other means</td>
<td>Requires a conscious effort at objectivity because the method is inherently subjective</td>
</tr>
<tr>
<td>Provides a ‘cross check’ facility between what people say and what they do</td>
<td>Results and findings cannot be generalised to the population at large as a small sample is often used</td>
</tr>
<tr>
<td>Provides specific information on peoples experiences at a particular point in time</td>
<td>Findings may lose relevance over time</td>
</tr>
</tbody>
</table>

(Fig 2 – participant observation, advantages and disadvantages, adapted from Mack et al 2005 P.15)

Cotner (2000) discussed the feelings and experiences of being both an insider and an outsider in terms of her research, as she researched in environments where she was not familiar, they were not her own working environment and so she had imposed herself on the situation. In phase two of this research participant observation is completed in a place where all the respondents or participants are really well known to the researcher and vice versa. Several of
Cotner’s observations relating to relationships between the researcher and the participants making her a ‘quasi-insider’ are not applicable as awkwardness or discomfort was absent through the participant observation phase of the research. Being completed in situ, in the normal working environment removed the imposition of a research process on others, creating a true ‘insider’ perspective.

Participant observation significantly strengthens the context for understanding data collected through other methods. The observation in the case study supports the findings from the phase one analysis, helping considerably to make sense of the other data (Mack et al 2005).

3.15 Analysing conversation, discussion and text data

On completion of the collection of data, a search followed for appropriate text analysis tools which would analyse the information required from the text of the conversations from forums, higher education prospectuses, focus groups, observational comments and a staff e-bulletin board. Several programs were examined for suitability with some appearing suitable initially but then being discarded. One example of this is the ‘tag crowd’ program (2010)\(^{19}\) which gives a very fast analysis of word frequency but has no further research applications.

The total number of comments taken from internet forums was categorised into posters conforming to these main categories as a method of sorting the data. (See Appendix III, Volume 1, P.17) This displays the categorised comments in full, catching the voices of those involved in teachers’ numeracy without alteration. The direction of the comments is almost entirely negative within each category. This initial simple sorting of the data provided a very clear overview of the comments collected with further analysis being conducted using a linguistic enquiry tool (LIWC).

When the data was subject to the LIWC program, or Linguistic Enquiry and Word Count program available online, the corpus text was fifty four thousand, seven hundred and seventy five words in length. Social words were not found to be used enough to conform to personal texts and were closer to the amount found in formal texts. Self-references (such as I, me, my)

\(^{19}\) Date of access provided 20/10/11
negative emotions, articles (a, an, the) and the use of long words (more than six letters) produced the same result, all conforming to formal text usage.

Three hundred and fifty nine codes were assigned in total to the text made up of comments from within the forums. Each of the codes was then collected and collated into emergent groupings. The initial groupings emergent from the data are as follows:

- Standards
- Skills in teaching context
- Asking for support and guidance
- Embedding
- Offering support/advice/guidance
- Poor maths skills may be positive
- Scathing comments indicating that the test is not hard
- Feelings about maths and maths tests
- Attempts at the QTS tests
- More positive descriptions
- The passage of time

All the data collected through the different phases and methods, collated and analysed, conforms to the same or similar type, all the data is made up of comments or strings of conversation. This continuity makes it possible to take a wider view of the results of this research and make comparisons between all the results available. This provides a fuller and more coherent picture of teacher numeracy allowing different themes to be identified.

Notes were processed in real time, typed into an electronic tablet PC or written in the research journal at the time, as people spoke. This stilted the conversations slightly as although the typing was fast, it still wasn’t as fast as the speech taking place so this did create a lag in conversation. In some instances this gave people time to think more about what they were saying and possibly produced an ‘experimenter’ or Hawthorn effect: whereby people are
stopping slightly to think about a more desirable response. This phenomenon relates more to the focus group data rather than observed comments, where people were less aware of the presence of the researcher.

Responses are grouped into the section where they occurred in real time, which is not necessarily where they ‘belong’. Peoples responses to questions or prompts do not always fit with the expectation of the researcher, they do not necessarily answer the question clearly or directly. Some people drift off track but provide more insight when they do so (possibly). A section was provided for this to happen in the focus groups with an open ended question at the end of each of the two group sessions.

The responses recorded do not take the form of a ‘conversation’ as such (although this does happen in some places) people were more interested in getting in their contribution. This is compounded by some responses being typed out of sync or order, as the contribution is heard or received by the typist rather than exactly in the order it was presented.

LWIC analysis of comments collected from educational forums relating to teachers numeracy indicated that the text conformed to a more formal style of language use rather than informal and did not contain a high amount of emotive language. This is likely to be due to the restrictive nature of the dictionaries used in the program and the associations indicated between words and their possible meanings.

The original analysis of this set of data took several forms. Initially collecting and collating the comments directly into emergent categories followed by electronic analysis with the LIWC program. The posters that were completed of all the comments categorised retained meaning and context, giving a clearer indication of the negative direction of the comments within the different categories.

The case study in phase two of research is ‘an in depth study of a particular situation’ (Shuttleworth 2015). According to Shuttleworth this method is especially suited to testing theoretical models by using them in real world situations. This is what happened in the case study of staff professional development. The need for strict rules in the design and implementation is more relaxed than in a quantitative study and so more flexibility is available within the research process.
The advantages of the case study method are described by McLeod (2008) and include the method providing rich, detailed information, and allowing the investigation of situations that may appear difficult as well as providing possible insights into future or additional research. The case study method does have an issue of transparency related to it as the interpretation of data contains aspects of the researcher’s opinion or bias. McLeod indicates that it should be clear within the case study which information is factual and which information is reliant on the researcher coming from inference or interpretation.

McLeod (2008) also describes the limitations or disadvantages of using case study as a method, which include the lack of ability to generalise results, difficulties replicating the research, which in some instances would be impossible and the time constraints which are exasperated by attempting to replicate. Case studies produce an involvement with an isolated individual or group and so the findings may not apply to others including individuals or groups that are similar. In this research phase two of the research does rely on the case study method, however there is an advantage of the research containing phase one, so that both the data and the findings can be cross checked to establish validity. The comments that people made in forums during phase one of the research are checked against what they do and say in phase two of the research, examining the similarities and differences.

Tapor master program\(^{20}\) can give more in depth analysis presenting some high frequency words in context and producing some basic statistics, but this is more quantitative in nature. Although a systematic approach is required, a search for indications on meaning and opinion are required, rather than an approach to words as numerically classifiable objects. The program was trialled with the data but discarded. The Hyper-pro 6 program further explored the language of the sample texts. Here the data was examined for word frequencies (50 most occurring words), and a key word in context feature was used with 5 words either side of the key word chosen from the corpus text to allow context to be taken into account. This proved to be unsuitable to analyse the collected data as the meaning of the conversational strings was lost, the actual ‘voices’ were not represented clearly. Again the data became akin to a set of numbers rather than part of a meaningful exchange.

\(^{20}\) Date of access provided 20/10/11
Initially it was intended to examine each of the key word strings for individual words that would give an indication of directionality further supported by context. This wasn’t successful however, as in many cases the context was negated by this action giving false positive or negative results. It was decided to examine each string in its entirety to ascertain direction. Although this demonstrated that many of the strings exhibited no directionality at all, several could clearly be identified within most samples of the texts.

The frequency count is also examined for positive and negative indicators, with a ‘dictionary’ of the different corpus positive and negative words being made up to ensure transparency. This analysis indicated a simple direction of opinion. There is no ‘one size fits all’ approach to the analysis of data and so it is understandable that the first choices and trials of method and tools proved unsuccessful.

After some extensive investigation, two tools were identified as being more appropriate and suitable for the simplistic and transparent analysis required the ‘LIWC’ program and keyword density. The LIWC program reported information on self-references, social words, positive and negative emotions in the text, as well as overall cognitive words, articles and large words. The program then compares the use of the words in the text to the use of words in both formal and personal speech patterns.

The key words used are as follows: Numeracy, Maths, Number, Arithmetic, Numerate, Core, Minimum, Calculations, Mathematics, Calculate, Mathematical, Innumerate and Num (as an abbreviated form of the word numeracy). In each case, the data was processed to remove individual names or avatars and any details that didn’t form part of the conversational text. The data must be prepared beforehand, which means removing all the date and time information and individual posters details, turning the text into a continuous corpus.

Prepared and unprepared data was examined for differences in results and although the differences proved to be small, they may not be insignificant if compounded, since the contributors information being taken into account does get amalgamated into the text and does alter the results as if this information were ‘text’. Therefore prepared data with all of the spurious information removed has been used as the corpus in each case to ensure that even a minimal error of this type will not interfere with results.
Further analysis of text from forums, higher education institutions, focus groups and observational comments, rests on the categorising of data into distinctive categories allowing for directionality to be identified. Each sample was reviewed in its entirety, as a conversation so that more contextual observations could be made. From each sample every conversation was checked for direct mentions of the keywords and associated information. Each element conforming to the criteria was noted down as a comment and collected. The collected comments were then checked though systematically for any commonality with which they could be classified. The categories came from the data itself as emergent and comments were collected together around their identifiable common themes.

The collected posts have been subject to qualitative categorical analysis, ascertaining and qualifying any specific strands of opinion in this area using simple constant categories (Constas, 1992) emergent from the data itself (Dey, 1998). Since data collected through observation or through the use of key words in this instance, may not conform to any real standardisation measures, a simple grouping of the data for analysis into constant categories is sufficient to underpin analysis (Dey, 1998). This grouping and categorising is an everyday activity, engaged in as part of the norm by human beings (Wolcott, 1994) whilst undertaking other activities allows us to make sense of the information that we find. The clearer the method of analysis, the more transparent the relationship between the data and the results is expected to be.

This collation of the comments allowed for the full context to be taken into consideration, forming a type of cognitive anthropology (Silverman, 2004) taking account of the way that people communicate fully or the fuller context of language, rather than simply taking incoherent parts of conversational text and drawing inference from them. Taking account of this fuller context of language used in the data is ‘crucial’ (Wodak and Meyer, 2009) to understanding borne out by the problems with analysis experienced initially where meaning was important but ultimately lost in the methods of analysis. Using information which may not necessarily be the product of objective and reasoned thought, but is based more on opinion, emotion or belief (for example from internet “blogs” and forums) is clearly subjective in nature (Pears and Shields, 2009) not easily lending itself to quantitative analysis as ‘meaning’ is vitally important.
3.16 Case study as a research method

The CPD programme was developed as part of a response to new legislation in 2013 moving towards higher levels of numeracy skills in the UK workforce generally, clearly demonstrated by the change from adult numeracy to functional skills and the redevelopment of the GCSE mathematics curriculum. Delivering functional skills mathematics for teaching staff became part of the curriculum offer in one further education college in the North West of England. A programme for delivery was drawn up, starting with initial assessment for staff members, a handbook to support the course, course materials via a Virtual Learning Platform (VLP) and timetabled classes. The program was aimed at and delivered to teachers already working within the college environment, the teachers were a mixture of experienced vocational teachers, trainee teachers, newly qualified teachers and peripatetic teachers across all subjects offered in the college and across all levels offered.

The subjects offered in the college are vocational in nature, including construction, hair and beauty therapy, travel and tourism, health and social care, accountancy and automotive engineering. The staff programme provided an opportunity for all staff to improve their functional skills, gain qualifications or update their knowledge.

All the supporting documentation referring to the teachers numeracy CPD programme is available within the appendices, providing a full picture of the staff development process for teachers (see Appendices IV – VII, Volume 1, P.30 – 43). All identifiers have been removed from sample documents. Participants were assured of anonymity and so all references that could have acted as an identifier or could have led to the possibility of identification have been removed from all documents, including names, and the names of online applications or programmes used for the administration of a VLE or e-bulletin board.

Flexibility was seen as important for the programme to be successful, with those staff responsible for delivery in mathematics functional skills being required to arrange ad hoc tutorials with individual staff members on the program, and timetabled and planned sessions using contextual and embedded learning materials where possible. The examinations for functional skills were planned to take place after all other college students had completed
examination or assessment in all areas. This provided a finite amount of time for classes and examination and a specific timescale from inception to completion for staff members participating in the program.

Members of college staff were required to complete a functional skills examination in mathematics or English or both subjects, this was a programme with no direct compulsory nature for those participating in the programme; however the expectation was that everyone would participate unless they had good reason not to and this was very clearly communicated. Individuals were provided with explanations from line managers as to the importance of participation in the programme for all members of staff, the possible benefits to them individually of participation and the move to professionalise the workforce. Some members of staff reported that they felt ‘pressurised’ to participate, rather than participating in a wholly voluntary structure. This is noted from responses collected through the research process in forums and through observation.

The programme had a strong reliance on e-learning and technology to provide an initial and diagnostic assessment for numeracy skills. This rested on the members of staff being able to use a computer to input answers to questions, as the assessment, marking and feedback was provided via a PC programme specially made for assessment in functional skills. All were able to complete the initial and diagnostic assessments without struggling with the level of computer skills required. They did however struggle with the use of the e-bulletin board as this wasn’t as easy to navigate and required several passwords and choice screens before a comment could be placed on the e-board.

Research into the functional skills CPD programme for staff in the college was split into three main sections, observation comments being collected, focus groups of those teachers who had attended classes and collection of the electronic bulletin board comments. Each aspect of the research followed the same methodology, collecting and collating comments, recording what people say about their experiences, their perceptions and their feelings.

3.17 Ethics in the research
All research work has ethical considerations to address. Blackburn (2001) stated that: ‘as human beings we are naturally ‘ethical’ animals’. In this instance, within this research work the ethical problems are limited, but still present. Ethics as a subject in itself produces ethical dilemmas which often rest on questions of ‘right’ or ‘wrong’ whether this is in behaviour (concrete) or in decision (abstract). Like any other specific and pre-prescribed code of ethical direction, the ethics of working with human subjects in any way is fraught with problems. The morality of our ethical decisions should always be questioned and evaluated to inform our actions in research.

Plato offers a view which provides authority to an ethical morality of right and wrong actions and decisions that is pre-existing (Blackburn, 2001). Is the morality simply ‘there’ to be discovered and understood, as Plato suggests, with other elements of the universe (mathematics for instance) or is that morality constructed through collective agreement by like-minded human beings who agree on the content and nature of morality, and in doing so – construct a moral code? This is relevant in terms of choices in the methodology that we use where our choices are relative to the task in hand and the accepted wisdom of the day. That ‘relativity’ in our choices implies that Plato’s pre-existing morality is actually a constructed and created morality or ethical standpoint and is open to criticism and significant change over time.

Examining the nature of ethics and ethical or moral decision in research is an interesting distraction from the reality of examining ethics in practice. It does help us identify the nature of ethical considerations as clearly subjective (Berg, (2001). Here the need is to examine ethics in terms of what will actually happen under the circumstances of this research and the required limitation of any ‘wrong-doing’ with either data or participants.

In an effort to reduce harm to human subjects or participants within research, very limited and narrow research samples or participants can be involved, (a smaller sample for any potential ‘harm’) this can have the effect of research being true in only one instance and losing relevance or failing to address issues of real importance (Brydon-Miller and Greenwood (2006). This presents us with a trade-off within qualitative studies of this type, between the type of information that is required and the conditions under which it is obtained, and this ‘tension’

\[\text{Here, ‘morality’ is viewed as an entity or is objectified as a ‘thing’ which can be identified. In reality there are many different perspectives on morality.}\]
between logic and ethics (described by Berg, 2001) must be both acknowledged and addressed if research results are to be set in a realistic context.

Research methods where other individuals are involved must be reasonable, responding to the reasonable expectations of normality and decency described by Blackburn (2001). Honesty would be the highest consideration in this instance, even where that honesty is not entirely positive, or paints a less than complimentary picture (Brydon-Miller and Greenwood, 2006). It is clearly the responsibility of the researcher to conform to generalised notions or collective assumptions of what is reasonable and honest practice in this research work. Complacency and a conviction of our own moral superiority must be avoided through a systematic revisiting of the area of ethical questioning for each decision and application of method within the research (Brydon-Miller and Greenwood, 2006).

In this instance, a reasonable and honest approach involves ensuring the right people have to privacy is upheld, universal human rights are also upheld and peoples welfare is paramount (Berg, 2001) in the examination of teachers’ numeracy. Involvement of others in all aspects of this work (that require involvement) is entirely voluntary. Whenever information is used that has been directly obtained from individuals, informed consent is obtained (Berg, 2001). To ensure issues of confidentiality, anonymity and informed consent were fully addressed; a consent form was constructed and used with all participants. This provided some information about the research being undertaken and the use of the data obtained, assuring those participating that they would not be named or identified at any time or in any way. Where extra information was requested relating to the research and the data this was provided verbally and where any participant did not want to give consent, any information generated by them was removed (see Appendix VIII, Volume 1, P.45).

Where data from forums has been used to identify the direction of opinion towards minimum core numeracy for instance, anonymity is maintained through the removal of avatars that individuals have used to identify themselves online. Avatars are used to identify individuals leaving postings within forums online, rather than their real names, these have been removed from all but the initial raw data collected and this raw data is not presented at any time within the research. These avatars cannot be viewed or observed at any time and the threads of conversation are isolated from their original context and environment to further ensure
anonymity where conversation has been collected. This information is already held within a very public domain and is clearly accessible to all, regardless of the use that it is put to. Where some information was available but required log ins and passwords for access, rendering it out of the public domain and within a specific area that did not have direct public access, this information was not collected for analysis to maintain privacy.

The need for anonymity is still present, since some individuals could still be identified through the use of those avatars and possibly traced through other postings using social networking or other forums, which would be an undesirable consequence of using the data for research purposes, these identity ‘clues’ have been removed.

The Institute For Learning (IFL) now the Society for Education and Training (SET) contained links to bulletin boards and forums or members use, conversation and questions relating to an educational context. However this data is not accessible, since the IFL (SET) has members who have paid a membership fee and must sign in or log in to use the facilities via the website. In terms of ethics it is important that there were no trust violation issues brought about by the research work. As a member of the IFL an individual researcher has access to the forum data generated by the IFL.

The forums and bulletin boards are not immediately available via the public access website and are therefore for members to view and use only and are not in the public domain. This would pose an ethical problem requiring permissions from members to use any data gathered. This was discarded as an option for data collection due to ethical considerations.

The main tenants of social media interaction, ‘Twitter’, ‘Facebook’ and ‘linked in’ all require a sign in (membership) and do not provide generalised access in the manner required to be totally accessible to the general public. Despite creating accounts for each of these interfaces, no information with any coherent or discernible theme was available without the informed consent of other account holders. Using this information would mean alerting other users to the presence of a researcher, this would also possibly include solicitation of data and information which by definition means that the data observed would not be naturalistic or naturally occurring. This was discarded as an option, due mainly to ethical considerations and because
this soliciting method would produce data which could not be compared with naturalistic data readily.

Although the information obtained from educational forums for the first stages of research was not provided specifically ‘voluntarily’ for the purposes of this research, the individuals volunteered their conversation, opinion and views as contributions to the forum in the knowledge that this information was public (Flick, 2009) making it possible to follow the conversation about a specific topic (Lee, 2000). In terms of other data, all other contributions from third party individuals or groups, although more direct is also entirely voluntary with informed consent.

The nature of the ‘volunteer’ is an area for debate in itself, as Berg (2001) pointed out it is almost impossible to determine whether those who volunteer had the same characteristics or traits as those who are not as eager to do so. For this dilemma, Berg found no definitive answers, with the researcher being responsible for determining whether their actions in using volunteered information would contradict any ethical consideration and consequently whether any ethical restriction would create impotent findings.

The problem with data collected which has been volunteered in this fashion of participating in public forums is that the actions of individuals and the opinions of those same people cannot be matched and therefore checked for consistency. Checking one against the other in this way would normally reduce fallibility in the data, checking what people say against what they do (Blackburn, 2001). Examples of this difference in action and rhetoric can be seen within the data collected from forums, where some individuals give a negative impression of numeracy tests and then report they feel really happy that they have passed them. Although it isn’t possible to check directly the actions of those conversing in forums against what they as individuals actually do in practice, the research in phase one can be checked against the research in phase two, effectively verifying more generally what people say against what people do.

3.18 Chapter summary
This chapter examined the methodology employed to answer the research questions posed in the introductory chapter. Initially a generalised overview examined the use of a research journal to support the research work. The different methods utilised, through the research work completed were described in a chronological sequence.

The use of internet data collected from forum postings was the first method in that sequence, followed by a contextual analysis of data gained from online prospectus’s relating to teacher training provision, concentrating more on the post-compulsory sector. It is difficult to ascertain the direction of such subjective elements as perception or opinion, whilst being certain that these elements have not been influenced by research itself or the researcher involved. Asking a question may create an opinion where previously there was not any judgement of significance. The decision was taken to investigate naturally occurring data that wasn’t subject to any influence from the researcher wherever possible. Educational forums provided this type of data, online and in the public domain. The voices of those involved could be captured clearly without external influences or solicitation of any kind.

The second element of research undertaken, assisting in the provision of a baseline for further research, was a critical analysis of support documents and resources available for the delivery of teachers’ numeracy. This was necessary to ascertain the availability and type of resources for trainee teachers and teacher educators, in combination with investigation into perceptions and opinions about teachers’ numeracy from investigating forums initially, between the two research methods it was clearly established that further research in this area was warranted.

The third aspect of investigation in phase one of the research, completing a review of baseline data, took the form of a type of document search as higher education prospectuses were examined for information relating to entry numeracy requirements for prospective trainee teachers, with a focus on the post-compulsory sector of teacher training. This was examined because the forum investigation revealed the lack of a trace element, in comparison with teacher training in the compulsory sector.

The case study (phase two) of investigation revolves around the participant observation of the delivery of a staff development programme for functional skills mathematics where analytical techniques proved to be appropriate and effective as the data secured and analysed provided a directional indication of attitude and opinion in a similar fashion to the first phase of research.
which could be specifically categorised and qualified, again an analysis of trace measures (Robson, 2002). Evidence of feedback and evaluation provided by the focus groups, observation and the use of an e-bulletin board demonstrate that resources have been utilised in a practical teaching and learning context which prepared for a fuller evaluation of the data overall.

Using emergent categories conformed to the naturalistic nature of the data collected. Having collected data without having exerting any influence over it, the aim was to influence analysis as little as possible. It is clear that the categories that are emergent for one researcher will not be the same for another. This is not a task that can be approached with an ‘empty mind’ and so is subject to bias which is clearly acknowledged.

Electronic programs which could be applied to analyse data were examined for suitability. The LIWC program and the hyper-pro 6 digital text environment were both tried as analysis methods with data, followed by Key word density analysis. For each of the programs, the corpus is pasted into the programme and the analysis completes immediately.

On completion of collection of all the research data, the original methodology was revisited and all the data was subjected to the same methodology. The data was coded via any emergent themes from the data, the codes collated and the results analysed. This involved a constant comparative method, re-visiting the original corpus at a later date and re-analysing the data to ensure wholly valid qualitative results, identifying and examining anomalies.

Higher Education Institutions (HEIs) in England responsible for teacher education advertise their courses generally in prospectuses. The prospectus contains a mixture of photographs, course details and entry requirements for courses. Here, online prospectuses have been accessed for research purposes from a sample of institutions which have been analysed in relation to the information that they provide for prospective trainee teachers. This content analysis specifically examined the information relating to the numeracy or mathematical requirements of teacher education courses.

After investigating people’s perceptions and opinions, this document search approach examines institutional practice. Again this is research into naturalistic data collected without solicitation, conforming to the methodology employed throughout. The main question in this document
search is: How do higher education institutions present numeracy entry requirements in their prospectuses for trainee teachers?

Data produced in phase two of the research also conformed to the same typology as the data from phase one. This was naturalistic data collected in a different way, through participant observation, providing further information which could be analysed utilising the same methods as those in phase one. The only data which does exhibit some difference in terms of being naturalistic or not is that collected through the use of forums. Here, although the data is solicited to an extent, the forums are not strictly guided and responses were free flowing. The data produced is not naturalistic but does conform to the typology throughout of ‘words’ being used as the raw data set and so analysis also conforms to the same principles as in phase one data analysis.

The data produced by the different methods conformed to the same typology. All the data represented conversation and words. Revisited over time the words and conversations were reviewed and analysed with several different themes emerging. Those emergent themes as findings follow on from this chapter.
4 Chapter Four – Research findings – Negativity
4.1 Chapter introduction

Different themes emerged from the analysis of the data collected in both phases one and two of the research work completed. Those emergent themes included negativity. At the outset of research there was an expectation (from anecdotal evidence and prior research) that not everyone ‘loves’ mathematics. The results of research were not surprising in that people were generally negative when confronted with the subject. The public perception of mathematics and numeracy has been reported as negative for example by Ashby (2009) and Jones (2012) with Sam (2002) examining specifically the public perception of mathematics and the ‘negative image’ or ‘negative view’ that is conjured up by the subject in the public eye.

The depth of negativity running through the data and the prolific nature of that negativity through the analysis of the different types of data collected through this research was however, unexpected. Negative views, feelings, past experiences and opinions persist through the analysis of the data collected in varying forms, including some harrowing personal accounts of experiences in mathematics classrooms from the past. Negative attitudes, perceptions and opinions expressed by trainee and more experienced teachers’ represent a research finding of surprising stature through research and analysis.

The negativity found takes several forms, from standards of professionalism being questioned by those who feel confident in their numerical skills to the use of mathematics and numeracy to measure intelligence, with those lacking skills or knowledge being seen as less intelligent. Negative feelings due to a lack of achievement, negative language being used and the recounting of very negative experiences that teachers’ have had within learning the subjects of mathematics and numeracy have led to individuals viewing this subject as difficult (Sam, 2002).

Standards in mathematics and numeracy emerged as a category from the data analysed and revealed that those without numerical or mathematical skills, especially those struggling to pass the professional skills tests for compulsory schools sector teacher training were marked out as unsuitable or as failing in their chosen profession.
Using mathematics and numeracy to measure intelligence was apparent in several forms through the data collected and analysed. Often this appeared initially to have a positive slant. Positive emotions and overall cognitive words conformed more to personal language use from data taken from educational forums. This is an unusual result, especially since positive emotions superseded negative emotions identified in the text by the LIWC program (see Appendices IX and X, Volume One P. 47 - 49).

Clearly by reviewing the comments in their totality and in a fuller context a clearer picture was obtained which demonstrated a coherent negative trend, missing from the LIWC analysis. Context proved to be vitally important in the analysis process, ensuring that important aspects relating to meaning were not missed. Where comments initially appeared positive, for example demonstrating a level of pleasant surprise at being able to pass an assessment, this does indicate that people didn’t expect themselves to pass and are essentially questioning their own level of skill rather than reacting with a confident approach.

Higher education institution prospectuses also demonstrated an underlying negativity in their presentation of entry criteria for prospective trainee teachers. A document search of prospectuses from HEIs responsible for teacher education courses, revealed reticence to include information about numeracy or mathematical skills as an entry requirement for prospective trainee teachers.

When the data was revisited after three years as part of a constant comparative method, a more substantial result was obtained, and this was compounded by being able to compare the data from phase one of research with phase two, ensuring that the data could be cross checked for any significant differences. Using a basic coding technique, assigning codes to the raw corpus and then collating all the similar codes into emergent groupings from the data, the negative trends in the data analysis were substantiated further. The final main strand of negativity observed was ‘hatred’ of the subject and surrounding phenomena including hating maths lessons, numeracy lessons, hating maths teachers especially in relation to past experiences and anything else to do with the subject being described as ‘hateful’.

**4.2 Negativity relating to standards**
‘Negativity’ was emergent from the data collected relating to standards and professionalism in education. This was apparent for both the sectors of compulsory and non-compulsory education. Most of the findings in this area related to forum data. The majority of these codes indicate a very negative opinion demonstrated towards trainees who have reported that they struggle with numeracy as this infers that they cannot then maintain the standards required of professional teachers. The opinions centred on standards for new teachers being too low initially as the professional skills test does not require a high level of mathematical skill, the questions (if graded) are not above the C grade of the GCSE in mathematics.

The test is made more difficult by the use of a mental maths section where candidates must listen to the questions and calculate the answer in a timed situation. The questions are related to a teaching context which is more supportive and appropriate for the candidates, however it is the perception of the low level of the questions presented that may contribute to the scathing nature of the comments in this area.

In addition to this initial aspect of standards being low, there are also comments relating to low standards in education being perpetuated by underqualified and under-skilled teachers. Opinions which were voiced in the forums included the view that it is not acceptable for trainee teachers to struggle with numeracy, especially primary trainees who will be responsible for teaching the subject directly. This view of teacher professionalism as an ‘inclusive deal’ presents teachers as individuals who must acquire appropriate traits to claim their membership of the profession (Sachs, 1999) training is a journey where people cannot know everything at the outset.

Would I want to be taught by someone who is lacking in teacher training or who has insufficient literacy or numeracy qualifications? No I would not, so why should the students expect or be given any less?’

Comment taken from forum postings

These reflect the opinions of the individuals commenting in forum postings, rather than the opinions ascribed to by the researcher.
Several of the codes point to the perception of professionalism being eroded by teachers who are not competent in basic skills. A trainee teacher at any level having or demonstrating poor numeracy and mathematical skills was not seen as acceptable:

‘I believe all teachers require numeracy and literacy skills at least level 2’.
Comment taken from forum postings

‘not be confident with most year 6 maths, no matter what age group you want to teach, is not acceptable.’
Comment taken from forum postings

The comments collected are very scathing in relation to the mathematical or numerical skills of others. Here there is no room for manoeuvre with a clear negative direction in the tone and in the specific nature of the words used: ‘no’ ‘insufficient’ ‘not acceptable’ ‘less’ and ‘lacking’ are all negative indicators used in these forum comments.

Of the comments relating to standards that were identified, the content was mixed as some people attempted to be supportive to others, but generally had a strong undercurrent theme of negativity towards those trainee teachers who couldn’t ‘make the grade’ especially in numeracy Professional skills tests for the compulsory sector.

‘shocked at not just the level of maths some of my peers have but also the attitude of people to the subject. Quite prepared to laugh off being ‘rubbish at maths’ as if it’s some sort of joke’
Comment taken from forum postings

‘Struggling with year 2 and year 5 Maths is not acceptable and I would challenge you to find any decent teacher, Headteacher, OFSTED inspector, parent or governor who thinks it is’
Comment taken from forum postings
Individual comments pointed to the upholding of standards being very important to the individuals posting their views within all sectors, incredulity that students would consider teaching if they were struggling with basic skills and an over-riding concern that teachers needed to have a higher level of knowledge than any of their students to be truly effective.

As outsiders to the argument, our agreement or otherwise with the statements is not important. The words that are used, the tone and the inherent aspects of these parts of conversation take our focus.

‘Does this make a mockery of people spending years in debt at university to specialise in an area? Is it fair for students to be taught at a level in which the teacher has never undertaken herself?’

Comment taken from forum postings

Several of the coded passages relating to functional or basic skills being used in a teaching context were again substantial in their negativity. Initially appearing to simply be factual, the underlying meaning of the information taken in context is inherently negative. These comments pointed to numeracy skills being essential for teaching in a general sense:

‘As trainees you probably have no idea the types of data and numbers that more experienced teachers work with on a daily basis.’

Comment taken from forum postings

‘as a teacher you will be required to work with data’

Comment taken from forum postings

‘Today I have passed my Numeracy Skills Test. It was my 18th attempt.’

Comment taken from forum postings

These comments portray trainee teachers as having ‘no idea’ about the numerical skills required of a more experienced teacher, implying that experience and the ability to work with
numbers in a practical context for teaching equals ‘better’. This is not presented as an area for debate here; the actual language used is where our analysis comes into sharp focus.

The language here is more subtle in terms of its negativity, using negative implication rather than the more direct assertions seen in previous comments relating to different areas. It would be difficult to disagree with the opinion expressed in the second comment, trainee teachers are unlikely to know any of the elements that teachers work with on a daily basis simply because they are trainees. There is the implication that this is a negative situation but in reality it simply is the situation. Why would trainee teachers have any in depth understanding of the demands made on experienced teachers as they are trainees? Short and sharp comments are offhand and imply a lack of patience or intolerance for others who demonstrate a lack of numeracy skills.

The number of attempts taken to pass the numeracy professional skills test is another example of how negativity described by the data. Codes allocated to the data collected relate to the number of attempts trainee teachers have taken before passing, or not passing in some cases. All of these codes relate to more than one attempt and some codes overlap with ‘feelings’ codes where individuals imply a lack of confidence in their own maths skills.

| 'We encourage our students to reach a required standard of knowledge and expertise, we should expect no less of the teaching staff' |
| Comment taken from forum postings |

| 'Our cohort leader said not to worry about the numeracy QTS tests - campus record is apparently 37 takes of the exam' |
| Comment taken from forum postings |

Taking the same test several times prior to passing indicates that this test is very difficult for people to understand or that there are other underlying issues associated with taking the test.

| 'I am really struggling with the Numeracy skills test, I have taken it 8 times now and stil not passed!' |
| Comment taken from forum postings |
The numbers contained in the comments are surprising, one person is admitting to eighteen attempts and thirty seven attempts (which may or may not be true) would indicate that there is a problem. The standard of questions contained in the test are not higher than GCSE C grade questions, however the method of delivery does make the test harder as mental arithmetic is involved which traditionally people do not have great confidence in, in terms of their own ability. Mental arithmetic requires auditory processing and the rigorous use of short term memory which is something people are likely to be less proficient with than processing written information.

Numeracy is an area where individuals really lack confidence and this alone can affect performance. If a test has to be taken thirty seven times before the candidate is successful, it could easily be argued that they were not successful at all. This may simply reflect a high level of anxiety about taking the test however a high number of failed attempts reported, does not indicate any level of positivity.

Some passages of conversational text relayed a more positive view from people who had passed the test however they still have the underlying negative slant in a lot of instances as people express ‘surprise’ at having passed the test, demonstrating that they did not expect to pass and therefore have a negative image of their own mathematical and numeracy skills. Self-deprecation seems acceptable in relation to numeracy or mathematical skills. Jones (2012) noted that being "no good at maths" carries little stigma. Sam (2002) agreed with this reporting that most adults, especially in developed countries are clearly not embarrassed to admit that they have a poor level of skill or produced a poor level of performance in mathematics and numeracy. One of the reasons that people give for being unsuccessful with maths is the length of time that has passed since they last did any maths. This indicates that the individuals felt they needed a reason for not passing the test or for feeling insecure about their mathematics and numeracy skills.

‘I have recently taken the numeracy skills test for the 7th time and FINALLY passed it!!!!!’
Comment taken from forum postings

‘I have struggled with maths ever since Primary school’
Comment taken from forum postings
Not having studied maths for a certain amount of time is often presented as a reason for not passing a numeracy test or for being uncomfortable with the subject. No explanation is required, however people still feel the need to explain, and they must produce a valid reason for themselves and others to cushion the impact of any failure or underperformance.

The participant observation conducted as part of the case study in phase two of research contained staff members who are surprised that they have enjoyed maths lessons and those who have gained confidence from a higher than expected diagnostic score in assessment.

4.3 Mathematics used as a measure of intelligence

Mathematics is often seen as a subject that denotes intelligence. If you are able to work reasonably well with concepts in numeracy or mathematics then you are perceived as ‘clever’.
According to Abrams (2013) in a study of students’ perceptions, 27 out of 30 students were under the impression that clever people are good at mathematics and science and if you are good at mathematics and science then you are clever. This is a common conception in relation to perceived mathematical ‘ability’ whether it takes the form of either self-appraisal or the judgement of others. Mathematics is seen as abstract in nature in the same way as advanced astro-physics and in reality is clearly difficult (Sams, 2002). Only scholars’ work in this area at higher levels especially and this perception informs a societal view of only clever people understanding difficult things.

More general comments relating to the QTS numeracy test provided a noticeable strand of negativity that points again to people measuring themselves in relation to their competency with mathematics and numeracy. Several participants were keen in their conversation to demonstrate that they were talking about other student teachers experiencing problems with the numeracy test, not themselves having any difficulty, this is clear from their comments. People measure themselves by how confident they feel with their numeracy skills and they are keen to ensure that although they understand the struggles of others, it is not something they experience themselves. They want to distance themselves from any difficulties or lack of achievement and do not want to be tarred with the same incompetence brush.

‘You could see some of the others really sort of struggling’

Comment taken from observation

‘a lot of people have struggled with numeracy/maths for many years.’

Comment taken from forums

Those who can do the test without difficulty imply a type of superiority over those who cannot and those who perceive themselves as competent and able would not want to view themselves in the same way as those who do not. They are keen to disassociate themselves from any poor performance in numeracy and present themselves as proficient and capable.
Ashby (2009) referred to the subject of mathematics as being revered with mathematicians having a high level of respect amongst their academic peers, demonstrating clearly that intelligence is associated with mathematical knowledge, a subject where those who succeed are perceived as intellectual or as possessing a cognitive development level which is above the ‘norm’. This conforms in part to our perception within society of intelligence itself and how this can be quantified or expressed through the use of measuring instruments. The use of the term ‘IQ’ is now an accepted part of the English language and informs our perception of what intelligence ‘is’.

In examining intelligence Schlinger (2003) has noted the movement away from standardised mathematically based intelligence quotient tests developed and favoured by Binet (1904) initially and continued and refined or re-developed by Spearman (1927) completing a fuller factor analysis where the ‘g factor’ was identified by a factor matrix examining correlations within and between factors. The ‘g’ stands for general and refers to the measure of ‘general intelligence’ which Spearman extracted from a multi-variant analysis model of correlation coefficients. The figure produced at the conclusion of the analysis is the measure of general intelligence possessed by an individual. Again the mathematical content is not confined to the analysis and the ‘test’ still had a heavy reliance on logical mathematical intelligence quantifiers. Sternberg (1984) represented a movement away from the very defined and quantifiable intelligence tests, presenting a tripartite model of intelligence made up of analytical, creative and practical aspects.

Intelligence is a label for behaviours exhibited in certain contexts, rather than being a definable set of knowledge or characteristics. The better the performance of a person in these IQ style testing situations using this type of mathematical and logical subject the more intelligent they were deemed to be. The public image of intelligence and the behaviours and knowledge that are related to ‘it’ are shaped in part by this history and underpin the idea that mathematical intelligence equals intellect: if you can do calculations correctly you are clever, if you can understand algebra then you are really intelligent.

Woodrow (2003) saw the change of language within mathematics to the descriptor ‘numeracy’ as demonstrating a shift in curriculum for ‘the many’ whilst ‘the few’ remain in control with their study of the much more valuable ‘mathematics’. Ideologically this may or may not be the case
but in England legislative measures have led to GCSE mathematics being the aim for all students and very limited numeracy elements being available. This could be seen as an equitable measure of distribution in society through the supporting elements of funding requirements and the raising of the participation age.

Everyone has the same entitlement and is encouraged through the supporting aspects to take up the appropriate qualification. Woodrow would be right in the assumption that mathematics has a possibly higher status in terms of perception at least, but wrong in the assumption that it is restricted in terms of opportunity for all in England. Woodrow questioned the result for those students who had taken the time and taken tests but did not benefit or pass when the subject of mathematics was used as a ‘gatekeeper’ to indicate intellectual ability. This approach presumes that mathematics is used as the main streaming subject as an indicator of intelligence and therefore is perceived to have a higher value to society in general than other subjects. Different occupations or professions require higher levels of mathematical knowledge and attract higher rewards because of this.

Current Government legislation is attempting to recruit and keep mathematics graduates as teachers in England. This has traditionally proved difficult because those graduates are tempted to work in finance or the private sector where personal remuneration is likely to be significantly higher for them. The Department for education (online, 2015 P. 4) states for 2015/16 applicants to the teaching profession:

‘Good maths teachers are always in demand. So when you train to teach the subject, you can benefit from the highest range of training bursaries available, or a scholarship if you have a top degree. Plus, a career in maths offers the job satisfaction of giving all young people the chance to conquer a subject that’s integral to their long-term success.’

The bursaries and scholarships on offer are up to twenty five thousand pounds. This high level of funding for student teachers is being offered because mathematics is seen as a subject in high regard and the subject offers a high level of mobility, a maths degree can provide a high financial return. Demonstrating dramatically that mathematics is, as Woodrow (2003) pointed out a subject regarded as a ‘gatekeeper’ denoting intelligence and power. Where people ask for help or support with a subject this indicates a lack of knowledge and power, where they are offered huge incentives this indicates individuals being invested with power.
Within both phases of research significant amounts of help were requested by people posting in the educational forums and on the electronic bulletin board in the case study for phase two of the research asking for support and guidance, this included asking for information on the requirements to teach and asking for advice and any available sign-posting to support the numeracy test for professional skills. This indicates that people want information and that they find mathematics, numeracy, teacher training and teaching areas where they struggle and need support.

'Any advice on the numeracy test? And trying to take in information that seems to just be being thrown at me!'  
Comment taken from forum postings

Here one individual clearly felt under pressure from the sheer amount of information to take in whilst completing teacher education; however the question about the numeracy test was the first sentence indicating that in any hierarchy this is the most pressing aspect of the question, with the second sentence quantifying the original question and acting as a subordinate clause. Mathematics is something that can be a struggle with at any level. This may be a perception or a reality, regardless of which it is, the negative result is the same for many people, they struggle, they fail and they develop a negative self-perception of ability.

'Does anyone know what numeracy content there is in a Level 2 Health and Social Care course please?'  
Comment taken from forum postings

When mathematics is used to measure their level of intelligence then those who do not work well with mathematics or numeracy will be seen as lacking in skills, ability and intellect.

4.4 A hatred of numeracy

One strong recurring negative theme throughout the data through both phases of research was that of 'hatred'. Hate is a very emotive word and conjures up the ultimate negativity.
Overwhelming negative feelings about mathematics and numeracy as subjects involving hatred and the other negative feelings these subjects evoke are demonstrated by collected comments, in this case especially from the forum data collected in phase two. The sheer number of comments that were coded as negative feelings codes (sixty four in total) indicates that the subject area is really emotive for those people responding in forums or posting comments. The codes allocated to the comments collected included codes related to feelings of hatred for mathematical or numerical tests and despair at not being able to pass the professional skills numeracy test.

The tones of these passages from conversations are negative in a very emotional sense. The tone suggests disappointment and fear and the language relating to the individuals emotional state and view of themselves is pointing to a negative view of mathematical ability impacting on and creating a negative self-view. The words used: ‘seriously upsetting’ ‘failed’ ‘panic attacks’ and ‘inadequate’ all point to the negative view of a subject and an individual’s experience of it being internalised.

‘The numeracy skills test is seriously upsetting me. I have had a number of attempts. The last time I failed by 1 mark, and I revised so much.’
Comment taken from forum postings

‘The reason for my failure were panic attacks brought about by years of feeling inadequate at maths at school.’
Comment taken from forum postings

The vocabulary used in many aspects does not point to individuals who struggle with their cognitive agility. The words have been recorded where possible verbatim so some aspects of speech are present including abbreviated language and some colloquial terms being used. The use of the word ‘inadequate’ for example points to an individual with a well-developed vocabulary and a clear ability for self-expression which is succinct and accurate. This doesn’t fit well with an individual who has a negative self-image of their numerical skills.
The results of coded information from the observed and recorded comments of participants in the functional skills mathematics CPD programme in phase two of the research demonstrated similar levels of negativity to the forum comments collected in phase one. LIWC analysis demonstrated that the information contained the negative emotions and social words of formal texts, the overall cognition of personal texts and the use of large words conforming to personal texts, indicating that this information was more personal than formal overall. This does correspond with the information in context, when taken as a whole the comments related to feelings and are clearly informal and clearly highly negative in their nature.

Fourteen specific passages related to direct statements of feelings about maths and included codes that refer back to comments about ‘hatred’ and ‘fear’.

<table>
<thead>
<tr>
<th>‘oh I hate this, it makes me cringe’</th>
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<tbody>
<tr>
<td>Comment taken from observation</td>
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<tr>
<td>‘I hated maths at school and that’s where I’m coming from. I am willing, you know, I will do it, but you need to know that I just hate it.’</td>
</tr>
<tr>
<td>Comment taken from focus groups</td>
</tr>
<tr>
<td>‘I hated maths and I hated going to school’.</td>
</tr>
<tr>
<td>Comment taken from focus groups</td>
</tr>
</tbody>
</table>

The word ‘hated’ is repeated twice in this short sentence representing more than twenty percent of the whole sentence, the word is repeated for emphasis but in both contexts of school and mathematics. This is a compound sentence with the hating of school being referred to in the subordinate clause, the implication being that the individual hated school because they hated maths or that hating school was reliant on hating maths. Mathematics and numeracy are closely linked or used as interchangeable terms by many. Here a hatred of mathematics is being viewed as closely allied with similar feelings for numeracy.
Sam (2002) discussed the public image of mathematics and addressed the very negative view that pervades society in general in terms of this subject and its ‘public image’. The negative attitude is seen as being made up of the two main domains of cognitive and affective relating to a person's knowledge, beliefs, attitudes, feelings and emotions. From this standpoint, a negative view can be made up of so many parts of the person that this is likely to be very difficult to change effectively. The public image was presented by Sam as made up of a collective negativity which encompassed the subject being described as ‘difficult, cold and abstract’.

'It said you are going to fit a carpet and you need to measure up the area of the room. I would never ever do that, I would never go round the room with a tape measure and then ask for this many square meters of carpet, who would do that, you would ring up a carpet shop and get them round to do the whole thing - that is the sensible thing to do. On the paper I just wrote, 0774866577 or whatever and then put next to it: number of an excellent carpet fitter’.

Comment taken from observation

This passage of text collected uses humour to cover a possible underlying anxiety. There is a kernel of truth in the statement since the context of the maths problem doesn’t represent a realistic situation for the person applying their maths skills to it. An irrelevant context is as meaningless as no context at all. Using humour to cover our feelings of inadequacy is very common with adult learners and trainee teachers learning mathematics, including using self-deprecation as a way of deflecting negative feelings.

In the staff development mathematics program some individuals present a relationship of avoidance with anxiety and negative feelings. Avoidance is not confined to the subject itself, the actual exam is also avoided where possible for many, avoidance of any involvement in maths classes being high, which is supported by the forum comments from phase one of research.

Very negative feelings towards mathematics have been explored by others researching in the field and keen to change the situation for future generations of students in classrooms. Ransom (2012) examined the question of how schools can help to change a negative attitude to mathematics for students in classrooms. He identified that the biggest barrier to learning in mathematics and numeracy is produced by the inherent attitude towards the subject of mathematics being an overwhelmingly negative one. Ransom calls this the ‘attitude barrier’.
Positive or negative attitudes are a prerequisite to change and action and Ransom describes the UK attitude to mathematics as: ‘dismissive’, which has contributed to many young people and adults accepting that it is okay to be bad at mathematics.

Widespread negativity towards mathematics was described by Ashby (2009) as appearing in many forms; he described misrepresentation in the media and the social stigma that seems to surround those who are mathematically gifted as two examples of this pervasive negativity surrounding mathematics. Ashby’s focus was on determining the causes of negative attitudes towards mathematics as a subject. Ashby discovered that the application of mathematics was difficult for many children to discern clearly, if tasks lack any context and do not appear to have any practical application then students start to lack motivation. A lack of self-belief was also observed in low achievers and a lack of understanding of mathematical language. All of these factors contributed to a negative attitude towards mathematical learning.

Jones (2012) reported in the news media on attitudes to mathematics and numeracy. Jones essentially asked questions in her article related to the idea that primary school children did not suffer from a ‘hatred’ of mathematics whilst secondary school children did. She concluded that the way the subject is taught, coupled with the way it is learned and a failure to attract talented and creative maths teachers to the profession plus a negative attitude to the subject area and the possibility of teachers passing on their own lack of enthusiasm for the subject to their students, all played a part in that ‘hatred’.

Past experiences of maths and numeracy learning, learning environments and teachers of mathematics were reported as extremely negative and highly emotive. These included many negative past experiences described by focus group participants in phase two of research, centring on teachers and school maths learning which has a longer lasting impact than would be expected for individuals, especially those who have higher level qualifications in other fields.
This comment from observation in the second phase of research has a lot in common with the data collected from forums initially in phase one. The overall tone is very negative and very emotional. The specific words used are also negative: ‘fear’ ‘terrible’ ‘humiliating’ ‘hated’. The word ‘hate’ or ‘hated’ is repeated through the different forms of data collected in the context of learning mathematics, taking mathematically based tests or exams and performing numerical tasks.

Generally individuals compared the course provided for staff development in functional skills mathematics from the case study favourably to mathematics in school – some harrowing individual accounts were hinted at and in some cases briefly presented to the individuals attending different focus groups.

This refers to a common practice in earlier twentieth century education relating to mathematics and numeracy. Negative reinforcement such as the ‘slap on the leg’ referred to above used in conjunction with humiliation produced by ‘standing on a chair’ in front of the rest of the class being used to punish a student and force them to conform to curriculum requirements. It would be easy to hate the person responsible for these feelings and experiences and by proxy hating the subject that was responsible. One of the bigger reasons people have cited for their ‘hatred’ of mathematics and numeracy is the way the subjects are taught for them, especially with reference to past methods of instruction. This is clearly demonstrated by a reflective piece written by Anne Miller, entitled ‘Learning to hate mathematics’ from the USA, the language that

\[
\text{‘I have a real fear of maths, I mean it. You know we had this teacher, did you go to that school as well? Was he there when you were? He was terrible - he made you stand up and recite the times table - honestly - no word of a lie. It was humiliating. I hated it. I hated him’}
\]

Comment taken from focus groups
she uses is inherently negative and includes the word hate a disproportionate number of times in the text:

'I started to dread arithmetic……struggled with math…..began to hate math….years of hating math……grew to hate……but I never understood……math grew worse……mathematics seem irrelevant and dull……that awful math feeling……forced us to participate……a terrible fear and hatred of mathematics……There was no joy..’

As a mathematics and numeracy teacher and teacher educator this makes very sad reading. That anyone could feel such a level of negativity for such a beautiful and essential subject is really unfortunate, especially when we note that for the writer of this account the hatred of the subject continues well into adulthood without anyone’s intervention to stop the problem in its tracks or make any attempt to reverse this negativity. From this redacted excerpt from the account of Anne Miller we can see that several different aspects are recounted that have contributed to her learning to hate mathematics, ‘hatred’ that she repeats several times. A compound effect can also be seen where each action and reaction and results in a hatred of mathematics for an adult grown out of a very disillusioned student.

4.5 Negativity demonstrated by a lack of information

Online prospectuses from teacher education providers were examined to establish how mathematics and numeracy entry requirements for teacher training in both sectors were presented. Using online prospectuses to identify the information provided for trainee teachers on entry requirements, text was collected which related directly only to the entry requirements and only to these subjects. Many passages related only to general entry conditions and did not include mathematics or numeracy.

‘This course is for people already teaching in the Lifelong Learning sector or for people who wish to teach in the post compulsory sector. Candidates must hold a professional qualification at Level 3 (or above) in the area they wish to teach in’

Comment taken from HEI online prospectus
The texts refer to other entry requirements, relating to other subject specific qualifications and provided much more generalised criteria for entry to their teacher training courses. The criteria mentioned are valid but simply omit any mention of mathematics or numeracy.

‘Graduates holding a degree from a UK higher education institution (or an equivalent qualification) CertEd candidates should hold vocational or professional qualifications at NVQ3 or equivalent in the subject they are teaching and hold significant work experience in the area in which they teach.’

Comment taken from HEI online prospectus

Institutions have outlined their requirements clearly but still provided ‘room for manoeuvre’ with terms being used like: ‘a professional qualification’ or ‘an equivalent qualification’ allowing for a plethora of different but suitable qualifications to satisfy entry criteria for undertaking teacher education for the post-compulsory sector. This is likely to be in an effort to reach the widest audience or to be available to the widest audience, including those without strong mathematical skills.

These institutions have omitted the requirement for mathematics or numeracy skills and in some instances have omitted to mention the requirement for any functional skills, GCSE level maths or English.

‘A good standard of academic skills are required as assignments and essays have to meet higher education standard’

Comment taken from HEI online prospectus

This can be interpreted as an attempt to avoid the mention of these areas to ensure that prospective candidates do not experience a negative reaction to the subject areas, ascertained as a phenomenon through the other strands of research presented here. People do exhibit very negative feelings, views and opinions related especially to numeracy or mathematics and so presenting these skills as a requirement would clearly be seen as ‘off-putting’ for some prospective trainees. It seems to be an approach adopted in different ways by different institutions. Several institutions have opted for vagary as an approach to the functional
numeracy or mathematical skill requirements. This indicates that the institutions themselves believe that mentioning mathematics or numeracy will be off-putting for potential candidates.

Several institutions opted for information related to English mentioned as an entry requirement, but without mention of mathematics or numeracy requirements for teacher training course entry.

| ‘A good level of English (level 2 equivalent) Competent IT skills’ |
| Comment taken from HEI online prospectus |

| ‘You need to have five GCSEs at grade C or above (including English Language or equivalent)’ |
| Comment taken from HEI online prospectus |

| ‘Students must have GCSE English or equivalent on entry to the course and Mathematics on exit of the programme’ |
| Comment taken from HEI online prospectus |

| ‘GCSE (or equivalent qualification) in English and Maths to Grade C or above, (or be prepared to work towards them)’ |
| Comment taken from HEI online prospectus |

The first institution presented here has included both English and ICT, leaving out numeracy or mathematics only. A clear indication that either mathematics is not considered important or is considered to be too daunting to include. The second passage refers to the five GCSEs required and that one must be English language but again omits the mathematics requirement. Seventeen other passages related to English mentioned as an entry criterion or requirement but the institutions did not make any mention of mathematics or numeracy at all.
The implication is that English is important for completion of the course and the skills taken from the use of English are relevant but that mathematical skills are not important or that they are not relevant to the course content in teacher education. This is further developed with passages which related specifically to English very clearly presented as an entry requirement, but mathematics can be achieved by the end of the course or needs a commitment to achieve by the end of the course. This demonstrates that English skills are seen as essential for teacher education in the UK, mathematics or numeracy skills are still a requirement, but individuals can be given more time to achieve. This represents a widening out of the entry criteria which offers flexibility but also provides more opportunities for a higher number of applicants:

`GCSE English, or equivalent on entry – Mathematics GCSE equivalent on completion`
Comment taken from HEI online prospectus

The prospectus text above makes it clear that developing mathematics skills or working towards an appropriate level of numerical skills is one approach that is used to avoid the necessity of mathematics qualifications being used as part of the entry criteria.

This makes it easier for individuals to apply for teacher training in the post-compulsory sector as they can apply and start a course of teacher education before they have completed mathematics GCSE or the equivalent functional skills certificate. Being ‘prepared to work towards’ a skill is very different to actually having that skill before you start.

There are also conditions of entry which provide an alternative to actual English and mathematics qualifications or certificates. These passages refer to an alternative being offered. For instance individuals can take initial assessments or diagnostic assessments for mathematics or numeracy when entering the course initially:

`You will have an initial assessment to indicate that you are working at level 2 in English and maths`
Comment taken from HEI online prospectus
Here, English or literacy are presented first, indicating that numeracy and mathematics are secondary or subordinate to the English and literacy as they are presented as secondary or subordinate in each of the sentences. This gives the impression that numeracy or mathematics is not as necessary, not essential for teacher training.

| ‘Completion of a Literacy and Numeracy assessment.’ |
| Comment taken from HEI online prospectus |

| ‘Students must have GCSE English or equivalent on entry to the course and Mathematics on exit of the programme’. |
| Taken from prospectus information for a post-compulsory teacher training course |

The need for a secondary level of English on entry to a PCE course as a minimum is not in dispute, but the requirement for mathematics to be completed by the end of the course, is in effect expressing this requirement as additional or as being subordinate to the English qualification. The need for mathematics here is clearly not as ‘pressing’ as the need for English, maths here is seen as second best, implying that it is not as relevant and clearly not as useful. Mathematics is being played down in a sense, providing more time for completion is acknowledging that prospective trainee teachers may experience angst about the subject.

There were mentions of QTLS in the corpus text that was analysed. This was mentioned as part of the course on exit for those training in the post compulsory sector. Mathematics and numeracy were not mentioned in the same prospectus information. The completion of QTLS in the post-compulsory sector requires evidence from the applicant of level 2 numeracy skills with either a GCSE C grade certificate or a level 2 functional skills certificate. The claim from the passage is not false in any way; it simply omits the additional information relating to mathematics or numeracy requirements. This omission indicates that gaining something (QTLS) should not be compromised by losing something (the interest of those trainees who do not have well developed numeracy skills)
The most interesting passage from the prospectuses related to mathematics or numeracy being presented as a learning problem or difficulty. A lack of numeracy skills has been grouped with dyslexia as a need and support is offered.

‘Our Skills for Life support ensures that any student with English as a second language, or Dyslexia, Literacy and Numeracy needs are offered specialist support to make sure that they stand the best chance of passing’

This is presenting trainee teachers’ numeracy requirements as a learning difficulty and implies dysfunction. Students with a statement for dyslexia are afforded learning support which may include a scribe or extra time in examinations, a support worker in class and/or in examinations, colour overlays for white paper or the printing of examination papers on coloured sheets. These concessions are not provided for individuals who have not yet achieved numeracy certificates.

The very different elements of dyslexia, ESOL needs and numeracy do not fit together in the way they are presented here. The language used indicates that numeracy is being presented as a problem or difficulty which is offered ‘specialist support’ and ‘support’ to help individuals get ‘the best chance of passing’ implying that they may not pass without help or support.

The link between students with learning difficulties and disabilities are often grouped with those learners who have a gap in their numeracy learning is echoed by the review of further education completed by Lingfield et al (2012):

‘Introduction of revised teaching qualifications for staff, including those teaching literacy and numeracy or working with students with learning difficulties or disabilities’ P. 35

The passages analysed from online prospectuses, examining teacher education courses can be categorised clearly as those that mention numeracy and mathematics as an entry requirement.
and those that do not. Ninety five prospectuses from the one hundred and thirty six institutions examined made no mention of numeracy or mathematics as a course entry requirement for initial teacher training in the any sector. The majority of prospectuses do not make any mention of mathematics or numeracy as an entry requirement for their teacher education courses in either the compulsory or post-compulsory sectors although this is more prevalent for courses in teacher training for the post-compulsory sector.

The underlying theme of the information from prospectuses appears to be that institutions do not want to mention numeracy or maths in an effort not to ‘put off’ prospective students, clearly believing that numeracy is an off-putting subject that conjures up very negative connotations for prospective trainees.

It is also possible that the different educational institutions do not value numeracy as much as they value literacy skills (they do not see these skills as being as useful as literacy skills in programmes of initial teacher education). This is most apparent from the passages related to English mentioned as an entry requirement, but with no mention of mathematics or numeracy requirements for teacher training course entry. It is clear from these requirements that mathematics or numeracy has actually been actively omitted from the entry requirements since English and literacy are clearly presented as a requirement of entry.

It may be that numeracy skills are omitted from prospectus entry information in the interests of clarity. Institutions need to set out the basic structure of a course but within suitable constraints, production of a prospectus is costly, each word has a cost and numeracy may have been sacrificed to make space for other elements deemed ‘more important’. The results from LIWC analysis confirms the very positive image that institutions want to promote in their prospectus information. No negative language detected at all from the corpus analysed. It is likely that numeracy and mathematics are seen as negative or may have negative connotations and so are omitted.

It appears that the data from higher education institutions providing initial teacher training for the post-compulsory sector has a directional and purposeful underlying negativity. With ninety five of one hundred and thirty six codes allocated to the corpus reflecting no mention of mathematics or numeracy as an entry requirement, other codes presenting English and literacy as an essential skills set on entry to the courses. With no negative language identified by LIWC
at all in the corpus text, implying the need for a very positive presentation which does not contain numeracy, it appears that the institutional standpoint is that numeracy requirements to enter teacher education are seen as very negative and off-putting for applicants.

4.6 No discussion, the lack of a trace element

Other indicators demonstrate a type of negativity in a general sense. The following two posts from forums relating to minimum core numeracy were collected during the initial stage of research on forum postings. In itself this indicates the lack of a trace element. These posts are part of a very small sample as so little data was available during the search. These posts are typical of the questioning nature of the postings that were found generally relating to minimum core numeracy. Between the questions being posted on the dates 08/07/11 and 28/03/07 respectively and the date of access of 23/12/11, no replies had been received. When returning to this data in 2014, there had still been no reply.

The significance of these types of posts having no reply is placed into context when compared to postings in the area of QTS (now professional skills tests) numeracy posts, all postings did receive answers and the postings and online conversations contained in the forums other than minimum core were significantly lengthier.

'I have just had my first tutorial on my PCE PCET course. We had to do online level 2 literacy and numeracy tests and print out the results. My tutor has now advised me to look at doing a level 3 numeracy test (I want to improve my numeracy skills).

Does anyone know where I would do this. I have been looking online but not found anything yet.'

Comment taken from forum postings
There are many different possible interpretations of the limited amount of data available relating to minimum core numeracy in the post-compulsory sector: It is possible that the minimum core of numeracy had such limited impact that it generated next to no conversation and trainee teachers, teachers and teacher educators in the post-compulsory sector have not generated any strong opinions or perceptions about this area of initial teacher training. It is also possible that no-one experienced any particular difficulty in teaching or learning of the minimum core of numeracy and so again little or no opinion has been generated in this area. It is clear from the zero responses that no-one had any input to these posts. They generated no responses in one instance, over a period of several years. This indicates a general negative direction in the sense that no help was forthcoming at all. People either didn’t want to respond on this subject or were unable to do so, both situations provided negative indicators.

4.7 Chapter summary

Negative comments and feelings expressed through the course of the research emerged in three main categories, standards, mathematics being used as a measure of intelligence and a hatred of mathematics and numeracy being reported.
In terms of standards the opinions expressed were very negative and scathing towards trainees who were struggling with the professional skills numeracy tests in forums. Trainee teachers had expressed their hatred of these tests and their seeming inability to pass the tests being very frustrating. In reply, the issue of standards of professionalism in teaching was brought up and those trainees that struggled with the test were negatively branded as unsuitable for teaching since this was presented as unacceptable to other members of the forums.

The perceived need to provide reasons for failure, for a lack of achievement or to account for underperformance in mathematics and numeracy was also pointed to as negative. It appears that there is no conflict here, that the perception is clearly negative is a feature running through all the data collected and all the results would appear to support this, however there was a significant dichotomy in terms of the different opinions presented, although they demonstrated a negative slant it could not always be clearly determined whether it was the subject itself of mathematics or numeracy that was the difficulty or examination fear, stress or prior experiences of failure that produced the negativity. All of these aspects conflict with the individuals desire to complete their teacher training and to be successful in their vocation.

Mathematics and numerical skills are used as a yardstick to measure intelligence and leaves some people feeling that they simply do not measure up. This can be reinforced by the negative views of others found in the forums who measured trainee teachers against professional standards in a negative sense. Sam (2002) pointed to negative views held by pre-service teachers influencing the image of mathematics for their students. This was due to those teachers being subject to the same negative views of mathematics as any other people in society at large. They hold the same opinions as others, including that ‘mathematics is difficult’ and ‘mathematics is computation’.

The finding of negativity contributes a good deal to the findings of the research overall. Negativity towards mathematics and numeracy may be expected generally, however here we can see that this pervades our teachers and trainee teachers significantly. For those training to teach the next generation in schools and for those lecturing on higher courses in colleges and universities this represents a problem.
A high level of negativity clearly runs through the findings from the research conducted through both phases one and two. Although not surprising that people react to mathematics and numeracy in a negative way, the depth of the reactions is shocking. The use of the word ‘hatred’ or variants of ‘hate’ are repeated so many times that this level of negativity is really significant. Negative views of the subject were prevalent but going deeper than this within individuals ran a negative self-image related to the feeling of being incompetent in the subject or lacking confidence in their skills. For many this has been the case from childhood and has continued into adulthood.

Negative feelings were attached to the negative past experiences of individuals, their lack of confidence in their own skills and significantly the negativity could also be linked to seemingly positive comments, people expressing surprise at passing assessments, for instance, indicating they did not have confidence in their ability to so. Hayes (2003) examined the emotions of trainee teachers more generally rather than related to mathematics or numeracy alone, finding a high level of negativity which was described as ‘striking’ and concluded that teacher education needed to take these emotions into consideration. The negative terminology which Hayes identified included specific terms such as: ‘distinctly worried’ ‘plagued my mind’, and ‘trepidation’ which agrees clearly with the research findings here.

The theme of negativity is present in the HEI data collected, looking at the prospectus comments that have been coded. Mathematics gets very little mention, in an effort possibly to avoid the negative and anxious feelings that this subject creates, most interesting are those codes which relate to English being clearly stated as a course entry requirement but not maths and similarly the code (only one, but interesting) that equated a lack of maths learning with a learning disability.

Higher Education Institutions have made the decision that numeracy and mathematics is negative in nature or creates negative feelings as a subject area and at the very least will prohibit prospective trainee teachers from applying for their courses. Evident by the omission of numeracy, which can be very clearly seen where English and literacy skills are mentioned, but zero mention of numeracy or mathematics is included.
These themes run through all the different coded sets of data from QTS forums to focus groups taken from the case study, within all stages of the research work, forming a large quantity of data that point towards the same negative direction in perception and opinion each time, from the ordinary person in the street to those people training to be teachers, to those teaching and finally to those training the teachers.
5.1 Chapter introduction

The research findings overall pointed to a great deal of conflict being experienced in relation to the subjects of mathematics and numeracy. This lies between standards and professionalism, a lack of skills and the depth of teaching required, conflicts in language and learning and finally a conflict between what is required to implement a subject area (teachers’ numeracy) and what is available to practically do so.

Conflict demonstrated between the maintenance of high standards as part of professionalism and the expected personality traits of altruism and empathy that are associated with being a teacher were clear in the forum data analysed.

The perception that low standards are perpetuated by poor quality teachers was a very strong theme in the data collected from forums. Some comments made by teachers are very scathing. Professionalism appears to be a real concern, standards comments and codes represent double the comments and codes of any other area within the initial stage of forum research data analysis.

A conflict between the lack of skills demonstrated by some individual teachers and the depth of teaching required was very interesting with some people expressing the opinion that those teachers who struggled with numeracy may have a better understanding or a more creative approach to teaching mathematics and numeracy to students who struggled with the subject also.

There is a strong conflict between the attitude and opinions of those who are able and competent in numeracy and the level of understanding that they will have to demonstrate towards those who struggle with this subject as their students or as their colleagues. Conversely there is also the conflict that some teachers who struggle with mathematics and numeracy may approach the subject in a more understanding and effective way for their students who also struggle.

More conflict was identified in the prospectus information of higher education institutions, producing information for prospective teachers considering training. There is an identifiable dichotomy
between the necessity of including entry requirements and the possibility of the information being off-putting or negative in nature.

The ‘embedding agenda’ also creates conflict, the need to draw out embedded numerical skills from other subjects’ conflicts with the practicalities involved and the depth of knowledge required to do so. This is coupled with the conflicting feelings experienced by trainee teachers between their possible fear and discomfort related to their mathematical or numerical skills and their desire to succeed. Conflict is a strong theme emerging through all the different data collected and analysed.

5.2 Conflicting Standards

A real conflict is clear between the comments which are supportive and provide advice and guidance and the comments that reflect teachers’ views on standards when analysing forum data. It seems that it is difficult to reconcile some of the traits that are viewed as being representative of being a teacher (empathy, sympathy, and a supportive nature) with the perceived professional side of being a teacher and the adherence to high/professional standards that this implies including knowledge, presentation, efficiency and effectiveness. This does filter through some of the other comments from different sets of results in focus groups within the second phase of research and observational comments which form a real theme that wasn’t wholly apparent through initial stages of research or coding work and merited more investigation. Although ‘standards’ was picked up in the initial collation of comments for forums, it did not appear to have the volume that has since become clear or represent the conflict which can so clearly be seen through the data in more thorough analysis.

The teaching profession contains several conflicts within the role itself for the individual. The need to manage behaviour in a classroom conflicts with the need to foster positive appropriate relationships which themselves must maintain an appropriate distance between teacher and student and must be clearly defined as a professional relationship which is not a friendship but must
include trust and respect. This demonstrates one aspect where conflict is clear for the teacher and the complexity of what is required as part of the role in the classroom. The conflict between professional standards and personal qualities follows a similar route and is fraught with the same type of complexity for the individual. Orlando (2013) identified the characteristics of great teachers and included elements which could be considered the ‘nature’ or personality traits of a great teacher as warm, accessible, enthusiastic and caring.

These are the traits that are generally expected of teachers and teaching is portrayed as a caring profession. This conflicts really clearly with the need for professionalism and the maintenance of high standards that are also expected from teachers. The conflict is made clearer by the comments:

- **Comment taken from forum postings**
  
  However, if the teaching profession is to retain or improve standards then I feel the relevant qualifications should be obtained in teacher training.

- **Comment taken from forum postings**
  
  I think the OP needs our support and knows her own weaknesses. Let's not judge- I think by even posting on here asking for help she is showing her commitment to improving.

- **Comment taken from forum postings**
  
  If you dont feel 100% confident that you understand yourself what you are teaching you wont be an effective teacher, simple as.

This data supports the idea that mathematics acts as a ‘streaming’ subject – if you are good at maths you are clever and if you are not, then you are not. This also supports the proposition that improving maths skills improves confidence, those that believed they had stronger numeracy skills in comparison to others also behaved in a more confident fashion.
In terms of teacher identity and the way human beings see themselves, anxiety appears when ‘control’ is threatened, essentially when we feel threatened in the sense of our ego, or identity rather than just threatened in a physical sense (Jacoby M, 1997). This anxiety is linked to our knowledge of our own vulnerability in a subject area like mathematics or numeracy or gaps in our knowledge. Those individuals, who are surprised by their success in assessment, are expressing relief that their control is maintained and their ego remains intact.

There was a strong indication that although there are many individuals who insist that numeracy is necessary (in standards comments from forum postings for instance) there are also those who believe that there is no numeracy in teaching, English is clearly more important and drawing out embedded elements of skills for life (termed SfL below) in vocational programs is ‘irritating’.

<table>
<thead>
<tr>
<th>'I’m getting a bit ‘narked off’ with SfL. I mean... I know some learners have SfL needs and we as managers, teachers/tutors/facilitators should be supporting learners/students to address these needs and signpost accordingly.'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment taken from forum postings</td>
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Comments taken from the e-bulletin board in the case study referred to skills importance. All the staff involved were asked to formally identify the math skills required in their own vocational teaching area using the e-bulletin board for their responses.

<table>
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<tr>
<th>'When reading plays and music, counting in dance, writing evaluations and assessments, when talking with students and staff, course planning, preparing statistics for self-assessment, calculating viability of courses, budgeting for staff and productions - basically what would be expected for holding down a graduate level job.....'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment taken from e-bulletin board</td>
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This material was solicited rather than spontaneous and so may have little value since the responses were designed to satisfy criteria. This did make people think about what they did in their vocational teaching areas, beyond this the truthfulness of responses is difficult to ascertain or analyse effectively.

The type of language used in the varying forms of interactions and the meanings, tones and inferences are in conflict with each other. The different forms of analysis used indicate that the differences in formal and informal language used, the levels of emotion used and the actual words used, leads to the question of how realistic or genuine some of the exchanges are.

5.3 Conflict between lack of skills and depth of teaching

One interesting conflict related to the opinion presented in the forums that those with lower level numeracy skills themselves may make better teachers as they have a greater understanding of the problems that their students face when learning this subject. This is really interesting because those with poorer mathematical or numerical skills, those who had really had to work at this subject to be successful, would possibly have more empathy with students who share the same experience. It does rely on individuals having conquered their fears and having become proficient with the subject. There is also the possibility that people are not able to judge their own ability accurately and are actually proficient and therefore are able without a great deal of work or effort and have simply under-estimated their own ability.
It is possible for teachers to empathise with a student’s lack of mathematical skill or reasoning, but is empathy alone of this type likely to enhance learning for the student? A very interesting view propounded in the forums, however this was not reflected in the research findings elsewhere.

The perceptions through these statements pointed to the idea that some teachers may turn a lack of numerical competence or confidence to their advantage, using their empathy and their own struggles with mathematics or numeracy they will have more understanding of the problems that students face learning in this area.

‘Indeed, it may help them to better understand the difficulties that many pupils experience with mental calculations and lead them to adapt their teaching accordingly.’
Comment taken from forum postings

‘The best maths teachers are not, necessarily, the ones who find maths ‘easy’.
Comment taken from forum postings

This view also has the sound of a sympathy judgement, or possibly genuine empathy. It reads in the conversations that individuals are trying to act as mediators, to find some positive aspect where there appears to be none. It is possible that in expressing this opinion, these individuals are not experiencing any conflict. They are not measuring what they think they should say against what they feel themselves and then again against what they think they should be seen to say by others. It is possible that these individuals are the only individuals who are not conflicting in any way between their own value base and experiences and a professional value base that indicates the type of values that they should be seen to express. Limited instances of comment make it very difficult to analyse fully or effectively.

Thompson and Goe (2009) examined what made an expert teacher and what did not, with the aim of improving professional development for teachers. They referred to Berliner’s 1994 study where
the speed of cognition in an expert teacher was presented as markedly faster and qualitatively, it was noted that expert teachers could identify patterns in their own practice and in the situations occurring in their classrooms, producing an effective and streamlined approach to learning that held significant gains for students. Speed of cognition and the identification of patterns points to a well-developed set of numeracy skills and a strong ability or mastery of conceptual manipulation in the expert teacher, not available to the non-expert without well-developed numerical skills.

Orlando (2013) wrote about the characteristics of great teachers and started with the premise that subject knowledge alone was not sufficient, tying student gains and the perception of a ‘great’ teacher to teachers’ attitudes to students and to their work role. This appears to agree with some of the forum comments that identified some teachers who may be poor at mathematics and yet be ‘better’ teachers than those that have a stronger knowledge base. Orlando went on to identify the nine characteristics that she proposed were the foundation of a great teacher. This included respect between students and teachers, high expectations and a love of learning. The maintenance of professionalism was also one of the characteristics outlined by Orlando but there was no indication of exactly what form this takes. Here Orlando diverges slightly from the warm and comforting proposition that to be a great teacher we need not have strong subject knowledge as other skills may be more important. However, the concept of professionalism infers being highly qualified in terms of both generic teaching and subject knowledge.

Setting high expectations for students implies that the teacher has a clear and solid knowledge of the baseline performance of their students and their projected progress as well as an in depth understanding of the national (and possibly international) comparison progress measures to be able to assess a student’s performance and progress accurately. This is not an unusual task for a teacher; this type of assessment of progress is a normal part of daily tracking and monitoring for student progress.

Many individuals examined through their comments in the data present numeracy or mathematics as important skills and knowledge for teachers to have. Whilst others are faced with a numeracy QTS test or a functional skills level two maths test, protesting that the test has no significance, that
it is ‘pointless’ or unnecessary. These individuals have a fear of failure that they may experience, they have negative memories associated with the subject from prior experience and they have the thought that they will be ‘found out’ as fraudulent in the sense that if they cannot do the maths, then they are not clever enough to be a teacher. All of this will affect the responses and the performance under pressure for mathematics or numeracy tests for individuals.

For those that are confident in their numerical skills there also exists a conflict of interests. They are less likely to understand the feelings of those who cannot (or do not) complete numeracy skills tests easily, they are also unlikely to understand in any depth those students who struggle with numeracy skills. They will be capable of providing the solutions to problems for students but not of understanding the reasons for there being problems in the first place. This is a really noteworthy conflict which is supported by the data from forums and observation comments in the case study. Those confident in their mathematical and numerical skills attended teachers’ maths classes in CPD to demonstrate their skills, rather than to learn. They also wanted to rush through the tests to demonstrate that they could do so (achieving superiority) and very clearly demonstrating their worth as teachers. This may be due to individuals simply demonstrating their human nature as ‘survival of the fittest’ but these individuals also demonstrated little understanding of others problems with the subject.

The same strand of conflict ran through forum comments with individuals expressing their disgust with those who could not pass the numeracy professional skills tests and using scathing comments to express this opinion. Lenon (2015) asked what really makes a good teacher? He identified four main characteristics the first of which was that they love their subject and have excellent subject knowledge, it is impossible to love something that you know very little about. Secondly, they need to have the right personality and this includes the ability to manage a classroom effectively and take control of all situations. Lenon (P.1) went on to say that:

‘They need to deliver a lesson with pace and interest, know how to mark work and record those marks, how to write reports, how best to teach tricky concepts, how to ask questions of pupils in the most effective way’.
This formed one of the four traits of a good teacher but clearly encompasses administrative, organisational, time management and assessment skills. Finally, Lenon identified that teachers need to have high expectations of their pupils. Lenon also ascribed a percentage weighting to each of the character traits where 30 percent of the weighting was taken up by subject knowledge. It is clear that experienced teachers know that subject knowledge is vitally important, and this includes numerical skills as the underlying numeracy in every subject as well as the generic subject of teaching is essential to effectiveness, but the teachers also feel empathy with those who struggle with the subject, as it is their nature to do so.

5.4 conflicts in language and learning

There were different elements of conflict observed in the data analysed from different research methods in both phases of the research. LIWC analysis of text was completed for forum data, HEI prospectuses, an electronic bulletin board, observed participants comments and focus group data. From analysis of all the data subjected to LIWC, self-references conformed to the formal use of text throughout. Social words used in the corpus for each area of investigation did not conform wholly to formal or informal text but tended towards formal use of text in each case. Positive emotions tended towards formal text, but not for focus groups or observed data. This is interesting as these aspects were face to face and direct rather than indirect collected information, so where people’s comments were collected directly, they used a form of conversation which was more informal. Negative emotions tended in all aspects towards the formal use of words.

The overall use of cognitive words taken from all the data together showed no tendency or directionality from the data if viewed as a whole. The results are mixed and do not exhibit any strong features. Bigger words (that contain more than six letters) are used a lot in HEI prospectuses, forum data and in the e-bulletin board, but not in the face to face research conducted through observation and focus groups. This conforms to an earlier result, for positive emotions where the same categories demonstrated that more informal text was used in face to face contact.
It is unsurprising that people behave in an informal manner (through their use of words) in an informal conversational situation; however this does make us question how genuine the information may be from other sources.

Clearly when people post information on electronic bulletin boards and forums they use a more formal type of text or speech pattern than they would in real life situations that are conducted in a face to face fashion, using both more formal types of speech patterns and longer words. This may also be an indication of a difference between speech and text that is inputted via a keyboard. This has uncovered an interesting aspect to be considered, especially for the use of similar methods is that difference in formal and informal language between the two environments.

When people spoke face to face in forums and through observational comments the speech became very emotive. The language used was also very emotive and led to physical aspects such as tears during stories that presented the individuals with feelings that they hadn’t expected to relive at that point in their lives. The question here would be which set of results is providing the most genuine or honest account? Words used in forums also seemed quite emotive until they were systematically analysed through the LIWC program for example which demonstrated more formal use of language, suggesting that people feel censored when they are producing a comment which has a lasting or semi-lasting existence. More forethought may be present when typing a conversational comment than when simply speaking. Essentially though, despite this disparity in the data (the difference in the language form) the data is still essentially saying the same things.

Words from conversation rendered as texts are easily subject to interpretations that the original speaker never intended. This produces a conflict between the written word and its meaning as intended by the speaker of the original words. Further to this Kridel (2010) presented studies of hermeneutics (language study or examination in terms of meaning) where written language inevitably contains a supplement of meaning lying beyond the restrictions of the text, but also a speaker is incapable of expressing the fullness of thought or what can be thought. Interpreters can therefore never fully understand every written or spoken word. All words, written or spoken can be a form of self-expression for the individual. However, an individual may be restricted in terms of their
use of language and its nuances, even the largest vocabulary can leave us searching for an appropriate word and the English language especially has several different words for the same ‘feeling’ for instance, demonstrating that even slight differences in that ‘feeling’ can be expressed reasonably succinctly but only with the use of the correct word. Meanings therefore are interpreted and mediated rather than fixed and absolute from any word whether written or spoken.

If we delve even further into the conflict between spoken written and interpreted language, the philosopher Kant (1724 – 1804) declared that we cannot construct an explanation of the world itself as it is (as it exists around us) because the things we know are already interpreted by us and by our prior experience of them. Our explanations or the spoken and written word either as conversation or text become part of our interpretations of the world around us, and filtered through prior experience.

In contrast to wholly negative forms of conflict, there is a conflict between what people expected in the CPD case study and their positive experience reports from focus groups and observation information. There were general positive comments about the delivery style of the course or the format of the course delivered for functional skills mathematics for teachers.

‘No textbooks being used in lessons – good! I hate maths textbooks’
Comment taken from focus groups

‘There are hands on activities’
Comment taken from focus groups

Can't believe I enjoy coming to maths lessons, seems like an Oxymoron to me! see I'm better at English!
Comment taken from observation

‘There are lots of different things to do’
Comment taken from focus groups
This clearly demonstrates that people’s expectation was negative and that their experience of the CPD program was at odds with their expectations.

Favourable reports and requests for context in math and numeracy delivery for them as members of the CPD programme but also for their students on vocational courses produced positive comments in focus groups and observation.

“I noticed there were sheets that had ‘teaching’ type things on them – like graphs with numbers of students and things like that’

Comment taken from focus groups

This provides one avenue to conflict resolution, the production of resources and experiences that counter negative perceptions and provide a positive outcome. For this to be effective, engagement is essential.

It is only when we question different values or belief systems that we find conflict between action and value or rhetoric and belief, as in the reported conflict here between the views demonstrated on teachers numeracy ability relating to standards and the requirement of the teacher persona to demonstrate certain personal qualities including patience and empathy. Schwartz (1996 P. 119-144) expanded on motivational values and their possible conflict with action for individuals and groups:

‘It is in the presence of conflict that values are likely to be activated, to enter awareness and to be used as guiding principles. In the absence of value conflict, values may draw no attention’.

Schwartz described a circular motivational value system where the pursuit of different values can occur at different or opposing points of the circle, creating conflicting values and actions.
5.5 Conflict between the resources needed and the resources available

Further evidence of conflict is provided by a critical review of resources available to support the implementation of teachers’ numeracy as part of the minimum core for trainees in the post compulsory sector and those studying towards the professional skills test for numeracy in the compulsory sector. The types of support available vary dependant on different factors, including the size of the response required. To measure the response to legislation and in a sense therefore to measure the importance accorded to legislation or to movement in teaching and learning, those responses can be examined by looking at the type, size, availability and sheer volume of resources to support practice available to the practitioner and the trainee teacher. The search was conducted with questions in mind: how much choice is there, what does the choice consist of and how appropriately does it support practitioners to address teaching and learning needs for teachers’ numeracy?

The internet is the fast way to examine repositories of stored information in a world-wide context. The search was limited to the English education system, and trainee teachers’ numeracy by using specific search terms in the Google search engine: ‘Minimum core numeracy’, ‘Teachers numeracy’, ‘Teachers learning maths’, ‘Mathematics for teachers’ and ‘What is minimum core numeracy’.

Because the internet is added to daily and research presented here is longitudinal in nature, there are significant changes occurring over time, the review or search process has been revisited to incorporate and update with new information, two years after the original 2011 search and again, nearer to the conclusion of the research process.

The searches, both old and new, produced information of different types, revolving around teachers’ numeracy and mathematical skills. The focus here is on the post-compulsory sector of teaching in the UK, however, the skills of trainees in the compulsory sector and the completion of the professional skills numeracy tests has become an issue with legislation changes after the original
search for information and resources in 2011 was completed. Information relating to QTS tests for numeracy has been included here as new legislation has impacted on the relevance of this information to the research. Information gained from the critical review of resources provides a strong addition to the contextual foundation of the research work as a whole, providing a more rounded picture.

The results of searching through hard copy and online resources provided information in different categories, for instance textbooks aimed at supporting trainee teachers with professional skills or level 2 tests, more general textbooks or course guides for teacher education, guidance for teacher educators and information from examination boards on content and assessment for numeracy in teacher education and online repositories of information. The categories of information which have emerged are as follows: textbooks, examination board information, teacher education support information, teaching and learning resources, mathematics and numeracy websites.

The 2013 text, ‘Teachers’ Standards in the Classroom’ by Blatchford is a response to the new teacher standards in the compulsory sector (2012) and addresses each of the elements of the standards in a seemingly straightforward way with questions for the reader within each section as a reflective exercise. This is primarily a text related to the standards document as a whole and provides an interpretation of these rather than advice on skills tests or a concentration on numeracy, it is a generalised response. This is more typical of generalised texts and is not a deficiency in the text; it provides an appropriate response and doesn’t pretend to concentrate on numeracy or mathematics skills, or any other specific aspect other than its outlined focus.

Another generalised text on achieving QTS demonstrates that literacy and numeracy can be presented in a slightly negative light. The text by Dennis Hayes ‘Learning and teaching in primary schools’ (2009 P. 2) published by learning matters, provides the following as part of the context of modern education in primary schools:
This expounds a popular view, that English and mathematics have taken over the curriculum and do not leave room for creativity. Creativity and spontaneity are difficult for anyone to achieve without the basic tools provided by numeracy and literacy.

Other texts include: ‘The Minimum Core for Numeracy: Audit and Test’ from the achieving QTLS Series (2009) written by Patmore and Woodhouse is a text intended to support trainee teachers in the post-compulsory sector but was not available via searches originally conducted in 2011, regardless of a 2009 publication date. From the contents it is clear that this text examines numeracy skills in the same order as the adult numeracy core curriculum and is clearly aimed at the personal numeracy skills of the individual.

Another text taken from the achieving QTLS Series, published by learning matters is: ‘The Minimum Core for Numeracy: Knowledge, Understanding and Personal Skills: Knowledge, Understanding and Practice’ (2009) written by Peart, this is aimed at examining the second part of the minimum core, which can be termed the social aspect, where trainee teachers examine factors and barriers affecting the acquisition of numeracy skills.

This text was reviewed on www.Amazon.co.uk which indicates that only limited amounts of materials have been available through the feedback displayed:
The text ‘Numeracy for QTLS: Achieving the Minimum Core’ by Keeley-Browne and Price (2011) published by learning matters, aims to cover all sections of the minimum core of numeracy. This is a clearly a cover all approach to the minimum core of numeracy. A synopsis for this text is available via www.Amazon.co.uk:

This aims to be the first core textbook in the market to support those undertaking initial teacher training in the post-compulsory/learning and skills sector (formerly FE). The text is structured in line with the requirements and specifications of the minimum core and therefore guides students to achieve the minimum core and pass the new national tests in order to achieve their QTLS qualification.

The synopsis is interesting since the book was not available via the first search for resources in 2011, and has a publication date of 2011, being the first core textbook at that point in time would indicate that very little supporting texts were available when the search (and research) started. Those texts that were available in 2013 and 2014 are a very slow response to legislation which appeared in 2004 and wasn’t available by 2011.

Several textbooks are aimed at specifically supporting teacher education qualifications. Minimum core numeracy or reference to teacher mathematics or numeracy skills does not appear either in the contents, the indexes, or in the glossaries provided. No reference is made to mathematics and numeracy although reference is made to QTLS status which does require qualifications in these subjects, so although the texts are not missing information that is essential they are omitting to signpost trainee teachers to essential features of their professional landscape.

‘At last, some useful resources to support the Minimum Core! Brilliant, thank you.’ (Senior lecturer, Truro College.)

Comment taken from reviewed resource
Mentoring trainee teachers is a large part of teacher education and has gained momentum in recent years. Several texts were examined which relate to this process. A mentor’s work is not undertaken in a vacuum but in context. This is one of the themes running through the information presented. However, the context of legislation relating to numeracy skills is not addressed at any point, mathematics or numeracy is not mentioned as part of this subject area or the context for the subject of teaching and learning in any part of these texts.

There has been a drive to increase the development of transferable skills in academic courses of education especially with reference to higher education including the development of critical thinking. Critical thinking is built on several foundations which include the use of a logical order, structuring of reasons, recognition, reflection and evaluation. Generalised types of text or texts related to the support of trainees during the process of teaching and learning often appear in trainee teachers cited works during academic submissions for teacher education; again, numerical skills are not mentioned in these types of text, in any depth.

‘Contemporary issues in lifelong learning’, Duckworth and Tummons (2010 P. 55) provides examples and case studies relating to numeracy embedded into sessions within different subjects. The embedded numeracy examples provided are actually overt numeracy examples, concentrating on calculation skills, not on wholly embedded underpinning numeracy skills. One example in the text is clearly demonstrating how numerical work can be ‘inserted’ into a history session (contextualised numeracy), but the statement is made that: ‘Level 2 numeracy is not ‘naturally’ embedded into history, which is to say it does not occur through the general disciplines history promotes, such as critical analysis’.

History contains (by the nature of the subject) dates and chronological sequences which are direct examples of numerical information, directly in conflict with the rhetoric of the text.

Examining bodies provide information within specifications for teacher education in the post-compulsory sector on minimum core numeracy. Many exam boards provide resources and
information to support delivery of their accredited courses as well as the basic outlines of information in curricula.

Information provided by examining bodies for teacher education providers consists of minimum core centre guides, minimum core summaries, sample schemes of work and integrated parts of guides for full qualifications. The following sample (Fig 3) is taken from the contents of a certificate for teacher training at level three:

<table>
<thead>
<tr>
<th>Structure of the qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rules of combination</td>
</tr>
<tr>
<td>Addressing literacy, language, numeracy and ICT needs in education and training: Defining the minimum core of teachers’ knowledge, understanding and personal skills</td>
</tr>
<tr>
<td>Signposting key skills in the qualification</td>
</tr>
</tbody>
</table>

(Fig 3 - Specification contents sample)

When the identified page from the specification for the level three certificates is examined, the information relating to numeracy (below) is sparse:

The personal skills in language, literacy, numeracy and ICT addressed through this Award will be developed in progressing through the framework to QTLS status and beyond and will allow for functional skills to be incorporated at an appropriate level to suit the delivery of learning through different contexts. For example:

- reading: eg find and select, from a range of reference material and sources of information, including the internet
- writing: eg understand significant features of English spelling and of the contribution of punctuation to meaning in written texts (including the design of teaching and learning resources)
- listening: eg listening attentively and responding sensitively to contributions made by others
- speaking: eg showing the ability to use language, style and tone in ways that suit the intended purpose and audience, and to recognise their use by others.

(Fig 3 – section of text from qualification specification)
This one page of text from a two hundred and eight page document is dedicated to the minimum core, mentioning numeracy skills. However all the example skills provided in the text are actually English or literacy skills rather than numerical or mathematical, in Fig 5 the skills listed are: reading, writing, listening and speaking. This demonstrates that the minimum core of literacy and numeracy has been written into specifications for teacher training courses in the post-compulsory sector, but that the concentration appears to be on the literacy aspect of the core. It also clear to see that with one page of two hundred and eight pages dedicated to minimum core skills, this has not been written into qualifications in a substantive way.

Guidance available for teacher educators specifically included an online and hard copy guide to standards in minimum core numeracy, a minimum core handbook, the main Fento guide (specifications) companion guide and an inclusive guide. SVUK and NRDC both produced guides and documents that related to general teacher education that included minimum core numeracy information. The 2004 NRDC guide, published by Fento, ‘Including Language, Literacy and Numeracy Learning in all Post-16 Education - Guidance on curriculum and methodology for generic initial teacher education programmes’ included specific examples of training strategies for trainees in post-compulsory teacher education SVUK and LLUK documents are still available from archives but have not been updated, demonstrating that it was not seen as important to be able to access these documents, especially the original documents.

Teaching and learning resources to facilitate the implementation of minimum core numeracy as part of teacher education in the post-compulsory sector are thin on the ground. www.brainboxx.co.uk and www.slidefinder.net both provided resources that introduced and explained the minimum core of numeracy for students in 2011. When checked in 2014, the link to resources did not function, making resources difficult to find initially and very difficult to keep. The links not being maintained could indicate that they have become obsolete and certainly that they are no longer used, no re-

23 These documents are archived rather than being readily available
24 These documents are archived
direction was available so the resources were not archived or added to a different website, making the documents obsolete.

Internet searches revealed blogs and forums where teacher educators and trainee teachers could discuss teachers’ numeracy skills and the delivery of teaching and learning in this area, most of which discussed generalised education issues across the world with the main contributions being from the UK and the USA. This produced very general information in a frequently asked questions format for teacher training. Revisited through the course of the research process, numeracy did not gain any momentum over a four year period.

The most fruitful search for resources to support teaching and learning resulted in websites which contained information and resources centred on actual content for individuals to use to support their own numerical skills development or for teacher educators to embed numerical tasks and provide some contextual tasks within the teacher education classroom, helping them to respond to the requirements of the minimum core of numeracy in the post-compulsory sector. These were not aimed specifically at trainee teachers or teacher educators to help them implement the core of numeracy in teacher education. These resources were aimed at mathematics and numeracy teaching and learning in a general sense. The use of these resources to facilitate learning in teachers’ numeracy is simply one possible use of these resources and their use would place a strong reliance on the skills of either the trainee or the teacher educator.

The critical review was revisited several times through the research process where more became apparent through varying searches for information. Some of the initial information became almost obsolete, including the guidance provided for implementation of the minimum core of numeracy in the post compulsory training sector. Although this constant comparative method yielded results over time, they were still not significant in terms of the provision for trainee teachers learning numeracy.

The majority of results were aimed at maths teachers in the mainstream, teaching functional skills or GCSE mathematics. A real gap was identified in terms of knowledge surrounding the area of teachers’ numeracy. The whole subject has been highlighted by government reform through 2013/14 essentially revolving around the professional skills numeracy test.
The aim of the change from QTS tests to professional skills tests being to equip the nations teaching force in our schools with a greater depth of knowledge and to provide a method of selection as the tests are now limited in the number of attempts a person can take (three) and the tests must now be taken prior to undertaking teacher training. This has not been matched in the post-compulsory sector. No emphasis has been placed on minimum core numeracy, the Institute for learning has been dissolved and any powers invested in the IFL transferred to the society for teaching and learning administered by the teaching and learning foundation. This produces another juxtaposition, teachers in the compulsory sector must be highly skilled and suitably qualified, whilst those in the post-compulsory sector are not subject to the same stringent requirements.

The resources examined can support teacher educators or trainee teachers in a practical sense. Information is clearly made available but is heavily reliant on the subject knowledge and skills of teacher educators. Specific instructions and supporting resources for the teaching of the minimum core for instance were limited at the time of the initial search in 2011.

Teachers’ numeracy is addressed by specific texts in the compulsory sector aimed at supporting trainees to pass the QTS numeracy tests. These are generally comprised of the same type of information which is contained in generic maths textbooks at GCSE foundation or numeracy level 2. Most provide generic skills practice as a targeted approach to the numeracy skills test. There are notable exceptions to this, mostly those resources which are supported with online content for trainees to be able to practice the tests in a more realistic fashion (referring especially to the mental maths aspects of the tests).

Different reasons can be presented for the lack of resources originally noted in 2011. The need for teachers to gain numeracy skills (if required) has gained momentum over time. More resources have been produced to address changes in legislation and the ‘overhaul’ of the teacher education system in the post-compulsory sector. This must be placed into the context of the functional skills and embedding agendas, the more recent changes to the QTS system of testing for professional skills and the changes taking place in the GCSE specifications and delivery for 2015 and beyond.
This explains in some part the production of more resources over time as the whole subject area has gained momentum.

More recent trends have indicated that teachers’ numeracy in all sectors must be more robust in the future. A STEM approach has been developing, with bursaries being offered of up to twenty thousand pounds for graduates in mathematics to train to teach in compulsory sectors, teachers being accredited as ‘master teachers’\textsuperscript{25} and QTS tests being reformed to stop trainees taking more than three tests in a year prior to full teacher training commencing.

When the research was revisited, several of the resources available in the initial searches had been archived and many of the statutory bodies had become obsolete (FENTO for example). New texts and information had appeared by 2013 and 2014 to specifically address the minimum core of numeracy in programmes of teacher education in the post-compulsory sector. These texts though were very new additions to the subject area and without the constant comparative method involving going back through the research and reviewing the searches completed, these texts would not have been identified.

From this critical review, taking into account the searches completed over time, it is clear that the response to the minimum core of numeracy for the post-compulsory sector has been very slow and not very comprehensive. Limited information and non-specific information has left teacher educators working with very few resources to deliver teachers numeracy in the classroom. There is a clear conflict between the support and resources required to implement effective learning for teachers in numeracy across all sectors and the actual resources and support that is available to do so. Several possible reasons have been examined through the chapter but it appears that this conflict is unlikely to be resolved until the negativity surrounding this type of learning for teachers is fully addressed.

\textsuperscript{25} This is a controversial aspect of teacher training as several institutions have opted to allow trainee teachers to complete ‘top up’ units to claim a ‘Master’s degree’ in teaching and learning which cannot hold parity with an actual Master’s degree due to the lack of depth involved.
5.6 Chapter summary

Conflict as a finding has been narrowed down to its main areas, conflicts in standards and the personality traits of teachers as professionals, the conflict between a lack of skills and the depth of teaching required, conflicts found in both language and learning and the conflict between resources provided and those required. Conflicts arose between the professional aspects and the need to maintain high standards and the personality traits of teachers where there is a need to demonstrate a caring and empathic nature towards others.

Lenon (2013) identified that a high level of subject knowledge was essential for a good teacher. Those teachers who lack confidence due to a lower level of subject knowledge or lower levels of skills, do not have a strong subject knowledge, including numeracy, especially for primary school teachers who will need to teach numeracy directly, will suffer in the classroom in terms of not being that expert teacher. Despite the voices of the forum attempting to indicate that some teachers may be better or have more empathy for their students due to having struggled with numeracy, the conflict here is also with the maintenance of high standards and professionalism.

Language conflict was interesting, the way people interact with each other via electronic media like an e-bulletin board can change with their awareness of ‘who’ is reading or ‘listening’ to their online conversation. A reasonably positive aspect was noted through the online bulletin board (observed as part of the case study in phase two of the research) which was not present in the focus groups of the same staff members. Much of the conversation was solicited by the lecturers responsible for delivery of the functional skills mathematics program rather than being entirely self-monitored or self-perpetuating and regulating as was the case with the online forums which were external to the program delivered. The very positive nature of the interaction was clear from the amount of practice sharing taking place via the e-bulletin board. Lecturers delivering the programme used this environment to post notes to each other, possibly in the hope of ‘leading by example’ and encouraging other members of staff undertaking the programme to participate in the online bulletin board.
Within the focus groups, a very different tone was observed from the tone apparent in the e-bulletin board. Here, people were keener to respond directly and the conversational nature of the focus group interaction meant that people went on to say things in response not only to the questions but to each other.

Within the second phase of the research another conflict arose within teaching and learning, which was the simple conflict between what participants (teachers) expected and what they actually experienced, especially with reference to the actual teaching methods, approaches and resources used.

In a search for educational forums and discussion boards to examine for the collection and analysis of data, generalised search terms using the ‘Google’ search engine did not provide any tangible results. For example, the search term: ‘teacher training forums’ produced four million, seven hundred and thirty thousand results. From the first ten terms (listed in the order of relevance) no actual relevant results were found. The search term: ‘education forums UK’ produced one hundred and forty million results. The first ten results produced information on links to resources for teachers, not discussion forums, when checked this provided general forum education (by subject) discussions, however, no relevant content relating to the numeracy skills of teachers or trainee teachers. As results are listed in order of direct relevance when they are returned through the search engine, each result losing relevance as the list goes on, so if results do not demonstrate relevance within the first ten in the list then this will reduce significantly as the results get into the millions. Although perseverance paid off and eventually forums which were suitable and contained appropriate information were sourced, this does indicate that numeracy and mathematics for teachers was not high on anyone’s agenda as a talking point.

A search for information was completed using methods applicable to a literature search for any subject of research. Local libraries, college and university libraries were examined physically for hard copy texts within and around the area of trainee teachers’ numeracy and mathematics skills

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Google was the fastest search engine which provided the most tangible results. Yahoo and Ask Jeeves were checked for improved use but were not effective.
development. Subject specialist librarians were consulted to aid the search; journals and online library content were also searched extensively. The search produced results relating to the professional skills numeracy tests but returned very little for the post-compulsory sector.

In 2011 the search was initiated with an internet search using the search term: ‘minimum core numeracy’ in the Google search engine this produced a significant number of results, but only two out of the first twenty sites produced information that was relevant to the numeracy minimum core for trainee teachers in the post-compulsory sector. The availability of resources and information gives an indication of how trainee teachers, teacher educators and institutions responded to the needs of teaching and learning in the classroom for teachers’ numeracy. Despite poor results from search engines and very limited resources available via the traditional search methods, the search for appropriate information, support mechanisms and resources continued and was revisited as part of a constant comparative method over several years. This did yield some additional results but a conflict or disparity between what is required to support the delivery of teachers’ numeracy and what is available was still clear.
Chapter Six - Model Development
6.1 Chapter introduction

This chapter focusses initially on phase two of the research, which is a naturalistic case study. The subject of the case study is the delivery of a functional mathematics continuing professional development program (CPD) for teachers, which is critiqued, leading to a model of delivery being developed in conjunction with information from phase one feeding into the model proposed. Initially an overview is provided with a simple narrative of the case study scenario. This lays out the procedures undertaken for the delivery of the functional skills CPD functional skills mathematics programme for teachers in a further education college.

The narrative is followed by an evaluative critique of the CPD programme which also utilises evidence and analyses taken from phase one of the research. The critique examines the process and procedures involved in delivering the CPD programme and the evidence collected from the participants through participant observation, collection of bulletin board comments and focus groups.

Models of delivery are examined with a model being built up from the evaluative evidence and the evidence from phase one of research also being taken into account. The fully developed model is proposed for delivery of teachers’ numeracy and mathematics learning with diagrams to aid explanation.

6.2 Research phase two - Case study narrative

Phase two of the research conducted took the form of a case study in a further education college in the North West of England specialising in vocational educational provision. The college provided diploma and apprenticeship courses, some professional development provision related to different employment sectors leading to professional qualifications (AAT for accounting for example) The college did not provide A-level courses but did provide higher education through franchise
arrangements with three universities. The college had approximately four hundred and fifty members of staff ranging from casual contracted employees to full time permanent employees with more than ten years of service. The college was in a semi-rural location with a student catchment area that scores highly in terms of multiple deprivations.

The demographic features of students included a varied spectrum of learning difficulties and disabilities, ethnic, cultural and religious diversity and social and economic deprivation. The college was graded as outstanding in every area in its last Ofsted inspection and has won multiple awards relating to staff development and student achievement including investors in people awards.

The functional skills mathematics CPD course for teachers was developed as a change in curriculum became apparent, the curriculum landscape was changing significantly and the educational focus was on the quality of teaching and learning. Ofsted were preparing to bring in the new inspection framework which included further education colleges and this produced that focus on classroom skills and knowledge demonstrated by teachers. Funding is a continuously changing landscape in further education which means that some qualifications provide a money making opportunity for those colleges that are willing to provide accredited professional development for their staff members that also attracts funding. Functional skills and before that adult numeracy certificates, represent part of a suite of qualifications which can be delivered to adults at entry level, level one and level two without any other prior qualifications or any other course entry criteria and still attract a definite level of funding without the requirement to pass the course.

In this case study every member of staff undertaking the qualification as CPD would have attracted funding regardless of their success or failure. More than two hundred members of staff were enrolled for functional skills mathematics.

<table>
<thead>
<tr>
<th>Is it for funding? I mean if it's making money for the college then fair enough it's not a lot to ask really.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment taken from observation</td>
</tr>
</tbody>
</table>
As indicated above the idea that this particular CPD programme was a money making opportunity did not escape some members of staff, however this was not an aspect discussed at any point. Information presented to those staff members participating was clearly and succinctly presented as professional development. The stated aims and objectives of the functional skills mathematics staff development course were presented in a handbook for participants.

<table>
<thead>
<tr>
<th>All Functional Skills Mathematics Level 2 programmes aim to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• promote the development of mathematical skills for home, leisure and work</td>
</tr>
<tr>
<td>• reward the achievement of learners for the mathematical skills they have developed</td>
</tr>
<tr>
<td>• prepare learners to use mathematical skills in a broad range of familiar and working contexts</td>
</tr>
</tbody>
</table>

This involves:

| • understanding routine and non-routine problems in familiar and unfamiliar contexts and situations |
| • identifying the situation or problems and identify the mathematical methods needed to solve them |
| • choosing from a range of mathematics to find solutions |
| • applying mathematics in an organised way to find solutions to straightforward practical problems for different purposes |
| • using appropriate checking procedures at each stage |
| • interpreting and communicating solutions to practical problems, drawing simple conclusions and giving explanations |

In addition, this programme aims to encourage you to identify where these skills are needed within your job role or the career you are preparing learners for, so that these skills can be developed and valued across the college.

Fig 4: Functional skills CPD handbook introduction

The objectives presented for the CPD course for teachers make no mention of anything other than mathematical competencies and information which can be found in the functional skills mathematics specifications for different examination boards.
A full CPD plan was formulated for the college staff which included functional skills mathematics and English. This initiative was outlined by the head of area who presented the idea that all staff had to undertake the qualifications regardless of their prior qualifications at any level within these subjects, due to the currency of their mathematics qualification, i.e. the time that had elapsed since they had last taken a mathematics qualification. The program was developed initially by the head of area and then supervised by the programme area leaders and delivered by a combination of the staffing team for functional skills and GCSE mathematics and English and the programme area leaders for those areas⁷⁷. The senior leadership team were on board with all area heads insisting that their staff participate. The whole maths and English department were informed of the plan and

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²⁷ My own role in this programme was as the line manager for staff and the programme area leader for both mathematics and English in the post 19 sector. I worked in conjunction with the staff team for functional skills and GCSE delivery and the programme area leader for mathematics and English in the 14 to 18 sector for the college.
presented with the documentation and supporting resources (textbooks and VLE) at a twilight meeting prior to the whole college plan being rolled out fully. This was not a negotiated session or a session where responses or suggestions were required. This session was simply to communicate the structure and expected content of the CPD course to be delivered.

Teachers within the Mathematics and English department were also expected to sign up for the qualifications and take the final examinations as this would support the other members of staff in the college to do the same. Within this session the structure was presented as complete and staff members were informed of their expected contributions and timetable of activities. This included working through holiday periods and taking qualifications that people were qualified to teach in some case to level 5 and 6, mathematics teachers taking functional skills mathematics tests, for example. This did produce some questions from members of staff who felt they were being forced to complete professional development that wasn’t suited to their needs in any way.

This is pointless, I have an A-level in maths and a degree in structural surveying - why on earth do I need to do this?

Comment taken from observation

Program area leaders for English and mathematics were expected to produce and populate an online learning platform for each of the subjects. A timetable was devised which included additional sessions delivered through holiday periods and individual tutorial slots. Teachers were expected to devise a scheme of work, session plans and resources for delivery of the program in taught sessions. The teachers had to keep records and track the progress of the staff members undertaking the CPD program as they would in their normal classes for these subjects.

The program devised consisted of an introduction evening for all members of staff to ensure that all essential information was communicated. A power point presentation was used to support this and it was delivered by the head of area in the main hall for staff undertaking the CPD program during a
twilight session. Two of these sessions had to be completed and staffed as teachers required support to log into the systems and complete assessments using an online platform.

The twilight sessions were completed by all staff who then worked on initial and diagnostic assessments for both subjects dependant on whether they were going to take one or both of the subjects in the current academic year. If only one subject was taken, the other subject would be planned for the following year in the same way at the same time in the academic year (towards the end of the year).

All staff completed the initial and diagnostic assessments using a PC version which automatically marks the assessment questions, indicates a level (which in the case of initial assessment is the operational level of the individual) and then provides a diagnostic assessment at that level which provides information on the skills gained already and those skills which need to be worked on by the individual. The electronic program then produces an individual learning plan based on the skills identified in the diagnostic assessment. The program diagnoses skills to level three. However this is not the traditional level three (GCE A-level) this program delivers questions in mathematics which are related to the GCSE level rather than Level 2 functional skills and indicates this by terming these questions ‘level 3’. The level three diagnoses provided some confusion for staff members, although this gave them a positive impression it was significantly misleading.

I was impressed with myself when it came out at level 3 - I expected you know that it would only be level 2, although the top end of level 2 - but even so - that's good.

Comment taken from observation

I was happy when the diagnostic came out at level 3 - sigh of relief - I know I'm not thick now - it's A-level that isn't it?

Comment taken from observation
Fig 6: Sample VLE page from functional skills staff development program.

An e-bulletin board was set up using an outside freeware program for education. That is, the e-bulletin board was separate to the e-learning platform used by the college. This meant that the board was difficult to use, staff required a secondary username and password which was not linked to their e-mail or the college VLE. This caused Information technology difficulties as staff could not use the bulletin board without inconvenience, with yet another username and password which made the use of the e-bulletin board cumbersome and unappealing. The board also lacked spontaneity because staff members were instructed to add posts to it, starting with an introduction and midway through the program they had to identify the skills required within their own area that linked to numeracy.

Both curriculum areas of English and Maths are an essential component for Supporting Teaching and Learning in Schools students as they are key role models for the pupils that they will be working with. Therefore effective skills in both areas are essential.

Comment taken from e bulletin board
The instruction to add posts came through the line management system which is compelling individuals rather than providing them with a bulletin board for them to post questions and comments or share practice as they wanted. Noticeably there were not four hundred and fifty responses to this request, although some staff did post a response, similar to the response above.

Staff members were required to sign up to different types of delivery that were provided. These included specific textbooks for functional skills at level one or level two, where staff could use the textbook alone or in combination with the subject area repositories provided on the college VLE to work totally independently through the program, actual classes held in twilight sessions after 4pm on specific week days for mathematics. The classes were mixed ability made up of staff undertaking either level one or level two functional skills. The VLE contained all the details from the taught sessions including the resources and activities in the form of different power points, links to videos

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maths and English are integral to many of the curriculum areas I look after. Some of these are obvious, maths in accountancy for example! However it might no be quick so obvious that maths is vital to computer games development. The process of generating and moving around in the three dimensional worlds common in modern computer games is totally dependant on complex mathematical modelling. My other areas include administration, business, management and media. Key to success in all of these is effective communication, and key to success in communication is effective use of language.

Comment taken from e bulletin board

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English and Maths are important in my job role as a learning support worker because if I can help my students boost their self esteem by improving their Maths and English skills then I'm hopefully doing my job correctly.

Comment taken from e bulletin board

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I use maths when supporting IT Level 2 students in their maths class!!! I must admit I struggle with aspects of that like fractions and ratios, so revising and learning maths is a good idea and can only enhance my learner support in future.

Comment taken from e bulletin board

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from you tube and worksheets which could be downloaded and printed. Individual tutorials were also on offer which staff booked in advance with the delivery staff responsible for their subject area.

The mixture of resources available and learning methods was popular with those staff on the CPD program. This was reassuring for staff who felt that they were being catered for with different resources and methods available to be able to study on the program. Many elected to undertake independent options to learn, however these individuals did not keep up their commitment to working on numeracy skills and mathematics and anecdotally when these people were checked verbally they said they had too many other things to do and so this had been placed at the bottom of the list really and they were going to get around to it. Other members of staff did elect to attend weekly classes delivered in the twilight slot, in between daytime and evening classes. These classes had very low student numbers, the first and largest mathematics class being made up of six students. The second mathematics class numbered four. All the members of staff who had signed up for mathematics elected to take the textbooks that were on offer regardless of whether they were utilising any of the other methods of learning or availing themselves of the other resources available. Eighteen people were recorded as logging into the mathematics learning area provided on the college VLE. Two teachers opted for individual tutorials in mathematics.

Whilst the CPD programme was being delivered, the teachers taking part were being observed for the research reported on here as part of the case study. Their comments related to or about the course were recorded in real time and each member of staff involved was asked to sign a consent form, allowing their anonymised comments to be used in the research. Only one individual did not want their comments used in any way and so all of their conversation and contribution of any type was removed, ensuring that the research and the results were ethically sound (see Appendix VIII Volume I) during the observation, comments were not solicited or discussed in any way, they were simply recorded as directly and quickly as possible in note format or word for word if possible. An iPad helped to capture information quickly and the research journal was also utilised to collect observational comments and data through the research process.
Staff undertaking the CPD program were monitored per subject using an individual learning plan system and notes on progress related to each class. The individual learning plan utilised was the same documentation that would be used for ordinary classes in mathematics and numeracy. This was difficult for staff to complete as so many teachers did not attend structured classes or tutorials. Very limited information on progress for many of the teachers was a barrier to tracking and monitoring effectively.

On completion of the program participants were invited to attend focus groups and evaluate their experiences of the CPD program over time. This was part of the research and again this was entirely voluntary on the part of the participants. Any evaluative comments made after completion of the program were also collected as part of the participant observation; these were collated with the previously collected and collated comments from observation for analysis. It should be noted that many more comments and conversations related to the CPD course may have taken place but were not in earshot of the researcher and so have not been included.

The data produced in the case study conforms to similar types collected in phase one of the research. Comments and conversation were collected through participant observation and focus groups in the case study as phase two of the research. The data has been analysed in the same way as the data collected through other methods through the first phase. This provides continuity in the treatment and analysis of the data providing results which can be compared clearly and without bias in terms of which phase of research the data was generated within.

The focus groups indicated some positive feedback relating to contextualised learning resources and the use of different methods. However some negative comments were recorded relating to the use of the e-bulletin board and the aspect of the course being compulsory for all staff. Many referred to being forced to complete CPD work that is not a direct personal choice. This impacts enjoyment and achievement. If an individual is forced to attend CPD it ceases to be professional development chosen by them to enhance their practice or knowledge.
These more negative comments indicate that some individuals are displaying resentment as it's not really much of a choice that though is it? You need to do maths and English, you need to attend this induction thingy, you need to do an exam - how is that a choice?

Comment taken from observation

I did them last year - they were the other quals - the multiple choice ones - do I have to do them again?

Comment taken from observation

well if I have to then I'll just do it.

Comment taken from observation

So do I really need to come to lessons? I got a GCSE you know but that was years ago - it's the same though isn't it? I'm sure I could just sit the exam really.

Comment taken from observation

can't believe you're going to make me sit a maths test - what have I ever done to you?

Comment taken from observation

as if anyone wants to do a maths test'

Comment taken from observation

really - we need to do classes? you have got to be kidding me'

Comment taken from observation
6.3 Critique of CPD functional skills program for teachers

Different aspects of the CPD programme were examined in light of feedback from the participants to assist in evaluation and reflection and support the development of an effective model for delivery of teachers’ numeracy skills learning.

The timing of the functional skills for staff delivery from the programme presented an issue - there was only a short time allowed at the end of the academic year and some teachers did have larger gaps in knowledge which needed to be addressed, yet others wanted to complete as quickly as possible. The information provide in the handbook for the participants indicated that they would be able to complete the initial stages of assessment for the programme and then ‘fast track’ to the examination. In reality this didn’t happen and those individuals who were keen to simply take the test could not do so, they were restricted in terms of time and had to wait to take the final examinations. The verbal feedback from these individuals indicated that they were very frustrated and in some instances didn’t bother to take the examinations at all.

I am not coming back in here to do a maths test when I am on holiday - that’s like twilight zone behaviour

Comment taken from observation

Can I do the exam in the next sitting or whatever they call it? When is the earliest I can do it - I'll do it now - I can do it whenever - just get on with it for me.

Comment taken from observation

Can I not just take the exam?

Comment taken from observation
To be truly flexible the program could have allowed for both of these eventualities. This flexibility would also be a feature of blended or multi-modal learning. Bacsich (2012) sees blended learning as any model that combines face to face instruction and demonstration in the classroom with any PC based activities or online provision. Blended learning can also be termed hybrid or mixed-mode learning. It simply represents a blend of methods in teaching and learning which includes computers or the internet.

Planning for this professional development program included a blended approach with the use of a VLE and the e-bulletin board, planning also initially took into account the stages of curriculum development described by McKimm (2007 P. 4) which included ‘agreement of the educational or professional context in which the programme is to be developed and delivered’, a definition of the ‘needs of the learners in line with the requirements of professional bodies’, consideration of the ‘aims and broad learning outcomes of the programme’ and an ‘identification of ideas and constraints’. Further aspects of curriculum development according to McKimm included:

- Implement and refine the programme
- Develop an appropriate and deliverable evaluation strategy
- Review and revise the course in line with feedback – has it met the identified needs of the learners and other stakeholders?

It should be noted here that the final three aspects of this model from McKimm have not been fully implemented or planned for within the delivery model set out in the CPD programme delivered in the case study. No review or revision of the programme were planned for, no refinement and no evaluation. These processes did occur through phase two of the research conducted, but were not expected by the institution where the case study was carried out and this is voiced as a criticism of the programme itself and the institutional planning process related to the programme. Without the research being undertaken no evaluative information would have been gathered which makes the programme short sighted and has implications for scalability and continuity within that individual institution. Where teachers had elected to take only one of the subjects in the academic year, it was
planned that they would take the second subject in the following year, so the programme needed to be sustainable to be repeated in the second academic year. Evaluation would have been an essential aspect of forward planning in this instance because the program was expected to be repeated.

Hirsh (2007) pointed to evaluation and reflection being an element that is often missed in learning programmes developed within industry for the workforce. Missing this vital aspect according to Hirsh removes the opportunity for learning to become internalised and therefore wholly effective. Any model development should take this element into account from the outset. The participants should be actively encouraged to participate in an evaluative strategy for their own benefit as well as the benefit of those planning and delivering.
In this model of curriculum change and development from the United Nations Educational, Scientific and Cultural Organisation (UNESCO) it is clear that evaluation and student assessment is an integral part of curriculum development. This diagrammatical representation also gives the impression that the whole process is a cyclical one rather than a linear development. So after the first year of delivery further evaluation and refinement would be expected, before progressing onto the second and subsequent years.

The model of delivery for the functional skills mathematics CPD programme did not take into account or address the negativity inherent within the teachers’ approaches to the subject area. Negativity was not addressed because it was not presumed to be there from the first instance. The model used a plurality of methods to ‘reach’ all the participants in different ways; however the participants for the most part did not want to be reached.

I hate it - it's just one of things no-one can do isn't it?
Comment taken from focus groups

Is it OK to do level 1 instead of level 2? I'm frightened of failing, I like maths, well I don't mind it, I just can't do it!
Comment taken from observation

I cannot believe I signed up for this - I will have to do the maths exam next month - dreading it - it is the one thing I hate - I passed the English, but maths!
Comment taken from observation

Individuals experienced and expressed a significant amount of negativity which was compounded by the way in which the CPD program was implemented. By making the CPD compulsory within the college, senior managers at times promoted a negative viewpoint, forcing people to undertake a subject where they already felt uncomfortable. This leads to resentment from individuals and further reinforces their negative and conflicting attitudes towards the subject.
The delivery of continuing professional development for teachers is often controlled in house by members of staff within the institution itself. In the case study this was also the case as teachers became teacher educators overnight. Those teachers who worked in the English and mathematics department were suddenly responsible not only for teaching their own classes of students but also for the delivery of staff development mathematics for other members of staff. No training was provided for those teachers who now had to perform this new part of their role.

Thompson and Goe (2009) favoured teacher communities as a way not only of promoting collegiate practices, which teachers are in favour of, but of making realistic gains in assessment for learning being effective and becoming entrenched as a practice within educational institutions. Within their report Thompson and Goe pointed to professional development for teachers being delivered or guided primarily by management or coaching individuals within education and pointed to this only being effective if those people had first ‘walked the walk’ and had significant experience and knowledge to communicate. They also moved away (through pilot work and the use of trial and error) from telling teachers what needed to be done and how to do it towards ‘doing’ with teachers as a more effective way of learning. Opportunities for practice, reflection, and adjustment were essential for any teacher development to be effective. Within the second phase of research (case study) teachers had to identify numeracy skills within their own subject area using the e-bulletin board.

The bulletin board was also used for teachers to report back on their problems or successes. This manifested itself mainly in the reporting of I.T. problems, rather than providing any meaningful interaction. Asking teachers to identify for themselves the numerical content of their vocational delivery subject provides more internalised experience for them to use as a learning tool. Asking teachers to report back on their most recent learning experiences within the professional development and feedback or ask for help is also a way to internalise the experience of learning in numeracy. Thompson and Goe (2009) saw the need to report back as a ‘spur to action’ which is essential for more in depth learning to take place.
These aspects must be included in any subsequent model development to allow teachers’ the opportunity to reflect on what they have learned and how they have implemented their learning or observed new skills and knowledge in practice.

6.4 Model development for teachers’ numeracy

A model for the delivery of teachers numeracy has been completed which uses the research as a foundation from both phases. The first whole model outline diagram (fig 8) provides a cyclical structure in the sense that each element leads to another and at some point in delivery the elements link both forwards and backwards with each other. Evaluation, the methods of delivery and the use of a hybrid model are linked to the research findings of negativity and conflict, allowing the model development to link directly with the research findings.

Bacsich (2012) examined educational models in terms of curriculum starting with the requirements of any model archetype insisting that these should be easily generalised and universally understood. Each sector should have clearly identifiable similarities and he presented the example of a virtual school, a virtual college and a virtual university having the same recognisable features. Archetypal models should also be scalable, sustainable, deliverable and deployable. These features must be taken into account when developing a model for delivery of numeracy for teachers.

A significant feature of the findings from phase one was reported as negativity. Teachers and trainee teachers demonstrated a surprisingly high level of negativity in their perceptions, opinions and relation of past experiences in mathematics and numeracy learning. This trend towards high negativity continued through the data collected and analysed in the second phase of research as this was also observed from the teachers in the case study.
A model that accepts the negativity that surrounds mathematics and numeracy and thus addresses this issue and has inherent features to do so is proposed which is based on the research conducted here and is likely to have more effective outcomes than a model which does not.

Teachers of all subjects need more than a limited understanding of the basic numerical and mathematical concepts themselves to be able to communicate effectively. What must be addressed is the ‘why’ of this proposition. Why do teachers need numeracy and mathematical skills? Teaching is a professional vocation, numerical efficacy is essential to success. The facts of the underpinning of numeracy skills and their importance to cognition generally are essential for people to have a greater understanding and approach the subject differently. In addition to this the advanced cognition afforded by numeracy skills (through the manipulation of abstract concepts) and the transferable tools gained are essential if teachers are to become expert in their craft, regardless of the subject they teach.

‘I was observed last week and when I was given the feedback, the observer said that I hadn’t covered the minimum core because I didn’t have any numeracy in the session. The observer suggested that I could have stated the price of condoms (I was doing personal health) or ‘something’ to include numbers or prices in some way. This seems a bit pointless, just to get the numbers in: it just doesn’t make any sense to me at all’.

Trainee teacher in the post-compulsory sector

Comment taken from observation

Model development must help people to assess and address their negative issues with mathematics and numeracy. The use of questionnaires to get people thinking about their skills and their experiences may be beneficial. This is in an effort to acknowledge the negativity that is inherent within the subject area, address the problem and allow people to move on.

The question of why these skills are essential is also important for teachers to discover. Otherwise any implementation is working against a tide of negativity coupled with a tide of apathy characterised by the ‘why do I have to do this?’ questions found in the forum research in phase one and repeated by some of the participants in phase two.
The case study was also used to evaluate resources used to deliver functional skills mathematics for teachers. Those resources were developed fully for mainstream delivery of functional skills (see Appendices XXI-XXV Volume II) and were completed as part of an author’s contract. Several comments were extracted from the focus groups that were encouraging about the context used for teachers running through the resources and the realistic contexts used for teaching and learning.

I couldn't like soak it up, but you ask me how many ml are in a medicine spoon and I get it cos that's real.
Comment taken from focus groups

I noticed that there were teacher based worksheets
Comment taken from focus groups

Those are the ones I can't remember! What do you ever do with them in real life anyway?
Comment taken from observation

Can't believe I like coming to maths lessons!
Comment taken from observation

Lucas and Claxton (2011) encourage the use of reflection on educators’ current practice in the classroom to examine how they can incorporate an approach to developing ‘composite intelligence’. This rests on the development of ‘habits of mind’ this is where students are encouraged to examine a secondary learning aim in addition to their ‘subject aim’. One of the examples presented by Lucas and Claxton is a ‘split screen’ lesson in a school classroom where students examine ‘magnets’ and also their ‘questioning’ techniques simultaneously.

This is a useful concept which can be applied to the learning of numeracy for teachers and trainee teachers. Whilst we are learning numerical skills – what underpinning skills are we learning at the
same time? Or in the context of Lucas and Claxton’s work what types of intelligence are we developing through the learning of numeracy? This would lead us to develop an overt picture of the skills sets underlying numeracy learning. Lucas and Claxton present ‘myths’ about intelligence, which include the myth that intelligence is an intellectual function, separate from emotional and moral functions. They present intelligence as a fluid and flexible construct, inter-connected to the person in every sense, representing interplays of every facet of an individual make up, not separate from it in any way.

An examination of the possible skills sets which are promoted by the different aspects of numeracy is presented in Fig 13. This identifies the underlying skills sets in the context of teaching generically, providing a context for numerical learning for teachers. The table indicates that numerical learning provides transferable skills and these different cognitive skills are then placed into a teaching context.

Learning ‘habits of mind’ acquiring transferable skills and ‘tools’ for expanding intelligence and educating in a way that purposefully provides these tools and habits will therefore increase an individual’s intelligence (if examining the subject from the perspective that selects amount of intelligence as a factor). Numeracy has a propensity to provide a high number of ‘tools’ for further learning and the acquisition of ‘more’ intelligence, numeracy as a subject has an inherent strength which makes it foundational to other subject areas.

There is also the connection that numeracy is made more difficult to learn due to the connectedness of the individual – emotional response impacts on ‘learning’ intelligence. Learned techniques for improving or expanding intelligence or habits of mind are often shown to be inert – they do not: ‘come to mind spontaneously when they are needed’.

Since the habits of mind are embedded in numeracy learning they can be applied to other areas of intelligence. Rather than being taught overtly, transferable skills are there already and with some limited manipulation can be seen as overlapping between the different subjects taught. Skills in maths are often repeated, cancelling down fractions and ratios for instance relies on the same skills
set – when the connection is made the skill becomes transferable from one area of numeracy to another.

Having transferred one skills from another in maths, having that link pointed out and utilised, it is not a huge jump to then apply the same skill in another area, reducing something to its simplest form or summarising when writing a scheme of work for example. This provides an example of a transferable skill in a teaching context.

Any approach to delivering mathematics and numeracy for trainee teachers would need to take the development of transferable skills into account to be more effective. Assiter (1988) provides a definition of transferable skills which wasn’t entirely fixed, but was described as including ‘problem solving skills’ and ‘critical thinking skills’, with ‘numeracy’ mentioned in a list of more definite skills sets. These transferable skills developed through academic work are desirable in terms of creating employability skills, or in making a link between the world of learning and the world of work, responding to the needs of employers. Transferable skills rely on other aspects of a person’s makeup to be wholly effective. Confidence is required to fully apply transferable skills.

Individuals require different experiences that cover a broad range allowing them to disassociate specific tasks from specific skills and so genuinely utilise transferable skills according to Lucas and Claxton (2011). ‘Habits of mind’ has become a popular area for investigation in the education arena.

Thompson and Goe (2009) developed eight modules of study to support the development and operation of teacher communities specifically addressing assessment for learning. They aimed for teachers to develop ‘habits of mind’ over time that impacted positively on their practice in the classroom. Thompson and Goe reflected on a project implementation for assessment for learning that initially they found to be unsuccessful in many ways, they were honest in their reflections and critical of the products of their research, refining this continuously over a period of time to be more successful and to have more intrinsic impact. This honesty and critical approach are essential to ensure more effective practice and the reflection on phase two of the research presented here (case study) in professional development utilises the same approach. Without honest and critical
reflection an effective model cannot be developed for the delivery of teachers’ numeracy as professional development or part of initial teacher education.

Another element of the functional skills mathematics CPD programme delivered in the case study was the use of different methods in teaching and learning. Different approaches make it possible to cater for different needs and research tells us that ‘active learning’ is often effective. This is true of learning in more than one context and applies equally well to learning in mathematics and numeracy. Using a plethora of methods in terms of teaching and learning and providing access to hands on and active learning experiences is likely to be more effective at reaching all the different types of people involved in the learning experience.

In terms of curriculum models and the design of curriculum, McKimm’s (2007) report examined vertical integration which is level based, integrating aspects of different levels of learning, applying lower level skills to higher level problem solving for instance, horizontal integration which is integration between subject areas. McKimm described this as knowledge clustered in themes. This is much more difficult to achieve as it requires a high level of integration and problem solving skills, inherent in the functional skills curriculum itself. Learners undertaking a horizontally integrated course may need support to move away from a traditional and didactic approach to learning.

No single approach to learning is advocated, rather a synthesis or a mix of approaches and methods are most appropriate according to McKimm (2007) this includes horizontal and vertical subject and level integration, problem based learning approaches (such as case studies) and contextualisation.

Hirsh (2007) completed research into learning for the workplace and produced a report which consulted academia and major employers in the UK. She concluded that the research led to a multi-dimensional model of learning strategy as no one size fits all approach was suitable. Within the model development here for this research, the same conclusion has been reached, one single approach to learning will not suit all the people involved in the process and therefore will not produce the most effective or positive outcome. A plurality or methods has been presented as the
most effective model of delivery as this was commented on in evaluative comments from phase two of the research.

As one of a selection of methods, online learning as a tool was integrated into the functional skills CPD mathematics programme for teachers in the case study. According to Hill (2012) online education has steadily grown in popularity but has produced a false dichotomy between traditional educational methods versus online education. This is only true if we take the case of MOOCs (massive open online courses) which have been hailed in some areas as the replacement in higher education for lectures, seminars and face to face classes. This has been quite short lived though, even with MOOCs being free to access they do not produce a full qualification for the learner and in most MOOC provision in 2012 less than ten percent of registered students actually completed their course fully. Moving away from wholesale MOOC provision, Hill points out that there is now an interaction between educational courses, creativity and technology, which is likely to produce a positive outcome for the learner.

Bacsich (2012) presented five models of educational delivery ranging across different sectors of education, all with a virtual learning, blended learning or online/PC based element. These propositions for learning take account of movements in twenty first century education and beyond as the MOOC and the VLE take on larger and larger roles in our education systems. In some instances, ‘Coursera’ (USA based) for instance, who currently boast 14479275 online ‘Courserians’ taking courses online with a choice of 1086 courses in partnership with 121 different universities. All the courses are free to access unless a verified certificate is required. The online aspect is the only aspect of learning, for the ‘Open University’ for example a mixed delivery model is still the preference. Any model developed then requires the inclusion of technology and blended or multi-faceted delivery to improve the chances of success but online methods alone are unlikely to provide high levels of student attainment and must be coupled with other methods of delivery.

Hill (2012) insists that there is a real transformative power in the current generation of online educational delivery models which should not and can no longer be ignored, although there is no single answer or solution relating to online education in terms of ensuring that the participants learn.
Hill was examining higher education models rather than further education and the likelihood of students at the higher level to work independently should be acknowledged as an advantage over wholly online courses at the further education level where much more instruction and practice would be required for skill and knowledge development.

The main model developed is transposed into a diagrammatic form in Fig 8 where conflict and negativity are proposed to be addressed through several means including a review of the learners past experiences in the subject. The model of delivery presented is an overview detailing the methods addressing the research findings of conflict and negativity. This includes a review of perceptions and identification of underlying numeracy skills to enable teachers’ to engage more intrinsically with numeracy as they are relating this aspect of learning to themselves and to their own subject areas. Contextualised delivery is also proposed and the whole model includes reflection, however this must be built into learning episodes for the learners. Evaluation and reflection are intended to be used as part of the learning in numeracy including collaborative working with peers, examining the application of numeracy within their own practice and evaluating those experiences. These measures in part are expected to allow teachers’ to not only immerse themselves more fully in numeracy as a subject but to support teachers to internalise positive experiences in the subject. This overview representation is then broken down into component parts in further diagrammatical representations.

The notion of a hybrid delivery model is presented in Fig 9 incorporating the three main methods of classroom, flipped and online learning. This expansion of the original model highlights how these aspects can be categorised and integrated to provide a rounded style of mathematics and numeracy delivery for trainee teachers. The hybrid model was applied in the case study in phase two of research and evaluative comments indicate that this approach was popular with the teachers undertaking the programme. The model was not suitable resourced and was not in place and ready to use immediately. Essentially a hybrid model needs to be well planned to allow the plurality of learning approaches to be wholly effective and to integrate with each other fully.
In Fig 10 the main research findings are expanded with the measures which can be used to address conflict and negativity. Self-assessment activities are advocated as a way of questioning students to make them think about the way they have approached these subjects previously and to examine how they feel about their own levels of numerical skills and negativity. Within this hybrid model, online learning is proposed to be more interactive with the other aspects of flipped and classroom learning. Links to online work are suggested by this model including assessment and activities which can be signposted from any class, not just a maths class. Using questionnaires is suggested as a way of provoking teachers to examine their own skills, their previous experiences and their views on numeracy. This could be achieved through other methods, but those learning should be encouraged to assess themselves and evaluate their own areas for development, identifying ways to move forward with positive momentum. Reviewing and evaluating is also suggested as a way to motivate teachers’ to think about the numeracy content of their subject and how they can best support learners in their classrooms. The expansion lists the use of contextualisation, evaluation, review and evaluations to counterbalance the strong negative aspects of the research findings overall.

The Fig 11 expansion relates to teaching methods and resources, listed under the headings active, online, assessment and contextual. Teaching can be seen as a profession where the individual teacher invests a lot of themselves in their classes. Trainee teachers will mimic what they see demonstrated when they become teachers in their own classrooms. If what they have seen is integrated, well planned and executed, resourced and integrated, especially with relevance to numeracy and mathematics as part of their course, they are more likely to replicate this delivery themselves.

The final expansion is Fig 12 which presents the online or virtual aspect of a possible model of delivery. Online delivery should not be viewed as a substitute for other essential aspects of a full course unless the course is a MOOC and is delivered online only. Online work can make a course fully supported and increase availability for students. Self-assessments for students, videos and podcasts, research links and downloadable material can all be used to enhance delivery and
support any flipped learning for students. Using online methods of delivery does provide a virtual learning environment where real interaction can take place and does provide a repository where all course documentation can be stored, but there is the question of; what happens when the I.T. is not working? Any course would have this problem and so hard copy must be available to support online delivery methods.

6.5 chapter summary

This chapter has examined the case study which represented phase two of the research. This was followed by a critique of the CPD programme from the case study and coupled with the feedback and information from phase one of the research leads onto an examination of model development for delivery of teachers’ numeracy and mathematics.

The model development is reliant on all the other stages of research to provide a foundation, the perception and opinion investigation undertaken in phase one of research provided a clear indication that people have a very negative perception of both mathematics and numeracy and of their own experiences within those subjects. This linked to phase two of the research where the same information was apparent in the case study. Throughout the findings conformed to negativity and conflict in both phases of research.

Research into curriculum model development indicates that evaluation is an important aspect which requires incorporating into models of delivery and a plurality of methods utilised for teaching and learning helps to avoid the ineffective one size fits all approach. Also to come out of the research were indications that context and active learning have part to play in producing an effective curriculum model for the delivery of teachers’ numeracy. Possible aspects of a model for delivery of teacher numeracy from the research completed would include the use of a softer skills questionnaire for numeracy (to identify maths anxiety and negative past experience) and a skills
preference questionnaire (formerly known as ‘learning styles’) not to diagnose an individual but to identify different methods that may appeal to their preferences.

Relating mathematical and numerical learning to ‘real’ life skills, events and situations, especially those that are relevant to the individuals that make up a group would be beneficial to provide some context to learning new skills and knowledge; this includes relating mathematical and numerical learning skills to vocational contexts if appropriate.

The synthesis of horizontal and vertical delivery models would enable people to identify underlying skills provided by numeracy and mathematical learning to clarify the reasons behind learning in mathematics and numeracy and ensuring that people identify numeracy skills in their own vocational teaching area, selecting skills from a list provided and promoting the ability to identify numeracy skills in teaching generically would support evaluative methods.

A model has been developed which presents each of these areas taken from the findings within this research. The main findings were negativity and conflict. The model developed aims to address these aspects within delivery of teachers’ numeracy, coupled with elements evaluated and observed through the case study, to be effective. The main aspects are presented in a simple diagrammatical format. This is then expanded upon to clarify a full model for delivery, with several different expansions of the original model provided as an explanation of different areas.
Fig 8 - Model of delivery for teachers’ numeracy

**Evaluation**
- Evaluation and reflection built into sessions
- Learning review
- Contextualised delivery relating to real life situations
- Contextual resources
- Perception review
- Identification of underlying skills
- Examine different learning choices
- Examine and address negative perception
- Review past experiences in mathematics and numeracy

**Methods of delivery**
- Course delivered through a plurality of methods for teaching and learning
- Individual learning via textbook/online
- Flipped learning methods
- Learning at own pace
- Co-operative or collaborative learning
- Different learning choices
- Online learning

**Hybrid model**
- Interaction with peers and group-work
- Learning review
- Identification of application in context of vocational areas

**CONFLICT**

**NEGATIVITY**
HYBRID DELIVERY MODEL

Online learning
- Resource repository
- Links to online content
  (You tube/Khan academy)
- Course content
- Assessment

Classroom
- Hands on activities
- Active learning
- Questionnaires
- Peer working
- Evaluation and reflection
- Reporting back on numeracy in class groups

Flipped learning
- Textbooks
- Written worksheets
- Link to online work

Fig 9 - Expansion one, the hybrid delivery mode for teachers’ numeracy
Fig 10 - Expansion two, addressing the research findings through the teachers' numeracy delivery model

**Measures to address conflict and negativity**

- **Questionnaires**
  - Self-assessment of own skills
  - Self-assessment of previous experiences
  - Self-assessment of own viewpoint

- **Contextualisation**
  - Teacher or trainee teachers vocational subject area
  - Generic teaching context
  - Real life or realistic context

- **Reviews**
  - Review of own skills development
  - Review of numeracy sessions
  - Review of attitudes and opinion to numeracy

- **Evaluations**
  - Application of skills in own lessons with learners
  - Identification of underlying numeracy skills in own lessons with learners
  - Reporting back on progress in own sessions with numeracy
Fig 11 - Expansion three, teaching approaches and resourcing a delivery model for teachers’ numeracy

**Teaching and learning methods/resources**

- **Active learning**
  - Hands on activities
  - Collaborative peer work
  - Real life objects/artefacts

- **Online VLE**
  - Catalogue of resources
  - Information/links
  - Interactive assessments

- **Assessment**
  - Self-assessments for negativity/past experience
  - Practice tests and test preparation
  - Learning styles assessment

- **Contextual learning**
  - Vocational contexts
  - Generic teaching contexts
  - Real life contexts
Fig 12 - Expansion four, online aspects of the delivery model for teachers’ numeracy

Discussion and evaluation tasks
Initial and diagnostic assessments (interactive)
Information for reference
Worksheets to print and complete
Practice tests online (interactive)
Course information
Self-assessments of skills
Case studies/scenarios
Course structure and documents
Revision texts
Learning videos and podcasts
Self-assessments to print and complete
Test preparation activities
Links to other sites
Information on contexts
Fig 13 - Underlying numeracy skills demonstrated for teachers and trainee teachers

Outline of numeracy skills and underlying skills inspired by work from Lucas and Claxton (2011)

<table>
<thead>
<tr>
<th>Numeracy subject area</th>
<th>Underlying transferable skills inherent in the numeracy subject area</th>
<th>Underlying teaching context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculation, addition, subtraction, multiplication and division</td>
<td>Identifying patterns and making connections – numerical patterns within the multiplication tables or repeated answers from completing a digit sum. Problem solving – deciding which operation or combination of operations to use and in which order. Logical thinking, sequencing and organising – working out in order patience – checking answers and applying algorithms to gain an answer may be a lengthy or frustrating using a process or method – Applying the process of an algorithm. Improvisation - getting to an answer using a quicker method or refining methods to be most efficient. Manipulating an abstract.</td>
<td>Supporting student groups with their own numeracy skills development. Error identification. Sequencing in scheme of work construction. Sequencing in lesson planning. Applying a process through provision of appropriate instructions Working with abstracts systematically.</td>
</tr>
<tr>
<td>Decimals, place value</td>
<td>Using money – standard currencies including the pound, the dollar and the euro utilise a decimal system. Identifying - the difference between £1 and 1p even though the numbers are the same. Linking concepts together - Linking place value for whole numbers with place value for decimals. Use of use of boundaries - the decimal point as a demarcation or boundary.</td>
<td>Supporting students with financial literacy. Personal finances. Identifying overlapping areas of curriculum and syllabus Identifying boundaries.</td>
</tr>
<tr>
<td>Measurement of length, weight and capacity</td>
<td>Physical manipulation - manipulating scales to measure amounts. Interpretation – the concept of size, weight or length in relation to a real life phenomena or object.</td>
<td>Converting between student scores and corresponding levels of progress. Following procedures required in the teaching profession.</td>
</tr>
<tr>
<td>Conversion – use conversion factors between metric and imperial systems and within the metric and imperial systems. Estimation is often a part of measurement – often embedded and completed as a matter of automaticity (making cordial for instance) Following a simple process - procedural nature of weighing and measuring.</td>
<td>Estimating student levels to support differentiation in the classroom Conversion between percentiles, raw scores and grades</td>
<td></td>
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<tr>
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<tr>
<td>Estimation is often a part of measurement – often embedded and completed as a matter of automaticity (making cordial for instance) Following a simple process - procedural nature of weighing and measuring.</td>
<td>Estimating student levels to support differentiation in the classroom Conversion between percentiles, raw scores and grades</td>
<td></td>
</tr>
<tr>
<td>Measurement of time, clocks seasons and calendars Establishing order – the sequence of months and years, minutes and hours. Planning - using time as a means of communicating – meeting times. Development of a time memory - for hours and minutes, getting up for work at a certain time. Timing tasks - estimating how long something will take.</td>
<td>Teachers time management Timing in lesson planning Timetabling for classes. Curriculum planning. Assessment planning. Analysing student performance</td>
<td></td>
</tr>
<tr>
<td>Averages, range, mean, median and mode Judging – examining the norm and comparing information. Comparing – making direct comparisons through averaged information, examining differences between population spreads. Developing a view of the world - understanding social phenomena in a numerical form. Relating – viewing information with different criteria in relation to numbers.</td>
<td>Assessing student work against the national average or cohort score. Calculating or engaging with measures of comparability including value added measures. Relating statistical information to students. Collating student performance data.</td>
<td></td>
</tr>
<tr>
<td>Graphs and charts, pie charts, bar charts, line graphs Visualising – transforming data and numbers into visual forms. Gathering information – collecting data. Dissection – breaking data or numbers down to form a visual representation. Articulating – presenting information in a different form.</td>
<td>Viewing trends in patterns of attendance or tracking and monitoring behaviour or progress. Value added calculation and application Plotting trends</td>
<td></td>
</tr>
<tr>
<td>Analysing – producing a visual analysis or interpreting a visual. Presentation of numerical information. Questioning – what does this graph/chart/table show?</td>
<td>Formula, algebra</td>
<td>Manipulating and exploring – using trial and error methods to solve an equation. Using logic and understanding consequences – examining the effects of different circumstances on variables. Simplifying or summarising – collecting like terms together, cancelling terms in equations. Experimenting – finding different ways to arrive at the same answer or different formulas for the same thing. Articulating – expressing real life scenarios in formula. Following rules – using the accepted methods in algebraic manipulation to solve problems</td>
</tr>
</tbody>
</table>
Chapter Seven – Discussion
7.1 Chapter introduction

This discussion places the completed research and research findings into the context of other strands of research completed within numeracy for teachers as a subject area. Elements which impact on this area include the different aspects of legislation that have been enacted relating directly to teachers numeracy, including GCSE and teacher education reform relating to professional skills numeracy tests and the change from the IFL to the SET in the post-compulsory sector. Information was scarce when the research was initiated and this has changed over time with more resources and more information being available through the course of the research, but is still not comprehensive.

In terms of a contribution to knowledge made by this research, the main research findings of negativity and conflict are examined in relation to the original literature review completed. The depth of negativity particularly is examined and the conflict experienced by practitioners, teachers and institutions is examined.

The methodology employed for this research is examined and reviewed in terms of being a newer and emerging twenty first century method using the internet as a source of raw data. This includes the model for delivery that has been developed being examined in the context of curriculum design, using emergent technologies to support teachers learning and applying numeracy.

The products of research are the tangible aspects that have been completed and result in actual elements that can be referred to. These include an article and published resources which emerged from the research process.

7.2 Legislation and reform

Legislation and reform of the compulsory education sector in England has had an impact on teachers’ numeracy. The implementation of a new national curriculum at key stages 3 and 4 states
categorically the importance of mathematics to the curriculum as a whole in secondary schools in England:

‘Teachers should use every relevant subject to develop pupils’ mathematical fluency. Confidence in numeracy and other mathematical skills is a precondition of success across the national curriculum’. (DFE 2013 P. 3)

The guidance for implementing the new curriculum then elaborates with information relating to specific numerical skills and how these should be applied over different subject areas to reinforce mathematical learning but also to raise students’ attainment in other subject areas. This is reminiscent of the ‘embedding agenda’ within the lifelong learning (formerly FE) education sector. The guidance for the national secondary curriculum describes mathematics as an ‘interconnected’ subject allowing students the ability to apply their mathematical ideas in other subject areas.

Any questions here are not founded on whether the information is right or wrong (this premise agrees with the main principles of the research work conducted here) but more on the practicalities of achieving this aim. How can the new curriculum be successfully implemented? What tools and resources will teachers need to do this? What are the support mechanisms and resources available to support implementation of this curriculum? This leads us directly back to the original research questions for this research which centred on the perceptions of numeracy held by trainee teachers or teachers, the support mechanisms available to support their learning and the improvement of delivery of teachers numeracy to make it more successful.

The premises of these questions point to a clear overlap between the implementation of new curriculum for secondary mathematics and the implementation of mathematics for teachers and trainee teachers. The questions in each instance are essentially the same. Teachers will be forced to examine different subjects for the underlying mathematical skills contained but may not be given the tools to do so in practical application.

New curriculum design for the GCSE system has speeded up the process and funding rules related to mathematics and English in the post-sixteen arena has led to significant changes. In this
particular sector, students must continue into further education or apprenticeship studying towards GCSE mathematics if they failed to gain the C grade. Further education providers have a responsibility for this provision alongside A-level and diploma provision.

Funding is contingent on mathematics and English study, if a student needs a GCSE in mathematics and is not working towards this whilst simultaneously working on their further education main learning aims, then no funding will be drawn down for them. This would have some severe financial consequences for any further education college or post sixteen learning provider not conforming to the requirement for GCSE provision. The Education Funding agency (2016) sets out the conditions of funding relating to GCSE in post 16 provision as follows:

‘Full time students (those on a study programme of at least 540 planned hours if age 16 to 17 or at least 450 hours if age 18) starting their study programme who have a grade D GCSE or equivalent qualification in maths and/or English must be enrolled on a GCSE or approved IGCSE qualification, rather than an approved stepping stone qualification.

A student who has grade D in both maths and in English will need to be enrolled on GCSE or approved IGCSE in both subjects in each academic year and is required to continue to study until they achieve at least a grade C’

For the compulsory schools sector mathematics GCSE counts as a double qualification for progress measures and English has both the literature and language components ensuring that this is also a double value subject. Schools may not have a condition of funding in the same way as Colleges and sixth forms but they do not escape the focus on mathematics for their essential performance indicators.

Further GCSE changes include the change to a wholly linear structure removing any coursework or modular options and the ‘new’ GCSE for first accreditation in 2017 is tiered numerically rather than alphabetically with a 9 to 1 stratification of levels rather than A* to G allowing for some sub-levels of attainment to be taken into consideration more than they would with the alphabetical system. The new system will align with a grade 4 representing a ‘C’ grade pass for the first two years to allow transition, this will then change to a grade 5.
The numeracy test for professional skills in the compulsory sector has been addressed with reforms that include a limit on the number of tests a trainee can take, now limited to three opportunities in total, a change to when the test is available for them to complete, at the beginning of their course rather than towards the end of their studies and a shifting of responsibility to the trainee rather than the institution for completion of the test. The test has also changed name from QTS numeracy to professional skills numeracy.

For teachers training in the post-compulsory sector the minimum core of numeracy is still a requirement within the training course. Further options have been made available to upskill both trainees and practicing teachers including courses and information from the National Centre for Excellence in Teaching Mathematics (NCETM) providing courses, training and conference events to raise the profile of numeracy for teachers. The National numeracy organisation has been developed online which relates only to adult numeracy, not specifically for teachers this is a new development in the subject area more generally. This movement towards a more robust level of provision to meet the needs of teachers and students especially within the post-compulsory sector is likely to be a response to the funding requirements in that sector.
Changes have taken place in the post compulsory sector of education with numeracy being seen as a stepping stone rather than an equivalent qualification. Functional skills mathematics is now seen as the stepping stone qualification which can lead to a GCSE qualification in mathematics rather than an equivalent to the GCSE C grade when completed at level two. This stepping stone has also been removed for students in the sixteen to nineteen bracket with GCSE taking priority, any student with a grade D must study towards their GCSE unless there are special needs and special circumstances which prevent this.

This does make some sense if the prior national qualifications framework is taken into account.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Entry Level Certificate</th>
<th>Entry Level</th>
<th>Entry Level Certificate</th>
<th>BTEC Entry Level Certificate</th>
<th>Entry Basic Skills</th>
<th>E2E Entry to Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Nationals Level 1</td>
<td>NVQ Level 1</td>
<td>Level 1 Certificate</td>
<td>BTEC Introductory Certificate, Diploma</td>
<td>GCSE (D-G)</td>
<td>OCN Level 1 BHS Stage 1 E2E</td>
</tr>
<tr>
<td>Level 2</td>
<td>Nationals Level 2</td>
<td>NVQ Intermediate Vocational GCSE (A*–C)</td>
<td>NVQ Level 2 Apprenticeship</td>
<td>General Qualification Level 2</td>
<td>BTEC First Certificate, Diploma</td>
<td>Basic Skills Level 1 Key Skills Level 1</td>
</tr>
<tr>
<td>Level 3</td>
<td>Nationals Level 3</td>
<td>AS/A2 in Applied Subjects (formally A/S/VCEs)</td>
<td>NVQ Level 3 Apprenticeship</td>
<td>General Qualification Level 3</td>
<td>BTEC National Certificate, Award Diploma</td>
<td>AS Level, A2 Level (A5+A2=full A Level)</td>
</tr>
</tbody>
</table>

Fig 15: Sample taken from the national qualifications framework

Those with a level two qualification would then have completed their stepping stone and would be progressing to the GCSE to top up to a C grade. This produces a small amount of disparity between levels as the level two functional skills qualification essentially becomes an extended D grade equivalent. From the diagram we can see where this discrepancy now occurs, previously the level 2 was clearly aligned with GCSE A – C grade and this is changing to level 2 functional skills being on a continuum rather than aligning with the GCSE grades.

Functional skills qualifications in mathematics with their focus on problem solving, do contain very little of the traditionally more ‘difficult’ or abstract elements contained in GCSE mathematics.

Functional skills have been incorporated into the GCSE mathematics specifications. The changes in specification and the slight disparity within the qualifications framework further demonstrates that the functional skills qualifications are ‘lower’ in status and content than the GCSE.
Students in schools, colleges and sixth forms are facing a more rigorous, demanding, broader and more in depth GCSE syllabus in mathematics, those training to teach in the compulsory sector are subject to the newer legislation relating to their QTS tests for numeracy which has seen the success rate plummet by more than twenty five percent, what of those in the post-compulsory sector?

Those trainee teachers who need to evidence Level 2 standards of mathematics in a general sense, only need to provide solid evidence if they intend to gain QTLS status through the professional formation process, which is not compulsory and may continue in their work roles uninterrupted, regardless of their mathematics or numeracy qualification. It is unlikely that this situation will continue as Ofsted is now using a common inspection framework and more and more colleges are calling for their maths teachers to be mathematics graduates and their lecturers in other subjects to be able to evidence their maths and numeracy skills. The review of literature initially also demonstrated that most of the surrounding information in the educational landscape was negative, indicating that a lack of numeracy skills was related to the life chances of individuals having a negative impact on society in general in an economic sense.

One report from Leitch (2005) examined a lack of skills for industry, reporting on the impact of essential skills gaps, this informed legislation and curriculum reform in relation to the basic skills, functional skills and GCSE mathematics curriculum. Leitch identified the negative impact of basic skills gaps in terms of their effect on employers, micro-economies and the macro-economy. The Leitch report has previously always been seen in relation to schools and colleges preparing students for the workplace but here the Leitch report can be viewed from a different perspective. Skills gaps occurring in numeracy have been identified here through the research and although Leitch did not present education as an industry sector, the findings in this research can clearly link with the gap in teacher skills as an industrial skills shortage or employment skills shortage. Teachers could be effecting students’ achievement and attainment negatively in terms of a lack of skills or the negative attitudes of the teachers themselves. The legislative context provides the backdrop to the contribution that this research makes to the knowledge base surrounding teachers’ numeracy.
7.3 Contribution to knowledge - negative and conflicting views

Negativity and conflict represent the main research findings here. Some teachers demonstrate negativity by attempting to avoid the subject wherever possible, the data collected from HEIs which showed on analysis a desire to present a very positive view of course requirements that did not include numeracy and mathematics in many instances. Conflict was apparent between the need to maintain professional standards as a teacher and the desire to conform to the personality traits normally expected of teachers in any sector of education.

Askew et al (1997) examined teachers’ experiences in teaching mathematics and their underlying pedagogies and approaches to professional development. Askew et al: teachers with limited mathematical understanding are not likely to be very effective, but presented no evidence that teachers with strong mathematical knowledge are better teachers. Lenon (2013) identified through research that a high level of subject knowledge was essential for teachers to be ‘good’ in their profession and be effective in the classroom. Callingham et al (2015) stated: ‘It is difficult, however, to imagine ways in which mathematically poorly informed teachers can effectively meet students’ needs’. P. 559. Within the work of Callingham et al there is the overall sense that numeracy relates strongly to critical thinking skills, problem solving and context, being distinct and separate from mathematics and reviewed as a concept across several different nationalities.

The relationship between subject knowledge and effectiveness as a teacher (in terms of pupil gains) was examined during the course of Askew’s research, with an inverse relationship between the two being found, higher qualifications in mathematics did not impact positively on pupil gains. The pedagogy of the teachers involved correlated more with pupil gains than did their own mathematical education.

While these highly effective teachers had generally, but not universally, overcome these negative views to become confident and connectionist in their views of mathematics, it is clear that other teachers, especially the transmission-orientated teachers, still saw mathematics as a fragmented
set of techniques and knowledge to be memorised. Thus the cycle of negative attitudes was likely to be reproduced in future generations of pupils.

From analysis of forum data teachers have expressed that they do not feel wholly prepared to teach any kind of numeracy especially, since they feel that they themselves are lacking in mathematical attainment. This negative self-perception attributed to the self-image of a teachers own ability in mathematics has an effect on the teachers entire emotional state and may then influence in turn the way that individuals perceive themselves (Jacoby, 1997). This negative influence on the ego for the teacher may lead to avoidance of numeracy or mathematics learning altogether wherever possible. This can also extend to those individuals who teach numeracy or mathematics.

If I do the level 2 I'll fail. I know I will. I've been registered to do the level 2.
Comment taken from observation

I think I'd rather do the level 1 and then I won't be embarrassed. I can do the level 2 next year can't I? I don't have to do it now do I? No? Thank goodness!
Comment taken from observation

I have done the diagnostic for the maths but I want to do the level 1 instead of the level 2.
Comment taken from observation

The negative views of mathematics and numeracy held by teachers' impacts on their practice as teachers (in this instance) more than their actual knowledge base. The perceptions of numeracy and feelings engendered by these subjects are ultimately more important than the actual knowledge involved. A lack of knowledge is a barrier that can be easily overcome by learning and achieving, negative feelings are much more difficult to eradicate.
White et al (2006) examined trainee teacher beliefs about their mathematical and numerical skills in Australia’s primary education sector. They found little correlation between beliefs and attitudes and actual attainment or ability to teach mathematics. They found that negative beliefs especially relating to individuals ability and confidence were visible in their data but that these did not correlate as a positive attitude did not indicate success in terms of application of skills. They concluded that a positive attitude on its own was not sufficient to succeed, trainee teachers also needed to have the appropriate subject knowledge.

White et al concentrates on primary levels of numeracy being taught as a subject and it has some similarities to this research but is in no way specific to the teaching of trainee teachers’ numeracy overall and so direct comparisons cannot be made. The research results of White et al were interesting in that they clearly identified that a positive change in attitude alone was not enough to be effective but that this was important for success.

Uusimaki and Nason (2004) examined Australian pre-service teachers’ negative beliefs and anxieties about mathematics. The methodology used by Uusimaki and Nason included interviews in a semi-structured format. Crucially the participants volunteered to participate in the study meaning that the data was not naturally occurring and that participants may be subject in some instances to the ‘Hawthorn’ effect, or experimenter bias.

A lack of conversation and forum postings especially with reference to the post-compulsory sector was clear especially with the few questions in this area being posted without responses over a period of several years. A lack of awareness especially in the post-compulsory sector was apparent through the research, although newer legislation in further education particularly funding legislation is affecting a change in that situation.

Initial internet searches and a critical review of resources to deliver teachers numeracy produced very limited results. This was given more clarity on investigation when it became apparent through comparisons of the data collected that there was an abundance of information for those training in the compulsory sector but not for those training in the post-compulsory sector. Higher education
institutions, advertising the entry requirements for courses of teacher training also demonstrated a type of negativity. Data collected from prospectuses demonstrated no negativity when analysed and indicated that it was unpopular to mention the mathematics or numeracy requirements for courses of teacher education especially again in the post-compulsory sector.

Conflict took several forms, between professionalism and the traits of a teacher persona, identified by Orlando (2013) as very caring and warm, these teacher traits may not fit well with the need for professionalism and may provide a conflict in values and moral beliefs of the teacher (Richardson, 2014) Conflicts between providing information and not producing negativity in HEI prospectuses and conflicts observed in language and learning expectations were found when analysing the data from phase two of research especially. More research is needed into how people interact via the internet in terms of their conversation and how their self-perception is built up into an online persona before we can ascertain how truthful these exchanges really are in forums. LIWC analysis indicated the use of formal text features within forums and informal features in focus groups. This indicates that people do converse differently via the internet than they do face to face, the significance of this difference is a matter of speculation and inference.

There was a notable conflict between the resources required to support the delivery of teachers' numeracy and those provided to be able to do so. A lot of reliance is placed on teacher educators, the assumption being that these people will be able to deliver numeracy and mathematics for trainee teachers without difficulty. Within phase two of the research, it was clear that some individuals didn’t relish the idea of delivering CPD for their colleagues without any additional training, information, guidance or resources.

The main research findings of negativity and conflict were integrated into the model of delivery, allowing for these aspects of the research to be addressed to improve the situation surrounding the delivery of teachers’ numeracy.
7.4 Contributions to knowledge - Developing a model for delivery

The model for delivery presented was developed utilising results and analysis taken from both phases of the research process, phase one and two. This results in a curriculum model for delivery which has been broken down into several parts for clarity. Clarity is vitally important according to Bacsich (2012) who examined model archetypes for curriculum insisting that these should be universally understood to be of practical use.

The model takes the stages of curriculum development into account which were described by McKimm (2007) as including an appropriate evaluation strategy. This is essential and was clearly missed in the original delivery of the functional skills CPD course in phase two forming the case study. Evaluation was not seen as part of the process by the institution responsible for delivery and so this was not incorporated either as part of the formative or summative process of delivery.

Evaluation is a part of research and curriculum delivery that is often missed (Hirsh 2007). This aspect is also encouraged by Lucas and Claxton (2011) who recommend reflection by educators on their current practice in the classroom to be more effective in the development of composite intelligence or transferable skills (Assiter 1988) and habits of mind.

The model utilises a hybrid approach to learning, partially used in the case study. Often termed ‘blended learning’ which Bacsich (2012) sees as any model of curriculum delivery that combines instruction face to face and classroom work with any PC based activities or online provision. Hirsh (2007) examining workplace learning concluded that a multi-dimensional model of learning strategy was the most appropriate since ‘one size fits all’ approaches were not as successful in terms of achieving either the employer’s goals or the employees or students goals.

Evaluation was a useful part of the process and in any replication cannot be missed as insights can be gained. In this research the insights were useful to develop model resources to support delivery.
The model proposed also includes online versions of learning, although not on the scale of MOOCs. Online learning can add another dimension and benefit teachers learning numeracy, this being a popular way to learn according to Hill (2012).

Addressing the research questions with particular reference to the final research question requires the delivery of functional skills mathematics at level 2 for teaching staff within an educational institution (further education) college. Different media, methods and resources were used to facilitate the development of a model for delivery of this type. The case study is directed towards answering the final research question, but the previous aspects of the research process cannot be ignored as they provide supporting evidence. No one size fits all approach is likely to work because as is apparent from the research findings, all trainee teachers are different and will respond to the subject of mathematics and numeracy differently.

The collection of comments and opinions expressed directly (with direct permission), were collected from participants in the continuing professional development programme and analysed through qualitative coding to provide feedback on the model used with the aim of refining and developing a more effective model of delivery.

Research to gather data on teachers undertaking functional skills mathematics concentrated on their perceptions, opinions and experiences. Staff may have gained confidence, a certificate or a better job from the completion of their functional skills mathematics at level two. This is not the subject of the research work here however. Here, the implementation of the model for delivery is the primary focus, with a view to improvement in perception and teaching and learning in the subject for teachers.

The interaction between the subject area, the model of delivery and the teachers’ perceptions represent the focus of investigation. Effectiveness is not being measured by achievements or outputs. We cannot find out what people think and feel from checking their exam results. In this instance the desire is not only to examine the status quo, not only to affect some improvement (as change) but also to create ‘new’ knowledge McNiff and Whitehead (2005). Analysis on completion
of delivery has cohesively tied together the information from the research aims presented to culminate in a development in approaches to teachers numeracy provision.

The development of models and theory in this way, built on data analysis and research, provides an informed summation. The distinct stages of research, separated by the different aims presented, provide a “cross check” facility for the researcher (Meyburg and Metcalf, 1996), testing the consistency of responses and evaluations from one stage to another (Garson, 2007). The completion of the differing research stages culminates in action, informing theory, leading to an improvement in the learning experience, the rationale for much of the research conducted by teachers (Evans, 2002).

Phase one of research was cross checked against phase two results to enable checking of what people say (in forums for instance) against what they do (in the CPD programme). Taking all the evidence together no discernible discrepancy was fund between the two sets of data. Teachers and trainee teachers exhibited significant amounts of negativity and conflict through both phases, what they said and what they did conformed to individuals with a negative perception, a conflict between professional identity and the requirement to exhibit what are seen as teacher traits conforming to the expectation of a teacher.

The development of a stronger knowledge base is essential in numeracy since teachers can learn from and with each other but only if they have a strong knowledge base to work with (McNiff and Whitehead, 2005). A more identifiable link may become apparent between teachers and lecturers in the secondary and FE sectors of education, since these two areas are likely to overlap, with FE lecturers in some areas entering into school teaching, as recommended by Alison Wolf (2011) in her report on vocational education. This recommendation may lead to a more coherent form of numeracy element in teacher training, where all teaches and lecturers will comply with the same levels of expectation. This is likely to be further enhanced by the parity between QTLS in the post-compulsory sector and QTS in compulsory sector, where lecturers are now licenced to teach in schools.
This research draws together the use of e-learning and new technologies for research purposes, linking abstract and stylized concepts with the real world's complexities, to provide further support mechanisms adding to the limited body of theoretical frameworks, currently relating to trainee teachers numeracy in education and training in England. The development of theory in relation to practice is essential if practitioners are to avoid the being uncritical and accepting routine ways of approaching their work which is a danger described by Everitt et al (1992). According to Gregson (2011) there are an increasing number of students taught by inexperienced and underprepared teachers, which in turn leads to an ever decreasing pool of educational opportunities for others.

Providing different ways to learn the content provided in the case study was evaluated as being a supportive measure in delivery of mathematics for teachers. Being able to respond to different learning approaches in this way was seen as being beneficial. This approach is one way of responding to the conflict that was clear in the responses to different methods of delivery. A positive conflict was observed with some limited amounts of positive feedback in focus groups from this approach.

Context was another aspect of evaluation, this was expected but not solicited as the data throughout conformed to a naturalistic study. Although only a small part of evaluation this was significant as it conforms to several other numeracy studies which also indicate that appropriate contexts yield favourable results for those who have previously failed in mathematics or numeracy.

As part of the model of delivery mixed methods were used to accommodate different learning preferences. These included hands on learning and contextual learning to provide a learning experience in mathematics and numeracy which holds relevance for the individual teacher or trainee teacher. In addition to this, flipped learning methods such as e-learning and online course content are coupled with more traditional methods revolving around individual tutorial and classroom learning.

From this set of different methods that teachers had to choose from, either in combination or by singular method the experience provided some evaluative comments from participants which
support several of the methods in preference to others. Information of an evaluative nature was
taken from both focus groups and observation.

Lucas and Claxton (2011) encourage the use of reflection on educators’ current practice in the
classroom to examine how they can incorporate an approach to developing ‘composite intelligence’.
This rests on the development of ‘habits of mind’ this is where students are encouraged to examine
a secondary learning aim in addition to their ‘subject aim’.

Whilst we are learning numerical skills – what underpinning skills are we learning at the same time?
Or in the context of Lucas and Claxton’s work what types of intelligence are we developing through
the learning of numeracy. This would lead us to develop an overt picture of the skills sets underlying
numeracy learning, which would include broad experiences where individuals can reason and
imagine. Habits of mind must be worked on, practiced and some clarity must be provided for these
habits to become useful and truly transferable. This is really necessary as there are many teachers
who cannot see where numeracy has any relevance to them as individuals or to their teaching
subjects at all:

| why should you need to pass your Maths skills test when you're teaching English or Languages? |
| Comment taken from forums |

| the ability to spell correctly will come in greater use than the ability to correctly calculate timed mental questions. |
| Comment taken from forums |

| since I am training to teach Secondary English, I really don't see what being able to do mental arithmatic in a timed situation has to do with my ability to teach my subject. |
| Comment taken from forums |

The main aspects of the model developed for delivery of teachers numeracy is a hybrid model of
curriculum, designed to incorporate the research findings utilising the evaluative data from phase
two of research. The model proposes to examine softer skills (to identify maths anxiety and negative past experience) identify skills preferences and provide a link between mathematical and numerical learning with ‘real’ life skills, events and situations. The model also proposes that mathematical and numerical learning should be linked to vocational contexts (teaching and any subject areas to be taught if appropriate) Learning via the proposed model should identify underlying skills provided by numeracy and mathematical learning clearly and allow teachers to identify numeracy skills in their own vocational teaching area and identify numeracy skills in teaching generically.

7.5 Contributions to knowledge - Innovative methodology

This research analyses data taken from the internet in the form of forum postings on education. Also analysed are other aspects of conversation and discussion which are collected from observation and focus groups in phase two of the research process. All the data collected for this research is in the form of words, text, conversation, accounts and discussions.

Convery and Cox (2012) concentrated on ethics in analysis of ‘e-conversations’ as an accepted method of collecting data for research, the main aspect that they pointed to was whether data was public or private. Even data that was in the public domain would have implications for use in terms of ethics if that data were in such an area that individuals would not expect their conversation to go further than a very select group (in a chat room for example).

Following the work of Ryan (2001) in analysing qualitative data, this research attempts to link the data to the research questions which were formulated originally. This rests primarily on how others make sense of their experiences; analysis is a form of decoding this sense making activity. Ryan described the whole process of research as cyclical rather than linear but that this did display a tendency towards having distinct stages which included dissecting the data for broad themes, asking questions about those themes emerging, examining tentative conclusions and evaluating the
individual researchers input in terms of what we focus on and why when analysing the data that we’ve collected.

The work of White et al (2006) in their study of numeracy teachers also used qualitative data analysis that relied on coding and a constant comparative method with main themes emergent from the data itself. All of the data collected for this research has been subject to this initial process of examination for broad and emergent themes, although this has been conducted with depth in mind, what is provided is descriptive (at that stage) rather than analytical. Ryan (2001) points out that this description in part provides initial analysis in terms of processing the data leading to abstract thinking or theorising allowing inferences to be drawn.

The more difficult aspects of analysis can be seen when we subject our findings to more in depth scrutiny. One of the biggest problems with using internet data (as is used here) is that there is almost no indication of tonality, inference or expression in the data collected. Often for written conversational text emphasis is placed on words or phrases with the use of symbols or icons which represent certain aspects of expression. For the treatment of the data in this research, all of this information was removed, concentrating solely on the words and phrases in conversational strings. The underpinning that this may have lent to some of the data is removed. In further studies it may be possible to keep this information intact and produce interpretations of the data that take any indication of tonality or inference into account more fully.

Research completed by Hayes (2003) used a similar methodology to this research, coding aspects of writing rather than aspects of conversational strings, but concentrating on emergent themes from the data itself. Hayes examined trainee teachers’ emotions and found that their feelings were significant with anxiety about their role playing a major part in determining their behaviour. As in this research Hayes pointed to the high usage of negative terminology in the processed data pointing to specific word usage, including: ‘distinctly worried’ ‘plagued my mind’, and ‘trepidation’ as descriptors. Hayes recorded that the intensity of emotions observed was ‘striking’ concluding that it would be an essential element of teacher education to take the trainees emotions into account.
The use of the internet to conduct research is a modern method for the twenty-first century which has evolved through the use of computers and technology. We live in a technological age and in the post 2000 years the use of personal computers and access to the World Wide Web is widespread. The internet has affected the lives of individuals to a high degree, a house without Wi-Fi access is a house deemed to be in poverty. Researchers have started to use the internet as a resource, collecting and analysing data, observing trends and disseminating results.

Project implicit from the USA is an example of the internet being used as a research tool to gather data. This gives the research project an international backdrop as data is gathered world-wide and then analysed. The project examines bias and perceptions, all the data is entered by the participants straight into an analysis program and produces immediate results which are then stored for further analysis.

Fig 16: Project implicit front page
Gavin and Rodham (2006) examined the use of the internet for research purposes, although still in its infancy as a method, the ethics of using and analysing found data from the internet has been questioned and researched as a stand-alone subject. Gavin and Rodham researched the use of data from public message boards specifically and ascribed to the view that those who posted this data could expect and in fact did expect to be observed and that the act of posting a message on a public forum or e-bulletin board was a public act. Gavin and Rodham concluded that there were not any ethical difficulties with the use of data found via the internet since no ethical boundaries were crossed and this represented no more dilemmas in terms of confidentiality or consent issues than in more traditional research methods.

Gavin and Rodham (2006) also examined the ethics of using the internet to collect qualitative data, concluding that the accuracy of data collection is increased by this method and that this has a positive impact on the accuracy of the inference and interpretation of the information gathered. Others have evaluated the internet as a research tool in terms of ethics, Brownlow et al (2002) and Convery et al (2012) concluded that data collected from the internet was subject to the same ethical considerations as data collected from any other source in any other way.

In light of the results this does pose the question of how accurate the information collected from forums and message boards can be if people who post information (conversational comments) do so in a formal rather than informal manner. Although not conclusive in any way, it does point to people feeling that their public ‘words’ are subject to scrutiny and so may self-censor, whether they are aware of that action or not.

Social networking, forums, e-bulletin and message boards are still new sources of data for the researcher in education. They are a signpost or legacy of the technological age and as Mason and Rennie (2008) argue, educators need to take account of technology especially with reference to social media trends to remain current and relevant to their students. They also argue that the use of technology in research and in education generally is not a paradigm shift but a growth, a development which is organic in origin and reflects the activity of those that use new technology.
E-bulletin board comments, forums and blogs represent an individual’s thoughts, conversational contributions or opinions at a fixed point in time. People are a ‘learning engine’ and assimilate new data to their schemata on a daily basis. Three weeks after a person has posted a comment, made available to the outside world through the internet, they may have changed their view significantly. The comment they originally made may not now be representative of their opinion in any way. The constant comparative method can only check if a comment is still there, or if further comments have been added, not how valid that trace originally was or how valid it remains.

The analysis of data streams to identify commonality and directionality of perception relies on the utilisation of opinion data taken from Internet forums, observation, focus groups and online prospectuses in both the first and second stages of research. This use of the internet to provide raw data represents an emerging methodological technique or evolutionary step in data collection modus operandi, leading towards a greater use of new technologies. The use of these methods may provide support for other researchers using similar, emergent methods.

7.6 - Contribution to knowledge - Products of research

One of the products of research into trainee teachers’ numeracy was an article published by the IFL. This article was completed as a response to the negativity identified through this research, counteracting negativity by providing information. As this is in part an action research methodology, to take some action to try and promote more awareness of numeracy seemed justified as not only being based on numbers or on the narrow and confined view of mathematics that makes it appear difficult to evidence for teachers.

The list of skills (contained within the article) has proved to be (anecdotally) interesting. Several teachers have commented that it helped them to think about numeracy in a different way. This message that numeracy is a foundation for other skills has become a central theme for the research which has been reinforced through the products of research including articles, resources produced
as part of the case study phase of research, an author’s contract completed for functional skills resources, the posters produced and displayed as part of the University of Bolton sharing research and shared resources used in the pilot stages of research, and teacher training courses delivered.

A draft planning text (see Appendix XXVII, Volume II P.35) has been produced, aimed at trainee teachers. The text is in draft form and requires a stronger concentration on the embedding of mathematics and numeracy especially and the use of context to support learning in this area through the teaching of transferable skills, again to be completed and disseminated, this is likely to near completion at the culmination of the project shine work as this will feed into the draft as it progresses.

A set of functional skills materials were produced as part of an author’s contract for Cengage learning, some of which were adapted for use with teachers to test their use in specific contexts and examine any feedback on the use of these type of contextual materials. Non-contextual materials were also produced which were trialled for ease of use and effectiveness in practice. The context proved transparent as several individuals did notice that the materials had been provided with a ‘teacher’ context.

‘I noticed there were sheets that had ‘teaching’ type things on them – like graphs with numbers of students and things like that’
Comment taken from focus groups

‘I noticed that there were teacher based worksheets’
Comment taken from focus groups

Producing functional skills mathematics worksheets and the creation of online content with context is another way that the importance of functional skills mathematics having context for learning has been promoted through the research.
Although the majority of the work was not provided for teachers specifically, the subjects were very varied including construction, hairdressing and beauty therapy and catering, all of which can contribute to the understanding of functional skills and numerical skills for the vocational teachers of these subjects, especially since the distributor has major coverage in worldwide markets including the UK, Canada and Australia, reaching the widest possible audience.

7.7 Chapter summary

This chapter formed a discussion around the subject area of teachers’ numeracy in light of the research conducted and the surrounding theoretical landscape. The main aspect which related to the subject was legislation which affects numeracy for teachers. The research findings focussed on negativity and conflict, model development, the use of an innovative methodology and the products of research which were presented as the main impacts in terms of a contribution to knowledge made by this research.

Legislation related to mathematics and numeracy has impacted over the course of several years. This has gained momentum with the link being formed between funding in further education and the mathematics GCSE learning aim requirement. Funding in this area is the most likely instigator of renewed vigour in terms of more information, training and resources being made available more recently with further education providers in the lifelong learning sector being required to respond to the needs of the post 16 study programmes. Other legislation on the landscape includes the implementation of new curriculum for the compulsory sector and for A-level and changes to the grading system for the GCSE in mathematics.

Research findings relate strongly to the original literature search although it is important to note that there were some positive notes especially in phase two where one of the conflicts found were between what people expected from their CPD numeracy class and what they actually experienced. They indicated that they were pleasantly surprised to find that resources catered for their subject area (teaching) and that their experiences of learning in the mathematics classroom were positive.
The unusual finding was not of negativity itself as this has been researched elsewhere but of such vehement negativity and such widespread negativity as this ran through all of the research conducted, giving a clear, strong and coherent indication of the direction of teachers’ perceptions of numeracy. This is not confined to a particular set of individuals within society at large but affecting trainee teachers and practicing teachers across all sectors, including within the post-compulsory sector. This is unexpected as teachers are generally the holders of higher qualifications and in the compulsory sector have GCSE maths at C grade or above as an entry requirement for teacher training.

Conflict was the second research finding, not as prolific as the negativity found and with some overlapping features, this centred mainly on the conflicts between what is available to support learning for teachers’ numeracy and what is actually available to support this learning, and the conflict between the need to maintain professionalism and the personality traits associated with being a teacher.

A model has been developed as a further contribution to knowledge within the subject area of teachers’ numeracy. Based on information gathered and analysed in both phases of research, the model aims to address the research findings of negativity and conflict. The information from phase two of research was the most relevant in the construction of the model presented as this did contain some small amounts of evaluative data.

The methodology employed to answer the research questions formulated at the outset is an innovative one, using the internet to locate data within forums and analysing this information using an online program as well as a more traditional method of content analysis. The methodology employed relates to conversation and discussion using forums and an e-bulletin board but also using a participant observation and focus groups as a cross check facility, providing interesting information about how people use their words in different arenas.
The products of research represent the final contribution to knowledge made by this research work. These include a published article, published learning materials for functional skills learning, the model for teachers numeracy delivery which takes into account the findings of negativity and conflict with the aim of providing teachers a way to learn in numeracy which is more effective for them.
8 Chapter Eight – Conclusions
8.1 Chapter introduction

A commentary on the process of the research completed allows conclusions to be placed into a fuller context. This is provided first within this chapter, as a brief summary of the research progression.

A proposed model of delivery for teachers’ numeracy has been presented which is summarised with information relating to the underpinning skills and knowledge contained within numerical or mathematical learning presented as part of the model. The main research findings of negativity and conflict are integrated through the chapter related to a model development for delivery of teachers’ numeracy. Methodological development and the possibility of promoting positive changes in perception of mathematics and numeracy are explored further from previous chapters. This chapter aims to present the main points of the research conducted, assessing any changes that would be completed if the research was replicated.

As a final conclusion, the possible next steps are examined that will take the research forward in terms of dissemination and include those actions already taken to further the research findings being disseminated within a wider arena.

8.2 Research progression

A brief summary of the research conducted provides context for the conclusions reached. Research was conducted in two main phases, phase one involved a search of forums, HEI prospectuses and a critical review of resources. Phase two involved a participant observation producing a case study of a continuing professional development programme for teachers learning in functional skills mathematics.
After lengthy consideration of anecdotal evidence gained through a collection of experiences within both teaching and learning in numeracy and mathematics, research was initiated, representing phase one, identifying a path for further work to follow through, which addressed the formulated research questions relating to perceptions and opinions, support mechanisms and resources and finally the effective delivery of numeracy for trainee teachers.

Menter and Elliot et al (2011) insisted that the formulation of research questions are ‘fundamental’ in research work and must be considered throughout the research process as this will achieve ‘coherence and order’. Here the research questions have been revisited on a regular basis with the use of a constant comparative method, examining the data collection and analysis on several occasions over time, ascertaining changes in the landscape of the research area. A research journal was used throughout both phases of research, allowing the research to become an integral part of practice, especially useful in the phase two case study.

Once questions were formulated, these were broken down into a set of aims to support the provision of answers to the questions. These aims directed the research towards methods of enquiry. These included the collection, collation and analysis of data from online forums relating to education, examining content specifically for perception and opinion revolving around teachers’ numeracy. This data was collated into comments posters using categories emergent from the data allowing a clear overview of the data at that point in the research.

A critical review of resources examined the availability of support for trainee teachers’ and teachers’ for teaching and learning in numeracy with a specific (although not exclusive) focus on minimum core numeracy for trainees in the post-compulsory sector. This focus stemmed from the lack of information that was available through the forum comments collected, almost nothing was available at the start of the research process and this changed by a relatively small amount by the time research was concluded.

A review of Higher education institution prospectuses’s investigated the instances of mathematics or numeracy being mentioned and the language used to communicate entry requirements for trainees
embarking on teacher education. These methods taken together provided a baseline of data to work from and established the need for further research. Again a focus was maintained and directed towards the post-compulsory sector where very little research has been conducted especially with relation to teachers’ numeracy.

The completion of a critical review of materials, resources and support mechanisms provided by the internet and hard copy relating to teachers numeracy, revealed a need for the raising of awareness in this area. Raising awareness of the numeracy skills required by trainee teachers took on an impetus through the evolutionary nature of the research methodology. To address the need for wider awareness I wrote an article published by the Institute for learning in April 2013, presenting minimum core numeracy requirements in the post-compulsory sector as more than calculation or arithmetic, pointing to the essential nature of numeracy as a foundation for the development of higher cognitive functioning and the basis for many of the problem solving skills required by teachers daily.

The research was reviewed over time and demonstrated some change in awareness as more resources were available in the second review than in the first. This expansion does indicate a positive change and a raising of awareness over time, initially very little information being available to support teachers numeracy skills. The results demonstrated limited positive and negative change over time with some resources being developed and added to the overall response to this subject whilst several resources were not accessible.

The constant comparative method used over time examined changes in the amount and type of resources available when re-visited via the internet. No massive shift was apparent even over a period of five years, especially for the post-compulsory sector. Over time the amount and type of supporting documents and resources or information remained stagnant, indicating a low level of interest in the subject area. This is similar to the lack of a trace element noted in previous chapters when examining online forum conversation. Professional skills tests are discussed online whilst the numeracy minimum core for the post-compulsory sector training is not. Similarly it was noted that significant amounts of texts are available to support professional skills numeracy tests
but minimum core is not resourced in the same way with texts, information and support becoming available only towards the end of research work when the initial searches were repeated and checked.

A review of higher education institutions information from prospectus documents available online, substantiated indications of a negative trend agreeing with the findings from the analysis of forum data. The negativity in this instance stemmed from the reticence of the institutions responsible for teacher education in England to mention the numeracy requirement for trainee teachers as part of their course entry requirements. Further to this, several institutions indicated that English was a requirement but that mathematics could be completed by the end of the teacher education course rather than being needed at the outset, indicating that they wanted to avoid the mention of their mathematics and numeracy entry requirements.

The final stage of research included the involvement and observations collected of the researcher in the formulation and delivery of a continuing professional development programme for teachers’ numeracy, leading to a level one or two functional skills mathematics certificate. A narrative was provided to identify the processes involved in the case study, ensuring this was transparent. The whole of the research in phase two was produced in several different parts, with different methods employed to capture the voices of the participants. The methods included participant observation, focus groups and the analysis of e-bulletin board comments. Again data was collected in the form of comments and conversations and analysed using the same methods as the data analysed in phase one.

All analysis included the use of the LIWC program to identify formal and informal language being used and a coding of the corpus produced from the data in each method utilised. Resources were piloted using the TES website which has UK wide coverage to establish the levels of unsolicited evaluative data that could be gained. This wasn’t successful as the data returned was limited, however as a pilot, the process was successful as this could be eliminated as a method.
The case study was also used to evaluate resources used to deliver functional skills mathematics for teachers. Those resources were developed fully for mainstream delivery of functional skills (see appendices) and were completed as part of an author’s contract. Several comments were extracted from the focus groups that were encouraging about the context used for teachers running through the resources.

The process of research to answer the original research questions has been completed with an identifiable set of interacting stages which has included critical reflection and research which was represented by parts of the implementation of the functional skills staff development programme. This follows the model of research presented by Menter and Elliot et al (2011) which can be cyclical rather than linear, and in this instance the research did not take a linear form due to a constant comparative method being used where research conducted was re-visited providing continuity.

The process of formulating and checking against research questions, outlined by Menter and Elliot et al (2011) produces focus and clarity which has been supported here by the use of a research journal, allowing the research questions to be checked constantly, maintaining focus throughout. Bryman (2004) indicated types of diaries used by researchers to gather data including the type of diary used by the researcher to keep track or check the progress of the research. Norton (2009) explained that the reflective journal records how ideas emerge and evolve, pointing to the reflective use of a journal being crucial in research.

In terms of coding the data which has been collated either from the internet or from live conversation through focus groups, even screening for inclusion or exclusion and the criteria used for this from the outset represents the start of the analysis process (Menter and Elliot et al 2011). Even though throughout the coding process for all of the data, the categories and codes have emerged from the data itself, the process is subjective; the influence of the researcher cannot be ignored.

The voluntary nature of participation in research and the democratic nature of the process according to Miller and Greenwood (2006) ensure that the interests of the human beings involved
are more likely to be clearly respected and control through the process doesn’t rest wholly with the researcher, but is in the hands of the participants themselves. When using a conventional (positivist) approach the researcher dictates the outcomes (Brydon-Miller and Greenwood 2006).

The coding process, using allocated codes from the data itself, conforms to a type of cognitive anthropology (Silverman 2004) focusing in depth on how people communicate, in this instance the focus is on a specific subject area. How people relate to each other, and to a wider community of students, teachers and others in terms of their numerical skills, forms a discourse that has been studied here to gain some insight into feelings and perceptions. This insight is gained through discourse analysis which examines the data (conversation and comments) providing a description of the structures and content of conversation but also attempts to explain the discourse and find meaning. Qualitative coding is an attempt to affix meaning (Seal 2007) which is necessarily eclectic (Wodak and Meyer 2009). The method used to code in this instance is eclectic in nature as the codes were emergent from the data, rather than being imposed on the information.

In this instance, research utilises an ideographic approach initially looking more at the individual through discourse analysis of forums and focus groups in the first phase. With the functional skills CPD programme implementation in the second phase examining the individual responses and comments through observation and focus group methods. This is an attempt to cross check the results against each other from the different methods used to test validity and the level of reliability of the findings.

The research work has evolved with reference to the methodology employed and has taken a cyclical rather than linear approach. Comments, opinions and perceptions have been analysed both at the outset and the conclusion of research within both the first and second phases. This body of work centres on discussion and conversation surrounding numeracy skills for teachers, both online and in real time. Discussion in mathematics and numeracy being a vital part of learning is often missed in favour of calculation, something which doesn’t tell us enough about the human side of this subject. The combination of phase one and two of the research produced a cross check facility to examine both conversation or discussion and practical application through the research.
8.3 Research findings

Two main findings emerged from the analysis of the data, negativity and conflict. The negativity found took the form of standards of professionalism being questioned with a very negative trend being apparent where individuals struggled with numeracy skills. The use of mathematics and numeracy to measure intelligence is also seen as negative (especially for those individuals who are not successful) negative feelings due to a lack of achievement, negative language being used and the recounting of very negative experiences that people have had within learning the subjects of mathematics and numeracy including really emotional and harrowing personal accounts of experiences in mathematics classrooms.

Findings related to negativity included a strand running through the data of 'hatred' for the subjects of mathematics and numeracy by teachers and trainee teachers. This was surprisingly prevalent and represents a really strong negative direction in terms of opinion and perception. The use of the word 'hatred' or variants of 'hate' are repeated many times within the data collected from both phases of research. Negative teacher and trainee teacher views of the subjects were prevalent but going deeper than this within individuals ran a negative self-image related to their own self-perception being negative in mathematics and numeracy, made up from a variety of factors, including prior experiences. Askew et al (1997), Uusimki and Nason (2004) and White et al (2006) studying teacher perception, all identified as part of their research that numeracy skills were lacking for teachers. Negative views can produce a 'ripple' effect where pre-service or trainee teachers influence their own students views with their own negativity (Sam 2002) Teachers hold the same opinions as others in the wider society believing that: ‘mathematics is difficult’

Mathematics has a negative connotation for many people as it has been used as a measure of intelligence, with those who struggle with numerical concepts being seen as less intelligent. Woodrow (2003) pointed to mathematics being regarded as a ‘gatekeeper’ whilst being used in intelligence type tests by researchers including Binet (1904), Spearman (1927) and Schlinger (2003). Conflict was demonstrated most clearly by the lack of information, resources, conversation,
and forum postings or resources available surrounding numeracy for teachers and trainee teachers, especially with reference to the post-compulsory sector of education. This was also demonstrated clearly by the lack of conversation, forum postings or information available surrounding numeracy for teachers and trainee teachers. There is a noticeable lack of awareness surrounding this area which became a real part of the research also demonstrated by the lack of information available when conducting initial electronic searches and searches through more traditional media.

Searches for information were fruitless in the first instances, producing limited amounts of information as time progressed. The internet could not provide information, the ‘Google’ search engine, using the search term: ‘teacher training forums’ produced four million, seven hundred and thirty thousand results, not relating to teachers numeracy. Through the educational forums, teachers asking questions about minimum core numeracy in the post-compulsory sector received no replies. There is a noticeable lack of awareness surrounding the area of teachers’ numeracy and mathematical learning especially with relation to the post-compulsory rather than the compulsory sector of education, which became a real part of the research.

So little information was available at the outset of research that a constant comparative method was used to identify changes taking place over time and the data was revisited at intervals. Although some forward positive momentum was observed, with more resources and information becoming available, this was still very limited and non-specific. Teachers’ numeracy has become more prevalent as a subject of interest mainly due to funding requirements. Regulatory requirements have changed through the period of the research process which has also impacted on the knowledge base surrounding teachers’ numeracy. This has mainly affected teacher education in the compulsory sector with minimum core numeracy accorded very little interest over the period of the research including in the latter stages. A clear difference in the amount of resources and information available for the different sectors was apparent.

Analysis of the actual words produced from the research process confirmed that a strong underlying current of negativity was present. The results from LIWC analysis indicated no negative language was detected at all from the corpus analysed taken from HEI prospectuses. Numeracy and
mathematics are seen as negative and as having a very negative image and negative connotation and so are omitted from the prospectuses.

Conflict as a finding was narrowed down to three main areas, conflicts between professional standards and the personality expectations of teachers as was the first finding from forums relating to conflict. The conflict between a teachers’ lack of skills in numeracy and mathematics and the depth of teaching knowledge required was followed by conflicts found in language and learning, what people say, how they say it and what they do. The personality traits expected of a teacher conform to softer traits including empathy, caring or understanding, and altruism. These are at odds with the harsher professional requirements of the vocational area of teaching where high standards need to be maintained in terms of subject knowledge, organisational skills and generic skills.

The opinion that those teachers who struggled with numeracy may have a better understanding or a more creative approach to teaching mathematics and numeracy to students, who struggled with the subject also, was voiced. Although interesting, research pointed to this being a misinterpretation or being reliant on a person reaching a mastery of skills and overcoming their difficulties or lack of skills, prior to entering the classroom.

In contrast to wholly negative forms of conflict, there is a positive conflict between what people expected in the CPD functional mathematics case study and their positive experience reports from focus groups and observation information. There were general positive comments about the delivery style of the course and the format of the course delivered. This was very useful and provided positive affirmation when the model for delivery was constructed.

Conflicts in language were apparent, which needed to be examined as they may have an impact on validity of the research findings in general. The way people speak in a face to face situation is different to the way they have a conversation online and the research analysis made this clearer. When people post their comments on electronic bulletin boards and forums they use a more formal type of text or speech pattern (identified by the LIWC program) than they would in real life situations that are conducted in a face to face fashion (as in the focus groups in phase two of research) using
formal types of speech patterns and longer words. Kridel (2010) presented studies of written language inevitably contains a supplement of meaning beneath the text, meaning that interpretations of a text or of a conversation can never have total clarity or identify exactly what the originator wanted to say.

The second phase of research revolved around participant observation of the implementation of a functional skills mathematics continuing professional development course for teachers. This course was delivered in a further education college and utilised several different methods of learning or approaches to learning to support teachers learning in numeracy. If trainee teachers are presented with the minimum core numeracy in the same manner as other learning if they are not encouraged to reinterpret or test their limits – they will approach it as they have always approached maths, with a very negative attitude. Cropley (2007) advocated flexibility and openness to ensure that society does not suffer from Gleichheitswahn (psychosis of sameness) or the slightly unhealthy tendency to desire the 'norm' and maintenance of the status quo.

Creativity in the curriculum for functional skills mathematics delivery is another essential element used in an effort to persuade members of staff to accept learning in mathematics. Guilford (1959) linked creativity directly with problem solving by the application of divergent thinking or identifying a variety of solutions to a potential problem. The 'knowledge base of creativity' described by Weisburg (1986) related to knowledge including expertise generally, a person needs the tools to be able to create chains of ideas and concepts to solve problems in a creative fashion. The ability to manipulate abstract concepts (numbers and maths) underpins creative and critical thinking.

According to Cottrell (2005) critical thinking is built on several foundations which include the use of a logical order, structuring of reasons, recognition, reflection and evaluation. All of these skills are derived from basic numerical reasoning. Without a basic foundation in numerical skills the ability to think critically and to examine or present an argument will be severely impaired.
8.4 - Replication

This research aims to promote a different view of numeracy, not only for teachers and trainee teachers, but also for students in classrooms, their skills, attitudes and perceptions being affected through a filter down effect. If teachers go into their classrooms with a more positive approach based on problem solving, logic and cognition rather than numbers alone, the students become in turn, more positive. This change in direction and perception can be supported through the provision of resources and information. The minimum core of numeracy within the post-compulsory sector is a minimum. Trainee teachers should be encouraged to work towards more than a minimum standard wherever possible. There is a difference between barely passing and excelling. Individuals should be given the tools to excel.

Trainee teachers are subject to the same influences as other learners, their own perceptions of the essential skills may make engagement in learning in these areas difficult. These internal factors can be influenced by elements of prior learning and implies that trainee teachers as students may still have a negative self-perception in terms of their essential skills numeracy development (Preston and Feinstein, 2004).

A model for delivery for teachers within the post-compulsory sector using elements that have demonstrated their effectiveness in practice through the functional skills continuing professional development programme has been explored. In terms of replication of the CPD programme, the criticisms levelled at the delivery completed in phase two helps to provide some direction. The timing of the course could be improved by offering this as a year round course, allowing more time for people to take on board new learning, rather than rushing through the course to completion. A full online version of the course with all documents and simulations and links to further interactive online content would support those who wish to refresh and review and then sit the test.

This research represents part of a major shift in professionalism of the workforce within the further education (part of the post-compulsory) sector. Subsequent development provides an incremental expansion in the support available within numerical learning aimed directly at teachers and trainee
teachers within this sector, through provision of improved choices, communication, awareness raising and resources. There will be secondary contributions to improved functional skills education in vocational and discreet classrooms, although this will not be subject to impact assessment as the results are likely to be difficult to view without a significant passage of time, more than this research will allow.

For a repeat or a continuation of this research the ethical stance requires more involvement and depth. Internet research relating to conversation requires an informed decision on the part of the researcher as to the nature of the data collected. In this instance the data was found in the public domain and required anonymising but there is an expectation that this will be seen and responded to by others. Although Convery and Cox (2012) concluded that in an open forum (such as those used within this research) informed consent may not always be required, it would be essential to examine the intent of those who take part in the conversations online, even in the public domain. Their intent may be to converse and they may not be perturbed by the fact that the information is public however, individuals may not be aware that their conversation is subject to analysis. It would be possible to ask for permissions after the fact, posting the question to contributors on their forum of whether they consent for their information to be used. For future work this may provide a solution to the issue of informed consent, even for information located within the public domain.

The methodology employed through the research was an expansion on current methods involving the internet. The methods could be developed further in any subsequent research to safeguard participants and possibly verify the information gathered.

8.5 Next steps

The research process does not end simply because the research questions have been addressed and the research period has reached the end of its time. For research to be effective there is a continuance or a set of next steps in an ever continuing cycle of research and evaluation. The next
steps here include the production of the model for delivery in conjunction with the supporting documents and resources as a standalone report made available to a wider audience for implementation, or to provide ideas on different ways to approach teachers’ numeracy learning. To know whether this model is effective or not will require the implementation of the cycle of delivery and evaluation with the possibility of further modifications. It should also be noted that the model for delivery refers to experiences collected and evaluated in one institution and so implementation, evaluation and replication would be required to fully evaluate effectiveness in other institutions.

Project funding has been secured in the post-compulsory sector for the completion of a mathematics into sport project, producing resources and guidance on the context of sport being used to teach mathematics named ‘All Stars’ in a way that reaches those that are disenchanted and disadvantaged in terms of mathematical attainment. This is the result of being one of the winners of the ‘let teachers shine’ competition for funding projects in mathematics delivery. This has included both local and National press coverage with an article in ‘Education today’ (see Appendix XXX Volume II P.103). The project uses sports as a context to facilitate learning in mathematics but also includes some generic aspects of mathematical learning which are often overlooked. The use of vocabulary exercises in mathematics lessons for example and clear use of student evaluation to improve the involvement of demotivated students in mathematics in the post 16 arena. As with the model of delivery formulated for teachers’ numeracy, this project work focussing on context in mathematics and numeracy delivery in the classroom requires implementation and evaluation to examine effectiveness of the strategies and resources produced.

Through engaging with the education and training foundation as a fellow and attending the consultation on the future of QTLS in the post-compulsory sector, mathematics and English were seen as essential aspects of this type of professionalism. Texts that support embedding of maths and English skills and demonstrate how this can be achieved in practice are in short supply and a gap is apparent where this sort of information is required\textsuperscript{28}. Further research to examine exactly\textsuperscript{28} This has been taken from the feedback on the consultation day (6/10/15) and so is anecdotal and is specific to the group of people that attended on the day rather than being a generalisation this is
what is required to support individuals especially with numeracy embedding and production of the required resources in a generalised sense may be the result of the consultation process, providing avenues for research to be completed and disseminated and made useful.

**8.6 Chapter summary**

This is the final summary presented within this research and briefly presents the research progression from the initiation to the conclusion, the research findings, aspects to be considered in replication of this research and the steps that could follow on from the research completed.

At the start of this chapter a summary of the research process was provided which examined the different stages from the start of the research process with the formulation of research questions and the matching of methods to address those questions. Products of the first stages of investigation research (categorising and analysing comment data taken from educational forums) include the categorised data as 'comments' presented as posters. Completing the first stage of research work provided a baseline for further work to follow on, establishing the negative direction of perceptions of numeracy from teachers through all the strata of education. Research progresses through the different research methods, all of which examined comment, conversation or discussion to the completion of a model for teachers' numeracy to address research findings and the examination of replication considerations and the next steps that could be indicated.

The system of teacher education has undergone some overhaul in recent history but has this gone far enough or are there some fundamental questions to answer and issues to address? One of these issues would be professional development as so many questions are thrown up by this research. The notion of professionalism is questionable when this consists of qualifications forced

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one small aspect of feedback from professionals in the sector.
on individuals against their will and with a clear financial gain to be had for educational establishments.

The research findings were also presented in summary form in this chapter in their basic distillation of negativity and conflict. Through this research work I have found that the hatred of mathematics and numeracy is not restricted to specific sets of individuals in society. The pervasive negativity surrounding the subjects also affects teachers in all sectors. People that are expected to be professional educated to a significant degree and to provide education for future generations experience hatred, fear and conflict when faced with mathematics and numeracy teaching or learning.

The contributions of this research are substantive (in terms of theory development, methodology, curriculum clarification and impact on practice) to the knowledge base of teachers numeracy education. This work represents an expansion in theory revolving around numeracy for teachers (almost wholly insubstantial in terms of scholarly or published work). Very few specific texts are available, although some materials have been developed within the last three years, theory, resources and longitudinal research has been largely overlooked.

Elements which may impact replication have been examined for this research and these centred on ethics of online research and issues of informed consent, especially where individuals know that their conversations are contained within a public arena but may not expect them to be subject to any form of research analysis.

The possible next steps for this research and the directions that can be taken now on completion of the research have been presented with any aspects that have already been completed. Some funding has been secured for contextual work which applies to aspects of the model developed for teachers' numeracy and ties in with this. Within the post-compulsory sector further investigation is really warranted to examine how well equipped further education lecturers are. Within higher education the perceptions of numeracy and mathematics would not expected to be an issue as
many individuals teaching in the higher education sector are required to demonstrate their higher levels of learning with Masters Degrees and Doctorates.

Higher qualifications then do not guarantee a high level of efficacy as there are examples of individuals with a high qualification profile who are not proficient with numeracy, do they guarantee a high level of teaching and learning in classrooms for students?

| ‘I cannot envisage myself passing this daunting numeracy test despite having a PhD in Psychology’ |
| Comment taken from forums |

According to a study by Perkin et al (2013) 88 UK Universities or higher education institutions are currently offering mathematics support sessions for their undergraduate students. This is part of measures to redress the balance of the ‘mathematics problem’ perceived as something which holds back the progress of these students and impacts negatively on their results. Although it is clear that several subject areas have a high mathematical content, for example nursing or engineering there is no reason to assume that teachers and teaching do not require the same level of support.

Has the system that we use to educate teachers been adjusted to attract more applicants with each student representing a significant amount of funding? Is professional development, especially in terms of numeracy appropriate for teachers as it is currently presented? Can the negativity of teachers towards numeracy learning be addressed effectively? These questions would form the basis for further research examining the impact this would have on the current movements in the English education system.
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