Adults learning mathematics in the workplace through their trade unions: what motivates them?

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Abstract

It is known that motivating people to learn mathematics can be difficult. My research explores adults' motivation to learn mathematics and focuses on learners who are overcoming many barriers to study in the workplace, in classes organised and funded by their trade union. The adults are aiming to gain a formal qualification, using less formal learning approaches, in a non-traditional context, hence this research offers teachers in more conventional education settings an opportunity to learn about successful alternative practice.

Using a grounded theory approach on qualitative data and by exploring the findings within a range of sources of research literature into motivation and mathematics learning for adults, the research distinguishes between initial motivation to re-engage with learning and motivation to continue learning. It identifies the dynamic interplay in motivation between the personal needs or goals of individual learners, and the influence of other members of face-to-face learning groups. This interplay is seen as shaped in the wider context of UK society, and, in particular, by the role of trade unions.

Adults in trade union organised classes report being able to successfully develop their mathematical skills and confidence through the use of 'collective' learning approaches, which develop positive social and emotional encounters in the classroom that are different from their previous experiences. Developing confidence while learning mathematics helps to shape their identities and, for this sample, has considerable influence on their motivations both inside and outside the classroom.

The significance of developing confidence is reinforced by the adults' use of emotional language when reporting changes in their feelings towards mathematics from negative to positive and their motivation to learn, described as an adult's 'Affective Mathematical

Journey'. This emphasises the importance of considering the emotional connection to motivation and cognitive development when reflecting on professional practice associated with adults learning mathematics.

Chapter 1. An introduction to the research

I am a teacher trainer in mathematics education for adults (16-75 year-olds) and I am fascinated by what motivates people to learn the subject. My experience throughout my professional career (a mathematics teacher in Further Education (FE) for over twenty years and an FE teacher trainer for over ten years) has shown me that motivating people to learn mathematics can be difficult. Official statistical sources also indicate many adults in the United Kingdom (UK) find learning mathematics difficult (DfES, 2003; BIS, 2011; OECD, 2013). Through this research I want to understand more about adults' motivation to learn mathematics and to use that knowledge professionally.

For my research I chose a group of adults who were learning mathematics up to General Certificate in Secondary Education (GCSE) level:

- in classes in the workplace;
- organised by trade unions, who provided the teachers and resources to support learning;
- who have often had poor previous learning experiences of mathematics;
- had busy working and family lives.

There is much research into learning mathematics that seeks to explain why children and adults have problems with the subject and subsequently become demotivated. But little has been written on the positive aspects of motivation, so I wanted to find out more about what drives people to overcome barriers to learn mathematics. Those I interviewed reported many obstacles to their learning including such factors as previous unsuccessful learning experiences, demands of shift work and family responsibilities. Yet they had chosen to re-engage with learning mathematics at or below GCSE level in the workplace through opportunities negotiated by trade unions with employers. This group of adults must have been highly motivated to return to learning mathematics and I chose to interview them to develop my own conceptual understanding of motivation. I also wanted to know

what, if any, role the trade unions had in that motivation as well as what the adults' experiences of learning at work had been like and what links there might have been between these experiences and their motivation.

Through my research I hope to provide new insights into adults' motivation to learn mathematics that can support teacher trainers in their practice and be usefully shared with trainee teachers and others who are about to enter adult education in more traditional settings.

1.1 Outlining my contribution to knowledge

There is limited research into adults learning mathematics but none that I could find into adults learning mathematics through the auspices of trade unions in the workplace, so I believe that my research into adults' mathematics education represents a unique contribution to education literature.

My research contributes to the much under-researched field of groups of adults who are harder to reach (defined in more detail in 5.2 Identification and recruitment of the sample) and who are motivated to learn mathematics in the workplace. Research into learning in the workplace has also usually focused on mathematical concepts used for work or notions of the transferability of mathematical concepts (or not) between school and the workplace (Lave and Wenger, 1991; FitzSimmons and Godden, 2000). In an endeavour to understand differences in learning approaches research has usefully focused on describing pedagogical characteristics (Evans *et al*. 2013) but no one has researched adults' motivations to learn mathematics in the workplace, overcoming many barriers to gain a formal qualification but in a non-formal learning setting.

The research will also contribute to the understanding of motivation to learn mathematics. Most research into motivation focuses on school children (Dweck, 2008; Boaler, 2009). With adults this field has recently begun to be explored but mainly looking at those

engaged in mainstream education in traditional college or community settings (Coben, 2003; Swain *et al.*, 2005) and never in the context of learning organised and delivered in the workplace through trade unions.

Research into learning mathematics has also recently begun to try to unravel the relationship between emotions and mathematics (McLeod, 1994; Hannula, 2006; Evans, 2006; Debellis and Goldin, 2006; Barbalet, 2004). But this research into the field of affect is still developing, especially in relation to motivation and emotions, and my research contributes further to that development.

1.2 The research questions

I have focused on answering the following three research questions:

1. What motivates adults to learn maths at work?

Through this question I wanted to explore motivation with individuals and identify factors that influence their motivation, including their own feelings and personal ideas, how others might influence them, and the influence of wider society on their motivations.

I am interested in motivation in its widest sense, so I wanted to know how adults felt about mathematics and the effects that learning mathematics has on their work, themselves, their jobs, careers, relationships with family, futures and anything else.

2. How do adults prefer to learn maths at work?

Originally I had linked motivation to the idea of identifying the transfer of mathematical skills between educational contexts and work. I thought mathematics learned at school might help and motivate their learning in the workplace. However as I soon realised adults were motivated in different ways to overcome many diverse barriers and I acknowledged the need to listen to how, as adults, they preferred to learn.

3. Is there any relationship between learning maths at work and trade union membership?

As the target group were all trade union members, I sought to identify any relationship between trade union membership and learning. Did learning through the trade union influence their motivation and if so how?

Indeed did the experience change the members' opinion of the trade union? Within the trade unions activism is often viewed as a way of benefiting members through collective action and group activity, whereas learning maths is sometimes viewed as benefit to the individual. So did learning mathematics only improve my interviewees' individual skills or did it change the way they viewed their trade union, or motivate them to act differently?

1.3. The structure of the research
I used the structure outlined below to explain the research process I used to answer the research questions.

In chapter two I put the research into context by discussing education traditions within the trade union (TU) movement in the UK. I discuss the historical development of education and its purposes in relation to membership strategies. I also discuss ways of learning promoted in trade union education in relation to activism, motivation and empowerment of workers.

In chapter three I consider some of the issues currently under discussion in the field of adults learning mathematics, concentrating on theories that focus on the influence of the wider social context and face-to-face social groups in the development of identity through learning mathematics. I introduce a model of analysis that I use throughout this research that utilises these multiple perspectives to help develop my own understanding of

motivation. I use this model to discuss three research reports that were influential when developing questions I used in interviews during my data collection.

In chapter four I discuss why I use an interpretist approach in my research influenced by critical and feminist perspectives. I examine my research approach in response to criticisms of qualitative research and issues of quality.

In chapter five I examine the practicalities of data collection and describe the grounded theory process I used to analyse the data collected. I discuss the development of the questions I based my interviews on and my methods of data collection. I also consider the challenges of my data collection, including the possible 'gatekeeping' function of the work-place contacts that turned out to be my only way of recruiting my interviewees.

In chapter five I also discuss how I used grounded theory to analyse the data and build a framework of concepts and categories that helped me explore responses to my research questions.

In chapter six I review the research literature that I needed to explore after my early findings indicated the importance of emotions in motivation, a process that led me to consider in greater depth the psychological aspects of motivation and its relationship to emotions.

In chapter seven I describe how I address my research questions using a conceptual framework of concepts and categories built from the data. This process helped me to conceptualise and interpret the data in relation to research literature, developing my thinking about motivation and emotions.

In chapter eight I discuss secondary findings from my research that indicate the significant influence of emotions on motivation. I further develop the relationship between emotions and motivation in a more holist way, illustrating the notion of what I call an adult's 'Affective Mathematical Journey' using the experience of one interviewee's story.

In chapter nine I conclude the thesis by addressing my research questions using theory to conceptualise my findings. Following this I discuss how my work makes a unique and credible contribution to knowledge in the field of adult mathematics education. I finish by discussing the limitations of my work and suggest further research that could usefully follow these findings.

1.4 Outlining my main findings

The findings in this research show the important contribution that trade unions play in motivating adults to learn mathematics and the significant effect that learning has on the adults who experience it. Trade unions play an important role in encouraging adults to join classes especially if they have had difficult previous learning experiences in more traditional contexts. I would argue the 'collective ethos' of the trade union contributes to the supportive learning environment experienced by the adults in the classes and this, along with their successful achievement, is central to building learners' mathematical development. These experiences have a profound effect on how the adults see themselves, their confidence, and how they intend to act in the future.

How people feel about the learning is also an important influence on their motivation. Adults need to trust people who are encouraging them to join the classes and feel safe in the learning environment. The research shows that these learning experiences inspire learners to feel more positive towards learning mathematics and those emotions contribute

to building their confidence and motivation to learn the subject, resulting in what I call a positive 'Affective Mathematical Journey'.

The process of analysis enabled me to address my research questions and increase my understanding of the role of emotions in motivation but also my appreciation of the learning and teaching of mathematics that happens in the workplace. The successful approaches to learning reported by the trade union adults in my research offers significant insights into mathematics education. Further, my research suggests teaching approaches that teacher trainers and trainee teachers of mathematics to adults in colleges might themselves find useful.

Chapter 2. Research into learning in a trade union context

My research is into adults who are motivated to learn mathematics through classes organized through their trade union, therefore in section 2.1 I undertake a brief discussion of the history and culture of trade union education, as this will necessarily influence the learning experiences of my participants. In section 2.2 I discuss the debates within trade union education in relation to the purposes of education. In section 2.3 I discuss TU approaches to learning comparing them to adult learning used in more formal education settings and in section 2.4 I discuss motivation to empowerment in a trade union context.

2.1 The historical and cultural context of trade union education

Trade unions in the UK have been interested in education since their development in the late 19th century. Calveley (2007), in her work on the history of trade unions and learning, suggests two of the original reasons for their interest were: (1) as a means of getting working people out of exploitation and poverty and (2) to encourage the understanding of the socialist cause. So, from a trade union perspective, there were economic, social and political reasons to become involved in educating the working class (p. 14).

The link between trade union activity and education is described succinctly in the famous George Bernard Shaw quote, 'Educate, Agitate, Organise'. Initially, this quote was adopted by the Fabian Society but its relevance is still apparent today and it was used again recently by the Director of Education at a Unite the union conference for Union Learning Representatives (ULRs) in February 2013. However, Trades Union Congress (TUC) education identifies 'it's core purpose concerns good industrial relations, equipping reps to represent workers …'(2015, p. 3), so in this research, what is of interest is that the purpose of learning mathematics within this context continues to be a source of debate.

2.2 A brief history of trade unions and education

Research into the history of trade union education (Clarke *et al*. 2008) identifies two sources of education for the working classes. One source, which they termed liberal education, was developed through organisations like the Workers Education Association in 1903 and aimed to improve workers' personal skills through more formalized classes. The

other source, termed trade union education, was developed by people who were often self-taught and within an ethos of political activism such as under the aegis of the Labour Party from 1907 and trade unions such as the Transport and General Workers (TGWU). I see these two differing sources of education still influencing arguments about the role and purpose of education within trade unions. Shelley and Calverley (2007)contribute to the debate when they use the terms Consumerist and Marxist perspectives to compare outcomes of what they call mainstream and trade union education. They argue that trade union learning is embedded in a 'Consumerist and market-based context of mainstream learning and skills policy', (Shelley and Calverley, 2007, p. 244) emphasising 'individualised' learning for materialistic reasons, e.g. a better salary for that particular person to buy more goods. Hence from a consumerist perspective mainstream education contributes to what Freire (1985) termed the 'domestication' of learners, where teaching and learning consists of the notion of 'banking knowledge', where teachers deposit that knowledge in students, what is referred as a traditional transmission teaching in mathematics (Brooks, 2013, p. 145). In contrast trade union 'activist' education is related more to Marxist ideals of learning for 'liberation to critique society'. (Shelley and Calverley, 2007, p. 244).

Benn (2004) takes the ideas further when she describes the links Freire makes between empowerment and 'conscientization' to collective learning. She describes a process where 'students become aware of the relationship between mathematics and society and how this is related to their own condition, situation and development in mainstream society'(p. 93). The notion of empowerment linked to 'conscientization' is a central theme when considering learning facilitated by trade unions, where learning skills is seen as part of the process of developing activists. This argument reflects a fundamental ideological debate about the reasons for the types of education provision within trade unions and relates to a continuing discussion over the value and purpose for providing long-term provision of learning mathematics through trade unions.

Indeed, it was only during the second half of the 20th century that trade union activity turned from what was a focus on industrial relations to include education itself. A real change became apparent when a paper was published in 1992 entitled *Bargaining for*

Skills: A TUC initiative to deliver the national education and training targets. In this document the TUC started to reassess its bargaining priorities

> ...moving away from the traditional, often adversarial… bargaining approach towards a more 'constructive….developmental emphasis'

> (Stuart and Wallis, 2007, p. 153)

Later, in 1997, when a Labour Government came to power, the trade unions supported the notion of 'Lifelong Learning' and were given a positive role in delivering training in the workplace. Calveley (2007) cites Heyes and Stuart (1998, p 459) describing how trade unions began to see the role and purpose of education and training differently, as

> ...a path to membership and renewal, and as a way of maintaining employer acceptance at the workplace.

> (Calveley, 2007, p. 25).

And the influential union Unite certainly sees the rationale for being involved in lifelong learning as linked to increasing members' personal skills and qualifications, improving their long term employability and advancing the member retention strategy (Barron, 2013).

Naturally, the focus for learning is in the workplace, where trade unionists, often through Union Learning Reps (ULRs) encourage (or motivate) colleagues to develop their skills. However whilst there was still an emphasis on courses for activists, such as Health and Safety Reps, evident at the beginning of my research project (2009) there was also training to help individual members develop their literacy and numeracy skills to support their overall development.

Six years later (in 2015), even through the UK's economic decline influenced by the world economic recession, and government cuts to organisations such as TUC unionlearn(House of Commons, 2015) the TUC continues to support the development of mathematical skills through their education programme.

2.3 Ways of learning within trade unions

Trade union educational pedagogy aims to:

> …develop a solidarity that comes from people sharing common values and working together for unions and working people.

> (International Labour Organisation, 2007, p. 10)

Consequently trade unions promote teaching and learning approaches that develop collectivist and activist principles, based on shared values and goals that seek to enhance the human condition, which is different from the traditional mainstream education ethos in schools and colleges. The purpose for learning through trade unions is overtly political and as such is not impartial in the academic sense. However far from being an inferior version of mainstream education trade unionists argue it is a:

> … vibrant, politically orientated branch of adult education with its own pedagogical approaches, modes of delivery, courses, structures and actors.

> (International Labour Organisation, 2007, p. 10)

The goal of TU education is to liberate and emancipate workers and so has strong links to notions of critical learning (Freire, 1985; D'Ambrosio, 2007; Frankenstein, 1985). This aim contrasts to state-funded learning, in schools and colleges, that some argue is about producing citizens that understand, reproduce and reinforce the society (Bernstein, 1977; Ernest, 1998; Lerman, 2000). I continue this argument in my next section in relation to empowerment and confidence.

Research by Ross *et al*.(2011) suggests the collective ethos to trade union action influences teaching and learning approaches used in courses, and suggests a potential to encourage activism. Liz Rees (2007) argues that trade unions have distinct aims and most learners attend their courses in a representative capacity, so they are expected to participate actively in classes when discussing difficult issues. She argues the aim of the trade union courses is to encourage learners to develop research and planning skills through experiencing active learning techniques. Rees suggests that:

> … working in pairs, groups and in course meetings, learners both work on issues and problems, and learn to listen and debate, cooperate, plan and organise with their colleagues.

<p align="right">(p. 228)</p>

Ross *et al.*(2011) go further suggesting motivation to learn is also related to the collective experience. They argue that learning experiences in trade unions are:

> … based upon reflection on experience, working with others, participating in learning that is meaningful and relevant, learner-centred and 'learning by doing'.

<p align="right">(p. 7)</p>

Rees (2007) also argues trade union education learning approaches encourage discussion putting the learners at the centre of the learning:

> ... talking about problems at their workplace and working with other representatives to determine solutions puts them at the centre rather than on the periphery of classroom activity.

<p align="right">(p. 207)</p>

This literature review looks at studies of co-operative and collective approaches to learning that might be similar to those found in the mathematics classes I discuss in chapter seven. This approach to learning is very different from the teacher / learner approach so often used in formal school or college - based mathematics classes; as Swan(2012) suggests, the use of the transmission model in schools and colleges is normative, where the teacher is the expert who 'transmits' knowledge to the student, 'who has a more passive role of receiving, listening, copying and trying to understand' (ibid, p.162).

But the act of learning in my research is situated within the trade union and the workplace and adults are immersed in the language, relationships and culture of that context when involved in the practice (Lave and Wenger, 1991; Lerman, 2000). The trade union

approach to learning builds on previous experiences of group members and so it relates to what Vygotsky suggests as a learning which is a:

> …product of the previous network of experiences of the individuals, including the teacher, the goals of the teacher and the learners, and the specificity of the learning itself.

<div align="right">(Lerman, 2000, p. 33)</div>

While Lerman further argues that a learner's trajectory is more than 'transformation in social practice' it also influences the practice itself. He suggests that a learner's 'mathematical identity', that is their relationship with mathematics, is developed through the practice, but also develops the practice, which in this instance is influenced by trade union culture, context and values, as they manifest in the work place and the classroom. I discuss the notion of identity and mathematical identity development in section 3.3 (on page 34) and it will be interesting to see if my findings suggest learners do become empowered to act differently with mathematics, as well as develop their own mathematical abilities.

2.4 Motivation and empowerment

I now want to discuss the notion of motivation in relation to empowerment in the context of trade union learning.

Hannula describes motivation as: the 'potential to direct behaviour' (2004, p.3) and the Cambridge online dictionary (2015) defines empowerment as: 'the process of giving people more freedom or rights'. I believe that a potential change in behaviour *(motivation)* is related to a person being given *(or indeed taking*) more freedom or rights *(becoming empowered).*

In chapters seven and eight I discuss the relationship between motivation, developing mathematical skills and empowerment of learners. There, I look for evidence of empowerment not only to negotiate on behalf of trade union members, but also to develop

a better understanding of personal financial calculations, such as mortgages. But Paulo Freire argued that empowerment could only happen in relation to changes in society; empowering people to challenge social norms and existing power structures(Freire, 1985) and Shelley (2007) also critiques the notion of empowerment at a personal level as a 'liberal humanistic perspective'(p. 117). When writing about education in trade unions he views empowerment as being the product of collaborative work, linked to an authority to act. He argues that gaining a qualification, such as one in mathematics, can be viewed only as part of an individualized process that teaches people to conform to normative behaviours, so reproducing socially acceptable identities and practices, rather than developing activists with an overriding critical perspective. In chapters seven and eight, I look for indications of a potential for a wider understanding of empowerment.

Indeed I would argue that enabling people to use mathematics to negotiate on behalf of others is empowering. It enables the individual to be part of a collaborative negotiating activity and by improving the negotiators' mathematics skills it empowers them to act 'with authority' discussing wages and salaries on behalf of their fellow trade unionists. This improved financial confidence can also influence personal and family circumstances.

But Freire (1985) was emphatic when writing about teaching and learning, deriding empowerment on a personal level as a 'nutritionist approach' to education, where lecturers take on a role of 'doing good' by helping the 'learners to eat of the knowledge of socially accepted education'(Freire, 1985, p. 45). Benn (2004) also relates personal empowerment to wishful thinking, unless related to the wider community and societal inequalities (ibid, p.14). This argument fails to recognize the liberating and empowering emotions that an individual can experience when they are motivated to overcome previous barriers to learning. It also fails to recognise the economic and social benefits that can accrue when individuals are given the instruments and knowledge to financially support local family networks, as well as engage with and challenge authority on behalf of others.

Benn (2004) also suggests that achieving a qualification in a formal situation may be seen by an individual as an opportunity ' to gain access to the powerful and prestigious discourse of academic mathematics'(p. 99). For example when an individual from another country gains a United Kingdom qualification such as one in Mathematics, this is a way for

them to gain recognition in the society, as well as an opportunity to learn about the social values of that society. It may be used to achieve a 'connection' to both work and society (Kelly E. , 2011; BERA, 2011),which I argue is empowering both for that person and for society as a whole.

I argue, too, that the notion of empowerment depends upon how the individual applies the knowledge gained. Indeed, Shelly (2007) suggests that some see personal empowerment as contributing to the transformation of society incrementally from the individual to society, 'for example, from family, to local community and to national society' happening 'through the democratic process' (ibid, p.119). I would argue that empowering the individual to act on behalf of others exemplifies this and is what trade union education is all about. This notion of transformation or empowerment remains contentious both within trade unions and the education sector although I agree with Wedege (2014) who argues that the learning of mathematics at work is an issue of social justice. Whilst Frankenstein(1985) also argues for the recognition of mathematics education as critical when she cites Powell and Bratlinger (2008),who suggest:

> … teaching 'traditional 'mathematics to students who have been marginalised from college or certain professions is a form of critical mathematics education appropriate to that context.

> (Frankenstein, 1985, p. 9)

In chapters seven and eight I look for evidence of concepts that I think further support the notion that individuals who learn mathematics, even at or below General Certificate of Secondary Education (GCSE) level, can be empowered by becoming more confident in themselves and perhaps even motivated to act on behalf of others.

Concluding remarks on learning in a trade union context
This exploration of literature and the ideas I have examined have enabled me to situate my research within the rich cultural and sociological context of UK trade unions. Furthermore this examination of the history of trade union education enables me to understand why

spending scarce resources on mathematics education may be controversial, in the sense that some may argue that such resources could be spent on more focused and effective activist training.

I examine the characteristics of learning promoted within trade unions to help me identify and understand where these differences might originate. However I do not claim that all trade union classes follow this 'idealised' approach, in so much as all school and college-based teaching approaches follow the transmission model. Rather, I seek to understand the social, historical and political context of trade union education that has helped influence the learning approaches that the participants in my research may have experienced. I also consider the notion of empowerment through learning, as this is arguably one of the main purposes of trade union education.

I use this discussion as a backdrop to enable me to address my research questions about adults' motivation to learn mathematics, the relationship between learning maths at work to trade union membership and approaches to learning that adults prefer. I discuss my findings in chapters seven and eight, where I use participant quotes from my sample narratives to explore their motivation in relation to the support of trade unions and their members.

Chapter 3 Research into learning mathematics in more traditional settings

My research is into adults' motivation to learn mathematics through trade union organised groups consequently in this chapter I explore research literature into the field of adults learning mathematics both inside and outside formal education classrooms. The literature is extensive so I introduce an approach, or model of analysis, I apply to help me consider research ideas. This helps to position and validate my work in what is an expanding field of research (Evans, Wedege and Yasukawa, 2013).

In section 3.2 I discuss in greater depth three pieces of research into motivation that were particularly influential when developing my research questions and data collection. In section 3.3 I examine the influences of learning mathematics on the development of identities and how that relates to motivation. Finally, I utilise the terms formal, informal and non-formal in relation teaching and learning approaches promoted in trade union adult education. These definitions help me to explore the differences and similarities in teaching approaches promoted in trade union education, discussed in chapter two, and those described by adults in my data analysis in chapter seven.

In chapter six I revisit the concept of motivation, in relation to the domain of affect and cognition, and how they contribute to this research into adults learning mathematics. I undertook this later literature research after I commenced collecting my data, when it became clear, through my grounded theory approach of study that I needed to develop a deeper understanding of the realm of affect and an individual's motivation to learn mathematics, particularly in relation to cognition and emotions.

3.1 Theorising adults learning mathematics
My research project focuses on adults learning a traditional mainstream education curriculum of mathematics up to GCSE level, but learning occurs in the workplace and is organised through trade unions. The participants are all over the age of 18 and they bring a

multitude of differing life experiences and expectations to bear in what could be construed as a 'second chance' to learn mathematics. My study therefore situates itself firmly within the growing field of adults learning mathematics[1] research.

Settersten, Ottusch and Schneider (2015) suggest that meanings and markers of 'adulthood' whether biological, social , psychological or legal are often different , often contradictory as well as continually changing. Legally adulthood in the UK starts at 18 when individuals can vote, learn to drive, get married, join the army or be sent to (special) prisons for 18 to 25 year olds . In 2016 the school leaving age changed (Education and Skills Act , 2008) and young people are now expected to stay in education or training until they are 18. My definition of 'adult' is therefore consistent with all of these markers.

FitzSimons and Godden (2000) suggest adult learners can be described as:

> …of an age or status where education is post compulsory in their particular society.' It may be 'their first formal experience of mathematics education; for others [as in this research] there may be a break of at least one year, possibly decades, since their last formal study of mathematics (p. 14).

The identification of those involved with post compulsory education, sometimes after many years, best describes the adult learners in my research.

Knowles (1970) popularised the term andragogy to develop the notion of teaching or learning for adults which he suggested was different from education for children known as pedagogy. His work is based on a range of assumptions about the characteristics of adults. He suggests that as a person matures (1) their self-concept develops and they become more independent, more self-directing; (2) They accumulate experience which they use as a resource for learning; (3) their learning orientates towards their social roles; and, (4) they become more interested in learning that they can apply to current problems, rather than

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[1] The international research forum Adults Learning Mathematics (ALM) is a growing field of

learning specific subjects (p. 55). Later he added two more characteristics: (5) the need to know and (6) motivation. However he came in for much criticism when he suggested children were only motivated to learn by external factors, such as their teachers, whereas 'adults' were intrinsically motivated through problem solving for personal or work related needs (Grace 1996, p.384). This is something I will explore in this research as my experience also points to motivation being more complex.

Early critics such as Smith (2002) also suggest Knowles fails 'to take into account the environment or context in which the adult is operating' (p. 5); arguing Knowles' work focuses on the adult as self-directed and autonomous, not recognising the social nature of learning. Coben (2007) adds to the complexity of the social context by suggesting adult learners in many countries are becoming increasingly 'non-traditional' (for example having English as a second language), having 'spikey [learning] profiles' and may be coerced onto very short courses in order to be eligible for social benefits (p. 13). Evans *et al.*(2013), reinforce the influence of the social context when they distinguish adults who are learning mathematics as having already experienced school- based education and who:

- participate in a substantial range of practices, such as working (or seeking work), parenting, caring and housework, budgeting and organising consumption, voting; and
- are conscious of having social and political interests

(ibid, p. 204)

In his later work Knowles *et al.* (2015) did recognise the importance of the wider political, social and cultural contexts that inform adult learners 'memories of social divisions, (e.g. class, race, ethnicity and gender) amplified in classroom experiences and reflected in classroom memories' (p. 15). Given the context of learning for the adults in my research - learning mathematics through trade unions, in non-traditional environments, and participating in a range of practices in their lives outside of work - I consider the political, social and cultural contexts of learning as important when researching adults' motivation to learn mathematics.

Research into adults learning mathematics now recognises a range of theoretical perspectives, methodologies and research approaches. In my research project I consider ideas from differing theoretical perspectives including the influence of education on people's lives and roles in society (Freire, 1972; Benn, 2004; Walkerdine, 1988). I also reflect upon learning in different contexts (Lave, 1988; Lave and Wenger, 1991),particularly in the workplace (FitzSimmons, 2004; Wedege, 2013).I have also utilised research into trade union education(Ross *et al.*, 2011; Rees, 2007) and the link to critical education in people's lives (Frankenstein, 1985; Wedege, 2004; Skovsmose, 2011). I later consider psychological research into motivation in relation to learning mathematics (Mcleod, 1994; Hannula, 2012).

3.1.1. Researching dimensions of research interest

Research analysis in the field of adults learning mathematics has developed several dimensions of interest. An important one is ways of learning in different contexts. I situate my study into trade union members learning mathematics in the workplace in a rich field of research that includes: tailors in Liberia (Lave, 1977); supermarket shopping in the United States (Lave, 1988); packing; pharmaceutical manufacturing and the Financial Services sector (Bakker *et al.*(2006); nursing (Coben and Weeks, 2012) and my own contribution concerning industrial bakers (Kelly, 2011) and construction workers in the United Kingdom (Kelly, 2012).

Another dimension is the problem of 'transfer' of knowledge between situations, for example between traditional school- and college-learned mathematics and mathematics used in the workplace The latter is a field I have been interested in since starting teaching in the 1980s and this influenced my choice of context for the purpose of this research.

Yet another dimension of interest in adult mathematics research is the relationship between the affective domain and mathematics that includes beliefs, values, attitudes, emotions and motivations. The framework for analysing the relationship within the field of affect to motivation to learn mathematics is still in development (Hannula, 2012) so my research adds to the range of contexts in which motivation, confidence and emotions is being investigated.

A final dimension of interest to my research is into the reason or purpose for learning mathematics. Reasons and purposes are influenced by political, social, economic and technical changes in society, and can be exemplified through the discourses of human capital, humanism and social justice. This research takes place within a trade union education context and so the social, historical and economic factors relating to the discourses of social justice and empowerment are also relevant to this work.

3.1.2 Developing my model of analysis

As indicated the range of perspectives I accessed in this research field is extensive. When considering the research literature I found it useful to develop my analysis on three levels: the individual, the social and the societal. These levels necessarily interact and influence each other but by using this approach my aim was to analyse the research data in a way that brought added focus and clarity to my thinking.

The individual level reflects the personal or subjective level; the social face-to-face group level is the orbit where the learning takes place and in which the person operates. The wider societal level considers the historical, social and economic factors appertaining at government and organisation levels. This model reflects one used by FitzSimmons and Godden (2000), who redefine the three levels as the micro, meso and macro. It is also similar to an approach used by Scheon (2011) when he tries to take a holistic approach to researching motivation. He describes the three 'domains' slightly differently, concentrating on social behaviour at the levels of the individual, the social and the cultural within the wider social contexts (ibid, p. 12).

At the individual or personal level I use what Wedege (2010) calls a *subjective approach*, which she sees as 'starting with people's competences and subjective needs' (p. 27). Walkerdine (2010) broadens the notion of *subjectivity* to include the personal and feminist perspectives where she explores social context, gender, class and status. Evans *et al.*(2013) also see subjectivity as important but they focus on 'the cognitive and affective as part of the whole person' (p.222). I understand the individual level as subjective needs and goals that relate to the personal (gender, class and social context) but also include the cognitive and affective domains as in my experience adults regularly describe how they feel about their experiences of learning mathematics. But like Benn (2004) I reject any

attempt to locate this problem with mathematics within the learner themselves, being subjective does not imply that blame should be with the learners.

I also wanted to investigate how the learning group, as well as fellow workers and family, might influence motivation and learning and so another level of analysis is the local, face-to-face social group level.

At the third level of analysis I incorporate the wider socio-economic influence. Wedege (2010) suggests using a *general* approach 'starting with societal and labour market qualification demands and/or with requirements from 'school mathematics'(p. 27). She suggests this approach is found in national surveys, focusing on poor numeracy in populations. In my research individual members have been given a 'second chance' to learn mathematics because trade unions have negotiated with both central government and employers to enable this to happen. Therefore the social context of learning and the societal values, history and culture within wider United Kingdom society are as important, as those that exist within both the workplace and the trade union movement and its ethos.

Lerman (2015) writes about using the idea of a lens that zooms into and out of different perspectives when undertaking mathematics education research. He describes focusing on the individual and zooming out to consider the classroom context, then zooming back into the individual. Winbourne (2008) suggests a wider zoom is needed taking in influences outside the classroom. This idea of zooming in and out of the three levels of analysis is a useful analogy in my research as this indicates a relationship between the three levels I chose to focus on.

3.2 Considering motivational factors in adult learning

In this section I discuss three research reports that identify motivational factors in relation to adults learning that helped in the development of the interview I used in my research. The search for literature into the motivation factors of adults learning mathematics, by its paucity, was an early indication of how limited current research was. This was especially true of research into groups of adults who are given (or take) a second opportunity to learn mathematics in a context outside of state sector provision but as a consequence are often

harder to reach for research purposes. The three pieces of research I found useful early in my reading were: *Beyond the daily application* (2005c) by Swain *et al.* and *Effective teaching and learning: Numeracy* (2007) by Coben *et al.* and *Learner journeys: Trade union learners in their own words*(2011) by Ross *et al*.

The first piece of research, Swain *et al.*(2005), was part of a larger project into what makes numeracy teaching meaningful to adults. They investigated and identified motivational factors affecting adult students' attendance and continuing attendance in numeracy classes. Although, as with my research sample, most of their learners were in work, their students were learning in mainly formal education settings such as colleges, whilst my sample were learning in the workplace. Coben *et al.*(2007) also researched what motivated adults to join and continue to attend numeracy courses (as part of a larger piece of work on effective teaching and learning). What interested me in her research was it took place in a range of institutions, including Further Education colleges, community colleges, a prison and a private training provider. However their research group differed from mine in that their cohort was mainly from the 16-19 years age group, while my sample were learning in the workplace and usually older. The research by Ross *et al.* (2011) was focused on learning through trade unions, so the context had commonality with my research, although they were interested in issues of equality and diversity. Their learners tended to be older as were mine, but theirs were attending a broad range of courses organised through trade unions, whereas I was only interviewing those who studied mathematics up to GCSE level. So each research project mentioned above had some common aspects with my work but also had differences and I was interested to see if their work could inform my research methodology and questions.

I chose the first two sources to give me some indication of the range of motivational factors that are relevant to adults learning mathematics, albeit in fairly traditional educational settings. The work by Ross *et al.* (2011), while focusing on adults learning a wide range of subjects, gave me perspectives on adults' motivations to learn through trade unions, in non-traditional settings. While helping to inform my interview questions the reports also provided me with ideas that I would be able to use to compare and contrast my findings as

part of an early process of validation of my work and later helped me reflect upon my analysis.

In their research Swain *et al.* (2005) found students' motivations were many and complex, citing over thirty motivational factors that they grouped under headings of Instrumental/ Utility, Understanding/Exploration and For the Self (ibid, Appendices F). Grouping the factors into three criteria helped distinguish those relating to the development of the self, the purposes and usefulness of learning and the development of subject knowledge. Coben *et al.* (2007) also found motivations were multiple and complex and they too included improving the self but also highlighted the importance of factors linked to a learner's future life, such as options to study or employment. Ross *et al.* (2011) categorized their findings as 'intrinsic', relating motivation to the self, for example the need for personal development, or 'extrinsic', related to the wider social world, such as securing a job in the wider economic context (p. 20-22).

I now examine the three reports, using the three-level model of analysis discussed earlier to help explore factors relating to motivation.

3.2.1 Identifying individual factors and subjective needs

When identifying motivational factors that related to individual or personal factors or needs I included motivation related to self-esteem (Swain, 2005, Appendix 1), which indicated a need linked to how a person saw themselves; keeping your brain active (Coben *et al.*, 2007, p. 20), which indicted a link to physiological need as well as a cognitive one such as filling a gap in knowledge (Ross *et al.*, 2011, p. 5). Ross *et al.* (2011) also found individual motivational factors relating to the adult's need to prove something to themselves or improve their life chances, which they also see as connected to raising their self-esteem.

Another individual factor found in all three reports was that of learners developing 'the learning bug' and expressing a motivation to go on to other education courses. This relates motivation to intended future opportunities and long-term goals.

I also identified the notion of self-esteem, or self-concept, and understood that as a belief in relation to achievement in mathematics. However all three of the research reports also discussed increased confidence in relation to motivation, so I looked for that during my interviews.

3.2.2 Identifying motivational factors linked to local face-to-face social groups

Coben *et al.* (2007, p.20) found helping children was an important motivator to learn mathematics but identified it as a gender specific variable, in that most of those who identified it as a driver were women. I utilise the function of helping children to indicate an example of a face-to-face social group motivator that I have also found in my own previous research (Kelly *et al.* 2012) and which I have experienced through my own teaching.

Ross *et al.* (2007) also found helping children to be an important motivational factor but related it to broader socio-economic issues. For example, they have identified that new migrants wish to learn about mathematics to help themselves and their children to integrate better into society. This suggests the premise that a motivational factor may be discussed at one level whilst related to others. In this case linking children as a local, face-to-face social group, to the social and cultural values of wider society viewed through ideas of 'integration'.

All three reports mentioned earlier also identify previous poor learning experiences as a common reason for adults to return to learning. It is important to state that I use the phrase poor learning experiences to cover many different, scenarios including socio-economic reasons, personal choices or difficult previous teaching and learning encounters. Ross *et al.*(2007) suggest the term 'poor learning experiences' includes: 'those who left compulsory education without qualifications' where union learning provides them with a 'second chance' to learn. They suggest this 'second chance' addresses:

> … socioeconomic disadvantage, in particular to those over forty...who experienced discrimination on the grounds of race…or those who were encouraged to leave school because of parental expectations defined by gender.

> (ibid, p. 20)

Swain also recognizes poor learning experiences as barriers to learning but uses Bourdieu's notion of habitus (2005, p. 31) to theorise the influence of social expectations on motivation, when working class families encourage young people to seek employment to help with home finances rather than continue to study. Ross *et al.* (2011) argue that it is a poor formal school experience that can act as a 'driver', or motivation, for trade union members to prove to themselves, or others, that they could succeed at learning. This connects the role of social face-to face groups to an individual's motivation to achieve, something I discuss later in chapter eight in relation to developing confidence (Weiner, 1972; Mahn and John-Steiner, 2002).

The difference between poor previous learning approaches and those which leading to success, when people are offered a second chance to learn is an important theme in my research, so I included appropriate questions in my interview schedule to address these issues of variable learning experiences across time.

3.2.3 Identifying motivational factors related to wider society

I suggest an example of motivation relating to wider society, is when an individual wants to achieve a mathematics qualification because it is an important signifier of intelligence that can facilitate future employment or educational opportunities. Research by both Coben *et al.* (2005, p.19) and Ross *et al.* (2011, p. 21) agree with this, although Swain *et al.* (2005) argue it has less importance in their list of factors (p. 48). Swain *et al.* (2007) argue that gaining qualifications via a mathematics course is a motivational factor in the short-term and categorise this as an instrumental or utilitarian reason for joining a class (ibid, p.48). In chapter seven I utilise this notion of initial motivation when analysing my data to develop a typology of motivation to re-engage with learning. I also consider that gaining a qualification can also be a long-term motivator, relating to future opportunities in life through gaining enhanced access to employment or education.

Indeed the importance of securing or improving a person's employment prospects in a time of economic uncertainty cannot be underestimated. Other research (Bynner and Parsons, 1997; OECD, 2013) also confirms a link between gaining mathematics qualifications and improving and enhancing people's life chances as well as improving their longer-term quality of life. Whist I understand that Swain *et al.* (2005) do not deny the importance of a

mathematical qualification and how it links to financial security, in terms of employment prospects and future earning power, the report questions its prominence over other motivational factors. Swain *et al.*(2005)identify the three main motivational factors in their research with learners:

> … to prove to themselves that they have the ability to study and succeed in a high-status subject which they perceive to be a signifier of intelligence…. for students to help their children, and for understanding and engagement, which leads to enjoyment and a sense of satisfaction. (p. 317)

They argue strongly that 'people want much more from their numeracy classes than learning how to read their gas bills' (ibid). I agree with this, although improved financial capability can be an important outcome of learning mathematics and, as a consequence, I looked for evidence of gaining qualifications relating to employment and financial security as a stand-alone motivating factor in my research.

In conclusion, these three research reports greatly assisted me in considering a range of motivational factors when designing the questions to ask during my interviews. By analysing the reports at three levels I identified motivational factors that a) included self-development at a personal level b) helping children or securing their current employment prospects at a social face-to-face group level and c) gaining a qualification as a signifier of IQ which could act as a key to opening up future employment or education opportunities at a wider society level. These factors all influenced the development of the interview questions, which I write about in chapter five.

However, the three reports were also an early indication of how limited the research literature was into adults' motivation to learn mathematics. This is especially true of research into groups of adults who have been given a second chance to learn in a context outside the state sector provision.

3.3 Considering motivation related to identity development through learning mathematics

In this section I discuss research into motivation, in relation to identity formation through learning. I see an individual's identity as developed by past history and current experiences, while motivation influences future intentions, for example to act or not to act in response to a particular opportunity.

Motivation relates to an individual's personal decisions about the opportunities they have now, their past experiences and their future life trajectories. In my research the participants previous learning experiences have been varied and often lacking achievement. However they are all motivated to learn by taking advantage of the opportunities being offered through their trade union membership. Therefore, when undertaking my analysis I looked for suggestions that they were developing their identities within the mathematics class, or 'mathematical identities' as a result of stronger academic attainment through positive learning experiences and look for ways this might influence their motivation to learn or use mathematics.

Lave and Wenger (1991) argue that the development of a person's identity happens through learning which 'locates' them 'in a social world'(p. 35). Wenger (1998) went further and emphasized the influence of social participation in learning within 'communities of practice', encompassing the process of 'being active participants in the practices' of the social communities and 'constructing identities in relation to the communities.' (Wenger, 1998, p. 4). Boaler *et al.*(2000) apply these ideas to learning mathematics in classes in secondary schools and suggest individuals not only learn mathematics but also 'gain a sense of who they are within the social practice of mathematics'(p. 3). Winbourne further suggests that 'identity' should be seen as the aggregation of smaller 'becomings' (or identities) identified with a learner's participation in a multiplicity of communities of practice, local and not so local, some of which are locatable within school classrooms and most not' (Winbourne, 2008, p. 82). Applying these ideas to my research suggests an adult may develop a 'mathematical identity' in the trade union classes which is produced by the acquisition of a new relationship with mathematics both inside and outside the classroom.

Wojecki (2007) suggests 'that adult educators may find successful teaching strategies that enable adult learners to have opportunities in which to re-author their identities to learning' (p. 169). So 'active participation' in a social learning group such as the trade union classes could give adults a second chance to learn and 're-author' their identities in relation to mathematics. Hence developing their 'mathematical identities' may enable them to develop not only their mathematical skills, but also what Winbourne (2008) calls their 'public identity'. (p.80) Applying this to my research, indicates the possibility of the influence of successfully learning mathematics going beyond the trade union learning group, perhaps into a person's home life, or even enabling them to influence future trade union negotiations.

Holland and Lachicotte(2007) see motivation formation acting 'in and across cultural activities over time,' which suggests the possibility of a change in a learner mathematical identity influencing their future choices (2007, p. 120). In my research I was seeking indications of changes in adults' motivation through the development of their 'mathematical identities' while learning, something that may happen over a significant period of time, maybe even years.

Illeris (2014) argues motivation has both internal and external aspects. Internal motivation includes needs, desires and interest, while external motivation comprises demands and necessities, but can also include compulsion and constraints. While many argue internal motivation is somehow 'better' or 'more genuine' I agree with Illeris that motivation is more complicated and external motivation can be a significant driver, for example, someone may be 'strongly motivated to learn something for work but have little desire to do so' (ibid, p. 102). He posits that even when someone is 'necessity – motivated' to undertake a course for work, that person can be transformed by the experience. He describes a learner 'radiating pride and relief' having overcome 'resistance and fear' to experience 'victory' and 'enrichment' (ibid, p.104) after successful learning. Illeris calls this *transformative learning,* describing it as 'a qualitatively new structure or capacity within the learner' (ibid, p. 5) and argues it covers 'all the dimensions of mental capacity and learning' (ibid, p.38), which are

cognitive, emotional, social, situated, societal and environmentally embedded. Consequently he claims the term identity is 'the most adequate concept or term to cover the mental whole and all of the dimensions that are involved in transformational learning' (ibid, p. 39). This notion of transformation through learning helped me to understand that motivation can also be changed through learning experiences.

In conclusion, motivation relates to possible changes in an individual's identity developed through learning. In this research adults are learning mathematics alongside trade union members, so their identities are developing and being developed in relation to a particular social context and learning group. In my study I am looking to see how motivation connects the individual to the social world and how that influences, encourages and enables them to learn. However, I am also looking for ways that the social world is changed as the individual's motivation is influenced by their mathematical identity as it develops through their learning 'journey'.

3.4 Learning using formal, informal and non-formal approaches

In chapter seven I use my data to explore my second research question about the type of learning and teaching experienced by adult learners in mathematics classes organised through trade unions and delivered in the workplace. In this section I consider the usefulness of employing the terms of formal, informal or non-formal learning to describe types of workplace adult learning in this trade union context. This discussion contributes to my data analysis in chapter seven (category 3), where I use the respondents' words to help develop concepts that indicate the characteristics of learning experiences that they find motivational.

Evans *et al.*(2013, p. 205) see 'formal learning' as happening in schools and colleges, where learners follow a state-regulated curriculum, usually resulting in certification. 'Informal learning' is defined as happening outside the classroom, for example in the workplace, where there is often no formal recognition of that learning, whilst 'non-formal' learning is something that happens more in everyday life. These three categories describe different types of learning but the categories themselves can overlap or become so broad

as to lose definition and this seems to be the case when considering trade union learning in the workplace.

Usefully, researchers into learning in the workplace (Dale and Bell, 1999; Garrick, 1997; Boud and Garrick, 1999) broaden the definition of *informal learning* to include learning that has different (pedagogical) characteristics to the more formal learning that happens inside educational institutions. Others widen the *informal* category still further to include notions of 'self-direction' as well as 'learning not formally structured' (Tusting and Barton, 2006, p. 25) but this definition does not help when describing learning in my research.

Using the above definitions, I see the learning in my research as having *formal* characteristics in the sense that the participants are learning mathematics related to Numeracy Levels 1 and 2 in the Adult Core Curriculum. So their curriculum is defined through reference to an educational sector rather than by their employment. They have textbooks and technology packages available to support that learning, and achievement is recognised through formal qualifications. Therefore curriculum content can be described as formal.

Nevertheless, the pedagogical approach that trade unions promote and discussed in the previous chapter is closer to being termed 'informal' or even 'non-formal' in that the approaches include using adult's previous experiences in life and work. They use collaborative approaches when learning and developing shared understandings of problems through discussion with peers. I see this as closer to what Resnick (1989) describes as learning through apprenticeships in the workplace, when she argues:

> … in schools people are expected to learn individually. Yet in work and personal life, most mental activity is performed in the context of some shared task that allows mental w*ork to be shared over several individuals.*

> (Resnick, 1989 p.12).

Resnick's description may relate more to mental activity that happens in workplace practice and 'getting the job done' but it does have common characteristics with the learning approach recommended by trade unions (Rees, 2007) in that it promotes a collaborative

approach when developing concepts. Resnick argues this approach to mental activity is different from that described as *formal* individualised learning approaches more often associated with state education classrooms. Although, more mainstream mathematics teachers are now beginning to use shared activities to encourage understanding when exploring mathematical ideas. Indeed Swan (2012)recommends mathematics teaching should have a collaborative orientation that uses activities and discussion 'to arrive at understanding.' He recommends this approach rather than teaching mathematics as 'a body of knowledge and standard procedures' to be learnt for an examination.

In this sense the approach to learning promoted by trade unions, even in mathematics classes, can be termed as less formal, or informal, where peers and teachers support the co-construction of ideas through discussion that enables feedback on misconceptions. This recommended trade union approach to learning is also underpinned by collectivist and activist principles (Rees, 2007) and I consider the influence of this approach on learners' motivation when analysing my data in chapter seven.

Griffiths and Guile (1999) also identify the characteristics of *formal* learning in schools and colleges as *'de-contextualised*, second-hand, individualized and needing motivation' (Griffiths and Guile, 1999, p. 159). Guile (2011) later wrote of the notion of *re-contextualisation,* reflecting the idea that learning is related to contexts, but problematized differently in relation to the social, historical and cultural experiences within the context (Lave, 1988; Lave and Wenger, 1991; Bernstein, 1977). Thus in this sense the mathematical learning taking place in meeting rooms in the workplace will have very different social and historical traditions to those experienced in a school or college classroom. In chapter seven I look for indications that the context of learning does feel 'different' from that experienced in school and college and so may be described as more informal.

I also interpret Griffiths and Guile's notion of 'de-contextualization' as relating to the notion of mathematics as abstract concepts learned as part of the school mathematics curriculum. Stech (2008) describes this as developing a particular way of thinking that is transferable and that enables mathematics to be utilised in different contexts. This may be true for some learners who understand and enjoy the abstractness of mathematics but for those

who do not, they may perceive it as lacking relevance to their lives and the workplace. I discuss this notion in relation to research into relevance and intrinsic motivation in section 6.1.5 (on page 80).

So in my research I explore the descriptions of the adult learners in relation to the characteristics that are defined as formal, informal and even non-formal. GCSE can be classified as formal mathematics, in that it derives from a state-defined curriculum, but the learning approaches recommended by trade unions are less individualised and more collaborative, so might be described as informal or non-formal. Trade unions also seek to make their teaching relevant to people's work and lives which necessarily involves learning approaches that are more informal or even non-formal, so I look for these characteristics when respondents describe their learning experiences of mathematics through trade unions, in chapter seven.

Concluding remarks into learning mathematics in more traditional settings
In this chapter I consider how to position my research into motivation to learn mathematics within the research field of adults learning the subject and suggest a three level approach to analysis to help examine the literature. I used my analysis to help inform my interview questions. I also consider how a person's identity, and hence motivation, can be developed through learning, which is useful when considering motivational factors to re-engage with learning. I finally consider how the terms used in the adult education sector might be considered to help explore approaches to teaching and learning recommended by trade union education.

Chapter 4. Methodology and addressing issues of quality

In this chapter I explain how I have been influenced by my histories and experience in the development of a world-view that I bring to this research. I discuss my reasons for using qualitative methodology and defend any criticisms of its application and explore ethical considerations encountered during the research. In chapter five I explain the practicalities of developing my interview questions that informed my interviews and the mechanics of sample selection. I explain the process of grounded theory analysis I use to develop my findings in chapter seven and eight.

4.1 Research purpose and methodology

Through this research project I sought to explore the notion of motivation in relation to adults learning mathematics, what sort of teaching and learning approaches influenced this motivation(s) and how their membership of their particular trade union, who organised the opportunities to learn the subject, shaped it. Motivation to learn mathematics is often seen as problematic (Dweck, 2008; Boaler, 2009), so I chose to interview a group of people who I thought might be highly motivated to learn to try to understand the issues. These adults were learning mathematics at or below GCSE level, while in the workplace, through opportunities negotiated by trade unions and employers. Having experienced previous 'failure' when learning this subject, which I discussed in chapter three, these learners have chosen to re-engage with mathematics, overcoming practical barriers such as shift work and caring responsibilities and other more emotional barriers. I was driven to explore what motivated these adults to learn and in the process learn more about what motivation actually *is* and what teacher and teacher trainers involved with adults might learn from this research.

4.1.1 Me as the researcher

As someone who has had a career in mathematics, I am regularly in dialogue with trainee teachers exploring my own and their worldview, in relation to the ways of understanding the subject and the positivist tradition of scientific exploration it encourages. Walkerdine (1990) describes this way of thinking as 'the path to rationality, displayed best in mathematics, is a path to omnipotent mastery over a calculable universe'. (p. 23)

I was inclined to a positivist worldview while studying A level Mathematics, Physics and Geography but when undertaking a university degree in Government and Economics, where I studied mathematics in the first year, and later my MA in Vocational Education, I challenged my then way of seeing the world and I started to consider 'that humans learn through their experience and that the nature of the experience influences the nature of the resulting knowledge'(Crawford, 1996, p. 96). The contemporary positivist ontological and epistemological tradition has come under severe criticism in research as a 'reductionist and mechanistic' view of nature, defining 'life in measureable terms rather than inner experience' relying on the interpretation of quantitative information (Cohen *et al.,* 2011, p. 14). Ernest (1996) further suggests ways of knowing and understanding are about recognising how the social domain influences the formation of the individual, and how the individual constructs themselves in response. I take that idea a step further and suggest that the individual also influences the social context in which they develop, as I do in my discussion on identity development in chapter three, closer to what Lerman might claim to be the 'person-in practice-in person'(2000, p. 38).In this sense the research falls within an interpretive research paradigm in that 'it is primarily concerned with human understanding, interpretation, intersubjectivity, lived truth (i.e. truth in human terms) (Ernest, 1996, p. 24).

However, in this research, I seek to understand what people think and feel, so I wish to explore their understandings of motivations through stories and narratives, told by the people who are learning mathematics at work.

4.1.2 Being sensitive and creating joint representations of experiences

Interpretivism, or antipositivism was developed within the Social Sciences, and in the fields of Psychology and Sociology particularly and is more concerned with understanding people and their behaviour. It focuses on individuals and their interpretations of situations, so naturally relies on qualitative data, which can come from a variety of sources including transcripts from case studies and focus groups, (Denzin and Lincoln, 2000; Bryman, 2012) but in my research mainly one-to-one interviews were prevalent.

However this approach to research is criticised for being too subjective and specific to offer useful insights into group behaviour (Bryman, 2012, p. 405), but Corbin (2008) argues that the notion of objectivity is not a useful way to assess the quality of qualitative data; rather a researcher has to develop sensitivity to his or her data. She describes sensitivity as 'having insight, being tuned into, and being able to pick up relevant issues, events and happenings in the data'. (Corbin and Strauss, 2008, p. 32). But a criticism of being *too* subjective could be made, so I agree with Cohen *et al.* (2011) when they recognise Bernstein's argument that a researcher becomes part of the research when they are negotiating with participants, yet the research is often written as though the researcher is 'outside' the situation'. I do not claim I am outside the process; rather I seek to develop 'representations' of the situation (Dowling and Brown, 2010, p. 3), which produces text from data analysis overlaid with my own interpretation based on my own history and experiences. So my perspective and interpretation will not be objective but will have what Donna Harraway (1998) calls a 'view from somewhere' (Olesen, 2003, p. 357). Somewhere, in this research, is a teacher of maths to adults with over twenty-five years experience and a teacher trainer with over ten years experience, as well as being a trade unionist for over thirty-five years and a political activist for over twenty years. The research I have undertaken is relevant to my work and my life experiences and therefore cannot help but be influenced by my own knowledge and biographies. So my interpretation of the learners' narratives could be seen as biased but I agree with Sarkar and Cybulski(2004) when they cite Heidegger (1962) stating it is also impossible to take away all of the preconceptions and presuppositions of the researcher. I accept the need to write in such a way that my bias as the researcher is explicit and not

complicit. I return to this notion of subjectivity when discussing confirmability of the data later in section 4.3.4. (on page 54).

4.1.3 Becoming more critical

Another criticism aimed at both the positivist and anti-positivist paradigms is that they tend to explain rather than change situations, to describe rather than to emancipate (Clough and Nutbrown, 2008; Bryman, 2012). As a lifelong trade unionist and one time political activist I am interested in the potential of this research to identify ideas used in trade union education that might usefully influence more traditional adult education settings.

The context of this study is adults learning in the workplace, which is often, along with vocational learning and apprenticeships, perceived as having lower quality and value than academic knowledge (Wolf, 2011; TES, 2012). Rather than developing the whole person to think critically and freely,(Hirst and Peters, 1970) learning at work is more often linked to an 'individual's economic progress and performance in the workplace'(Shelley, 2007, p. 117).However trade unions were more involved with training for activism and empowerment, as discussed in section 2.1 (on page 14) so this research and the teaching approaches used in mathematics classes are of interest to my work. I want to explore if this research could usefully improve mainstream mathematics education practice. Hence the study adopts a critical approach in that I am seeking to 'understand, interrogate, critique and transform actions and interests' (Clough and Nutbrown, 2008, p. 17).

The learning described in this research occurs because the conventional route has failed the people I interviewed and learning at work has offered those adults a second chance to achieve. Hence I am interested to use the learners' narratives to describe what they define as 'other' and 'different' that has motivated this achievement. It can be argued that the learning that takes place in the workplace has been 'marginalised' through the 'powerful dominant discourses' of formal education (Cole, 2010, p. 60) but I want to help inform

educators about these 'other' forms of teaching and learning, which have proven to be so useful to adult learners.

This research is also underpinned by my own personal belief that learning mathematics, at whatever level, is only valuable if it is related to the empowerment of that person and enables them to live a fuller life that contributes to the betterment of themselves, their environment and society. Because of this I understand trade union learning as a way of enabling people 'to achieve social justice and challenge societal norms through collective action' (Shelley, 2007, p. 117). My personal belief about education is also close to that expressed by D'Ambrosio, who wrote about the goals of education being 'to promote creativity, helping people to fulfil their potentials, but being careful not to promote docile citizens' (D'Ambrosio, 2007, p. 26) and more particularly that 'Mathematicians and math educators must accept, as priority, the pursuit of a civilization with dignity for all, in which inequity, arrogance and bigotry have no place'(D'Ambrosio, 2007, p. 25). So my research is also critical in the sense that the researcher is also concerned about the ethical and political dimensions of mathematics education itself

4.1.4 Influenced by feminist research perspectives

Feminist ways of understanding the worldview have been useful to me to help understand my own history of learning experiences, for example when I was training to teach in 1981, a mathematics teacher trainer explained to my learning group that "girls were innately less able to do mathematics than boys". Hence Burton's (1987) ideas resonated with me when she theorized that 'education systems, staff attitudes and pedagogies all reinforce the selection of females and minority groups away from mathematics' (p. 29). Hacker (1990) understood society as a place where both technology and mathematics was also used to exclude women from other professions, such as engineering. But Benn (2004) went further, arguing that mathematics was a tool in the construction of a 'male dominated euro-centric, patriarchal and hierarchical society' (p. 109). My own experience and being exposed to these ideas has helped me develop my own thinking about the role of power and culture within society. Social attitudes may now be changing and this analysis may need updating, but feminist thinking was influential in my early teaching career and

continues to inspire my teaching and research in mathematics today. Indeed feminist research has also always sought to explore personal viewpoints, because as Reinhartz (1992) suggests when citing Datan (1989, p. 175) ' it is an axiom of feminism that the personal is political' (p. 234). This is one reason why I carry out analysis in my work at the individual level because I want to use personal viewpoints to consider the influence of affect on motivation. But I stress, as does Benn (2004), that I reject any attempt to locate the problem of not being motivated to learn mathematics within the learner. Being subjective does not mean blaming the learners rather it seeks to understand their viewpoints.

Throughout this section I have sought to explore and explain my own 'world view' and show that my approach to this research, influenced by feminism, aims to be critical and interpretist.

4.2 Ethical considerations

During this research I was very aware that it was important to pay due consideration to the ethical issues of data collection, and as such I had to gain the approval from South Bank University's Research Ethics Committee, a copy of which can be found in Appendix 4.2.a.

Indeed I had a responsibility and a willingness to actively embrace the ethic of respect in that:

> Individuals should be treated fairly, sensitively, with dignity, and within an ethic of respect and freedom from prejudice regardless of age, gender, sexuality, race, ethnicity, class, nationality, cultural identity, partnership status, faith, disability, political belief or any other significant difference.

(BERA, 2011, p. 6)

My responsibility to my participants included me ensuring that I was open about the purpose of the research and its uses. There was no place for subterfuge in this research. In fact working through the trade union organisations encouraged openness because I had

to inform various gatekeepers including the union officials and ULRs of the purpose of the research before I could gain access to potential learner participants. (In Appendices 4.2.b. see a copy of a letter I sent to an officer in Unite the union, copies of which I also sent to an officer in NIACE and a ULR in the Union of Shop, Distributive and Allied Workers (USDAW).

I gave written information about the research to each participant prior to my meeting with him or her. I then made sure that participants gave knowing consent before they were interviewed, by explaining at the beginning that they could withdraw from the study at any time without explanation. However I did request that they let me know within a particular time scale, so that I could remove the data before publishing the report.

I heed the importance of protecting the confidentiality and anonymity of participants when analysing and writing up the research. My intention to do this was made clear at the beginning of each interview, with me explaining that: I would not share any information with other interviewees; I was the only person listening to and transcribing the tapes from the recordings and any quotes in my analysis would be made anonymous to ensure that none could be traced back to a particular individual. The only slight exception to this was the identification of one company, whose manager was happy for the company name to appear in the research, and be recorded on the consent form. However I have not included this information in this thesis, as it did not add anything substantial.

I was also aware that it was my legal responsibility to store and retrieve any personal data according to the Data Protection Act 1998. I ensured that I kept any personal data secure and that I used secure IT systems, password protected, when storing and transcribing the interview data, either in aural or visual form. I also personally transcribed the data and used NVivo software to aid its analysis and ensure participant anonymity. I kept interview

notes and signed consents to use the data in a locked storage space. The evidence will be destroyed when the doctoral process is complete.

It is also very important that I ensure my methods of research are 'fit for purpose' especially with my stated political perspective, as the findings should be trustworthy and authentic (discussed in the next section) to the social world in which the research is situated, whilst I also have a duty to 'protect the integrity and reputation of the educational research community' (BERA, 2011, p. 14). Given my own social, historical and cultural experiences I have a responsibility not to sensationalise or distort my findings and it is an important part of my ethical approach that I am aware of trying to avoid 'bias' or the skewing of my findings, whilst being open and honest about the purpose of the study.

4.3 Issues of quality in research design and methods
In this section I discuss issues of quality in relation to the data collection and analysis. This research is not about the cognitive processes of learning mathematical topics or checking mathematics skills. It is about exploring people's ideas, feelings and experiences in relation to their motivation to learn maths. So, this qualitative research uses a grounded theory approach to analysis and I expand upon this later in this chapter and also in chapter 5.

Within any research project the issue of quality of analysis and findings is pivotal. Indeed there is an on going debate about what criteria should be used to judge quality in qualitative research (Charmaz, 2006; Corbin and Strauss, 2008; Bryman, 2012). Bryman (2012) describes how some researchers have tried to adapt the notions of reliability and validity, usually used to judge the quality of quantitative date, to the judgement of qualitative data with varying degrees of success.

For example, in order for qualitative research to be rigorous Lincoln and Guba (1986) argue for trustworthiness and authenticity. The criteria for trustworthiness are credibility, transferability, dependability and confirmability, which they suggest answer the four basic

questions of rigor in research, which should be 'concerned with truth value, applicability, consistency and neutrality' (p. 76). Lincoln and Guba (1985) then added the criteria of authenticity, which they suggest relates to the notion of fairness and trying to balance the different stakeholders viewpoints that need to recognised in social research, or research in 'naturalistic' settings. The criteria are ontological authentication, which is concerned with 'raising the consciousness' of issues in research such as the effect of political, cultural or social impoverishment' (p. 81). Educative authenticity, which relates to being aware of 'others constructed realities', even if not necessarily agreeing with them. Catalytic authenticity which seeks to empower the voiceless and tactical authenticity which aims to stimulate action by ensuring interviewees are 'not seen simply as "subjects" who must be manipulated…or deceived in the interests of some higher "good" or objective truth' (p. 83).

I now discuss the quality and rigour of the approach I used in this research using the list of criteria reflected in the section headings:

> 4.3.1 Credibility of my findings,

> 4.3.2 Transferability or generalizability of findings,

> 4.3.3 Dependability,

> 4.3.4 Confirmability- the researcher as part of the research,

> 4.3.5 Authenticity relating to ethical consideration and the recognition of multiple perspectives

However, I do strongly agree with Corbin, when reflecting on her work with Strauss, when she states that in the end the research has to:

…resonate[s] with the readers' and the participants' life experiences. It is research that is interesting, clear; logical…that has substance, gives insight, shows sensitivity and is not just a repeat of the "same old stuff"….

(Corbin and Strauss, 2008, p. 302).

4. 3.1 Credibility of the findings

To ensure that my research was credible, whenever possible I discussed my analysis and emerging findings with learners after their interviews. I did this as I did not want to lose the 'essence' of the interviewees' stories and to check that I had not missed anything that would be relevant to my understanding of just why people are motivated to learn maths whilst at work.

The process of checking analyses to seek corroboration, or otherwise, of the researcher's interpretations with interviewees is a type of 'respondent validation', (Bryman, 2012, p. 319)or what Lincoln and Guba (1986) call 'member checks' (p. 77) with stakeholders. In this research I commenced this early in the process and after the first two interviews I transcribed the data, wrote up an early draft analysis and sent it to two interviewees. A week later we met again to discuss my draft, as I wanted to get their opinions to confirm, or adapt my understanding thereby putting my work under their direct scrutiny.

The responses they gave me were generally positive. I asked them about their feelings about the analysis and one of the respondents, a 52 year-old male said:

"It was nice that you quoted us exactly, It may not be grammatically correct how we said it, but that is what was said…. it makes it more realistic. You were capturing a moment…it was a true situation and that's how people feel".

This response and other affirmative comments from the second interviewee confirmed my interpretations and helped me gain confidence in my analysis as it resonated with their 'life experiences' (Corbin and Strauss, 2008, p. 302). Wilson *et al*. (2008) suggest an even greater involvement of the interviewees can be obtained by including them in the writing up of the research, 'through a hermeneutic process of testing interpretations' as a way of building credibility into your work (Wilson *et al*. 2008, p. 380). Early in the research it was possible to re-interview two participants and discuss my write-up of the interviews with them, but as the number interviewed increased in the second year the practicalities of redrafting content through discussion with an ever larger and more dispersed group of participants became unmanageable.

However during the final phase of my data collection I was able to further corroborate my findings with another two female respondents. After I had carried out their interviews. I asked the women if they would be interested in commenting on my findings from the analysis of earlier interviews. The two women volunteered, so I was able to carry out another form of 'respondent validation'. By discussing my analysis of data collected thus far and comparing it with their own experiences we checked to see if their experiences repeated, added anything new or contradicted my analysis. This approach combined respondent validation with a limited form of joint creation and analysis of stories (Cohen *et al.* 2011).

It was also important to ensure that I followed processes defined as 'cannons of good practice' (Bryman, 2012) in the field of research by submitting my ideas and thoughts 'to members of the social [academic world] world'. I interpreted my academic world as including supervisors with expertise in doctoral level research to whom I regularly submitted my work. These people ensured I followed recognised research processes and through my writing encouraged me to explain my thinking behind the qualitative research and analysis I undertook. I was also fortunate enough to be part of an international research group called Adults Learning Maths (ALM), made up of experts from within the

research field of adults learning mathematics, and with whom I could discuss and assess the quality of my research.

4.3.2 Transferability or generalisability of the findings

Qualitative research is often criticised for an inability to make generalisations across populations, as the samples are too small. However Huberman and Miles (2012) argue 'the idea of sampling from a population of sites in order to generalise to the larger population is simply and obviously unworkable' (p. 177) as most qualitative research happens over several years over a small number of sites. Hence they argue most work on generalisability is now focused on developing a 'concept' that is more useful and appropriate to qualitative research (p. 177). I agree when they argue that all research is in context, so I prefer to consider the notion of a transferability of findings.

Grounded theorists contend that it is important to produce a 'thick' description of both the context and the culture of the research to enable others to make judgements about the possibility of its transferability (Charmaz, 2006; Corbin and Strauss, 2008). In this research I explained the context of trade union learning in chapter two, including the debate about the purpose of education within trade unions and the organisational structure that is in place to support the learning of mathematics. The interviews took place in the workplace, where the respondents worked and learned with colleagues who were all members of the same trade union; hence they knew each other through various shared social experiences. Research into trade union learning maintains that members' social identity is also influenced by the 'collective' experience of trade union action (Kelly and Kelly, 1994) hence when considering my research question 'How do adults prefer to learn maths at work?', the influence of this concept on learning and motivation is a valuable and appropriate one to explore.

In my view the transferability of this research to other contexts and its credibility lies in the recognition of *what* motivates adults to learn mathematics, the *different* learning approaches that can be used to build adults' confidence when learning mathematics and the *role* organisations like a trade union can have in that process. Nevertheless I recognise as Payne and Williams (2005) argue, any inferences may be seen as what is termed *moderatum* generalisations*. Moderatum* in that they are moderate in scope, not sweeping sociological statements, and also moderate in that any views stated are open to change and 'are testable propositions that might be confirmed or refuted through further evidence'(p. 297).

4.3.3 Dependability

When considering the dependability of quality in my data analysis, I need to critically reflect upon the research methods I used and the processes of data collection and analysis in order to be confident of my concepts and theories. As such I developed a systematic approach to data collection and analysis, so that my research process is auditable. Lincoln and Guba (1986) argue 'an auditable trail' needs to be established for two reasons, the part of the audit that examines the process results in a dependability judgement, while the part concerned with the product (data and reconstruction) results in a confirmability judgement (p. 77)

Hence to ensure my findings were dependable I explain the process of grounded theory I used to develop concepts and categories in chapter five. The product of this process, which directly addresses my research questions, I develop in chapters seven and eight.

Nevertheless I also needed to ensure the data I collected answered my three research questions relating to motivation. To develop the questions I needed to ensure their relevance and so I built a platform from ideas rendered in the research literature and the three research reports discussed in chapter three. I built on a previous exploratory piece of research I had undertaken into why people (not specifically trade unionists) were motivated to learn mathematics at work. This small piece of research was a draft pilot project undertaken as part of the London University South Bank Professional Doctorate in

Education programme of studies and is available in my portfolio of work (Kelly 2010, unpublished).

Thus I already had questions that had been tested to ensure they provided relevant data on my first research question … 'What motivates adults to learn maths at work?' and contributed to my thinking about the second question … 'How do adults prefer to learn maths at work?' However I needed to develop further questions to specifically include ideas that addressed my third research question namely, ' Is there any relationship between learning maths at work and trade union membership?'

I used the revised set of questions as a basis for two interviews to confirm the relevance of the data. This was a useful exercise as my initial thinking on the second research question … 'How do adults prefer to learn maths at work?' … was that adults might indeed want to learn mathematics relevant to their work or to build on what was learned previously whilst at school. However throughout the two early interviews it emerged that their learning preferences related more to the 'different' approaches used to teach in the workplace. By using the flexibility of a grounded theory approach to data analysis I was able to adapt questions that enabled me to explore what respondents identified as significant.

I then used the software package NVivo[2] to help me organise and analyse the data I collected in response to my questions. The software package also produced an auditable trail for the development of my thinking and helped me to illustrate links from the quotes from interviewees to the concepts and categories I built in order to address my research questions. In Appendices 4.3.3a there are printouts of quotes and diagrams that helped to develop my thinking. In appendices 4.3.3 b, I include examples of background thinking which could be termed memos (Charmaz, 2006, p. 72). These were key to helping me

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[2]**NVivo** is a powerful computer software package that is used extensively in academic research to organise, analyse and track unstructured qualitative data.

understand the overall process and analysis of data. They include prepared notes and diary extracts to show the procedures I used when negotiating and organising the interviews with union members. As well as memos of literature I had read that were relevant, I have included notes on meetings with my supervisors and early thoughts I had about possible concepts and categories I could build from the data. I refer to further printouts from Nvivo in chapter five when I discuss in greater detail the framework of the concepts and categories I developed. I have also retained drafts of my writing on my computer and my backup disc, and the data analysis in NVivo that are available for audit.

4.3.4 Confirmability -The researcher as part of the research

I addressed concerns that relate to the effect that my personal perspectives, attitudes and values may have on the collection and analysis of the data earlier in section 4.1.2 (on page 42). I agree with Corbin (2008) when she argues that a researcher has to develop 'a sensitivity to the data' but also be open about their own values and preconceptions in order that their interpretations and 'reconstructions' to can be judged (Lincoln and Guba, 1986, p. 77).

In order to further deal with these concerns I also sought to check my own interpretations of the data with trade union members during the research, using 'respondent validation', as already described above. I endeavoured to confirm the voice of the learner by reflecting my draft analysis back to the interviewees, gaining confirmation that my analysis reflected their experiences. But I am aware that they could have been seeking to agree or please me as 'the researcher', giving what they saw as 'socially desirable' answers, or may simply have wanted to agree with someone who had spent time interviewing them, listening and valuing their ideas, a phenomenon known as 'acquiescence' (Bryman, 2012, p. 228). However I gained confidence in my early analysis when one 55 year-old male (55) said:

> "If someone is trying to say what they think they want you to hear, that's wrong. But if you interview someone long enough I think the truth does creep out if you ask the right question".

I am confident that the time I spent with each person, the questions I asked and my sensitivity to their situation enabled me to access confirmable data for this research.

4.3.5 Authenticity – multiple perspectives

The notion of authenticity is important as it relates to the researchers ability to recognise various viewpoints that stakeholders hold within different social worlds, and by so doing aims to arrive at better understandings (Bryman, 2012, p. 392). Most researchers also agree that interpretation necessarily means that there are multiple perspectives on any given situation (Atkinson, 1986; Denzin and Lincoln, 2000). As I endeavoured to produce a joint representation of experiences, as described earlier in this chapter, my understandings may be different from another researcher who has never been involved in political or trade union collective action. As Corbin and Strauss (2008) suggest my 'explanation is only one of many "plausible" interpretations possible from the data'. Indeed they argue the notion of multiple perspectives reaches to the very credibility of research, in that they 'reflect participants', researchers' and readers' experiences with a phenomenon' (p. 302).

I am concerned with what Lincoln and Guba (1986) might describe as tactical authenticity as one of the main purposes of my research is to give a voice to another perspective that is less often heard, so I endeavoured to be open and honest with those I interviewed, as described on earlier. I am also concerned with their notions of educative and catalytic authenticity in that I want to add new perspectives to those voices already heard in academic circles. My research takes place in learning environments outside formal education and in the workplace. The venue and teachers are organised by the trade unions, negotiating with employers to give time and space for their workforce to learn. The learners are workers and members of a trade union in that workplace. The researcher is also a trade unionist, although my main teaching experience has been in the state education sector. So the research is about exploring meaning in a specific context (Plant,

2005) and from a particular perspective and I understand that others with different academic experiences may interpret things differently and emphasise different 'findings'.

Through this discussion on the quality of my data I have used what I understand to be relevant criteria to reflect on the approach I utilised for data collection and analysis. Through this research I sought to raise awareness of 'different' teaching approaches that are successfully used to motivate adults learning mathematics outside mainstream education.

Concluding remarks on methodology and addressing the quality of the research
Through this exploration of my worldview and by considering quality issues in relation to my research I am confident I have been open about the purpose of the research and its uses.

By recognising multiple perspectives, following ethical guidelines and discussing the criticisms of qualitative research and how I dealt with them in my research, I hope to have convinced the reader of the integrity of my work. In the next chapter I deal with the practicalities of the data collection and the process of analysis.

Chapter 5. The practicalities of my research

In this chapter I turn to the practicalities of developing the questions I used in the interviews and how I recruited and accessed people in my sample. I also explain the process of grounded theory analysis I applied to develop my findings in chapter seven and eight.

5.1 Developing the questions for the interviews.
When developing the interview questions it was important to ensure that they were an 'explicit statement of what it is that the researcher wants' (Bryman, 2012, p. 715) which in this case is to fully address the research questions:

- What motivates adults to learn maths at work?
- How do adults prefer to learn maths at work? and
- Is there any relationship between learning maths at work and trade union membership?

I had previous experience of developing questions for research interviews when I undertook my pilot research project in year two of my doctoral studies programme. Those questions were about motivation in relation to learning mathematics at work (Kelly, 2010). I therefore built on that previous work to develop new questions but extended them to include additional factors after reading three reports into adults' motivation (discussed in chapter three). From Swain *et al.*(2005b) I included factors such as self-esteem and the influence of the family (p. 43). From Coben et al(2007) I included those previous factors but added 'gaining a qualification and getting a better job' (p.19). From Ross *et al.*'s (2011) research into the trade union learning I came across factors such as motivation related to improving life chances, overcoming poor experiences of formal education and filling gaps in previous learning (p.20). I include a copy of the questions I used in the interviews in Appendix 5.1.a

To enable a valid rapprochement between my research questions and those developed for the interview schedule I mapped them to each other and then to possible factors that might appear in response to those questions. (See Appendix 5.1.b 'Linking research questions to interview questions and possible factors')

Another strategy to try to ensure the capture of detailed and relevant information was by using some limited repetition of questions on different aspects of motivation throughout the interview, thereby attempting a deeper mining of the responses to ensure I did not miss any important information.

5.1.1 How the interview was carried out

Before each interview I gave each participant a brief written outline of the interview process (See Appendix 5.1c), discussed the content and asked him or her for written consent to undertake the interview (See Appendix 5.1d). I explained that the content of the interview would remain anonymous and that only I would listen to the tape when I made a transcript of the interview and used this to analyse the data. I explained that they could withdraw from the research at any time without giving a reason. However I did give a deadline to the withdrawal period, which was up to a year. This length of time seemed reasonable for the interviewees and would also ensure that a late withdrawal would not seriously impact on the analysis of the data set. In the event no one withdrew.

Using questions discussed in the previous section (5.1) as a template for my interview schedule, I used a semi-structured approach to ensure that relevant topics were covered while allowing for interesting personal narratives to emerge (Flick, 2002) thereby trying to give focus to the learners' words rather than use an approach where a 'powerful expert' is 'doing work on a larger number of relatively powerless research subjects' (Mertens, 2005, p. 17). This process enabled me, the researcher, to better reflect on my own assumptions about motivational factors and in the early stages of the research process to adapt

questions, for example, introducing questions on 'different' teaching approaches, which I discuss in the next section.

Using a semi-structured approach also meant I used a common set of questions, which during my analysis allowed me to compare some of the responses, while recognising the uniqueness of others (Flick, 2002), which I discuss in chapters seven and eight.

5.1.2 Adapting questions after the first two interviews.

One of the reasons I decided to use the flexibility of a grounded theory approach to data collection was because I needed to be able to adjust questions in the early part of the data collection phase to reflect any emerging concepts. This enabled me to delve deeper into the research topic and capture rich descriptions of what my interviewees identified as important (Charmaz, 2006, p. 29).

For example, after the first two interviews with trade unionists it became apparent that the learning experience itself was very important to their motivation. In fact it was more important to them than being able to remember mathematics learned at school or college, something I had assumed would be important when recapping previous knowledge.

I discussed the emergence of this new 'factor' with my supervisors and we agreed that using a grounded theory approach encouraged ideas to emerge from the data, so for the rest of the eighteen interviews, I included questions that helped me capture this data more systematically. The participants talked about their learning experience as 'different' and 'easier', so I used open-ended questions about 'difference' to allow the interviewees to describe the learning approaches using their own words and focus on what was important to them.

5.2 Identification and recruitment of the sample

I wanted my sample to include women and men trade unionists who are not members of a professional class but people who are working class in a Marxist sense, using their own labour as the means of producing wealth and in most cases not having other financial resources to rely on (Bottomore, 1983).

During my research I refer to my subjects as 'hard to reach' because in order to undertake this research I had to negotiate several layers of bureaucracy to reach them, which I discuss in the next section. However, Flanagen and Hancock(2010) critique the common use of the phrase 'hard to reach' as a 'contested and ambiguous term' (p.1). They argue the phrase is often used in the health and social care sector to describe people from an 'organisational or societal perspective' who cannot or will not engage with mainstream services, and are then described as 'marginalised' from the mainstream; however they also suggest that non-engagement maybe due as much to the failure of the main organisational system to provide an accessible service. In my research adults' experiences in mainstream formal mathematics education were poor, resulting in many choosing not to re-engage with learning mathematics. A poor initial experience might also have resulted in adults choosing not to be interviewed by a researcher who was a mathematics teacher in the state sector, which could be further justification for referring to my sample as being 'hard to reach'.

For my research I was looking for people with quite unique characteristics, which may also have made them harder to reach. I purposefully looked for people who were learning mathematics at work at levels 1 and 2 in the National Standards for Adult Numeracy. Level 1 is equivalent to school GCSE grade G-D, and Level 2 is equivalent to GCSE grade C-A (OFQUAL, 2012). They did not have to learn mathematics for their jobs but I wanted to interview people who were motivated enough to gain a qualification at work, through a 'different' context and where they often had to overcome several barriers to learning. So my sample are 'hard to reach' in that they are a distinctive group who are in non-professional jobs, learning mathematics up to GCSE level, in the workplace through the auspices of trade unions and who might have had previous poor experiences of learning, and are 'reachable' only through their trade union or their work/employer.

In order to gain access to possible interviewees with the required characteristics, I needed to gain permission and support from several key individuals, in research terms these are known as gatekeepers. In the next section I describe how I used gatekeepers' support to identify and recruit people to interview.

5.2.1 Using gatekeepers to access learners for my sample

I originally intended to use of the support of the Equality and Diversity officer in 'Unite the union' to help gain access to a diverse sample of learners, with the required characteristics mentioned above. However in 2013 there was a change of leadership because of the previous merger between Amicus and the Transport and General Workers Union in 2007 that created 'Unite the union'. The leadership change also resulted in restructuring in the organisation and key union officers whom I originally contacted were not reinstated in the same jobs. I therefore had to start again contacting their new Head of Education, Jim Mowett. I had to introduce my research, and myself and convince him of the value of the study to the trade union.

Ultimately I had to negotiate my way through several layers of 'gatekeepers' to access the interviewees. Gatekeepers are people who had to agree that my research could happen in order for me to access potential participants. Bryman (2012) suggests gatekeepers are often concerned about the researchers' motives and what the organisation can gain, or lose, by taking part in the research (p. 85), for example the cost of staff time or potential risks to the company's or trade union's image.

I had worked with trade unions in the past and was aware of their teaching and learning programmes, so was interested to find out more about the way they supported people to learn. But in order to gain the trust of the key gatekeepers, I had to contact people I already knew through my previous political and education activity, and use those contacts to access the key people in the TUC, National Institute of Adult and Continuing Education

(NIACE) and 'Unite the union', who in turn could help me gain access to Regional Officers and Union Learning Reps who worked with learners.

I had to send e-mails explaining my intentions for the research and attend interviews to explain how I intended to carry it out, to gain formal permission to interview trade union members. Below I describe the different contacts and routes I used to access learners and in Appendices 5.2.1 include copies of some of the email correspondence sent to key gatekeepers.

From July 2012 to June 2014 I took the following steps:

- I used a contact within NIACE, to approach key people in 'unionlearn' the learning and skills organisation of the TUC. Through this approach I was able to access the first ULR I interviewed and three of his learners.
- In 2012 I contacted the Head of Education of Unite. I had worked with the union previously to help them develop quality assurance procedures in the development of their trainers and I therefore had established contacts in the organisation. Later that year, at a Labour Party Conference in Manchester, I met the new Head of Education and explained my research to him. I then met him early the following year and he introduced me to the Head of Lifelong Learning in Unite, who in turn, arranged to have me invited to a UNITE Union Learning Reps (ULR) conference attended by Regional Organisers and ULRs. This group of people were key in organising courses and learning in the workplace and instrumental in identifying and recruiting people for me to interview.
- At the ULR conference I spoke about my research at the end of a workshop run by NIACE aimed at encouraging adults to improve their maths skills. Over 20 ULRs attended the workshop and at the end of the session I spoke briefly about my research, the type of people I wanted to interview and asked for help to access the learners. I asked those who were interested, and had access to people learning maths while at work, to give me their contact details.

- Twelve people showed interest and gave me their contact e-mails. I contacted them all the following week and three people replied, who were willing and able to help set me up with potential interviewees.

- The ULRs had to then negotiate with their managers in the workplace to allow me to access people on the company premises and give me the time to interview them. They also had to identify union members with the characteristics I listed to ask if they would be interested in me interviewing them. The interviews happened later in 2013.

- By 2014 it became apparent that using this method had introduced a bias into my sample, that that was representative of mainly white, British males. I therefore had to return to NIACE, and later TUC unionlearn, to help me access more female learners. Through unionlearn I re-contacted a ULR who had been helpful early in my data collection and he successfully identified another female participant for me to interview. I contacted a Prison ULR through a NIACE-run training programme on developing mathematics skills and I contacted three more women through the TUC, who were learning mathematics through Health and Safety training programmes.

I wrote criteria of learner characteristics I needed for the research, to assist the officers and ULRs in deciding and contacting which learners were appropriate for the study. By acting as 'gatekeepers and recruiters' they were using their personal judgements in the selection process. This may have meant that some members of the trade union population were more likely to be selected than others and indeed the people I interviewed had all achieved a qualification notwithstanding my request that I wanted to recruit participants studying maths at work. This might have been because the officers and ULRs may have been engaged in *impression management* (Atkinson, 1986, p. 66), hoping, quite naturally, to give a good impression of the success of the work they did.

5.2.2 Recruitment and selection

This method of sampling, using contacts I knew and relied upon, could be described as a convenience sampling 'simply by virtue of its accessibility' (Bryman, 2012, p. 201).

However the sample was singularly not a random one and I had to gain permission to access the learners, so I see this process of identification and recruitment as better described as purposeful, 'criterion sampling'(Bryman, 2012, p. 419).

Another possible way to describe this identification and recruitment method could be multi-stage cluster sampling. This form of sampling comprises of 'not the population to be sampled but the groupings of these units.' (Bryman, 2012, p.193). So the clusters in my sample were:

- in different trade unions
- working with people who were learning whilst at work
- in different companies
- in different geographical locations
- learning mathematics

However this description fails to reflect the hard to reach nature of this group of learners and my reliance on gatekeepers to gain access to interviewees with the required characteristics.

The reliance on gatekeepers such as ULRs reflects the notion of 'snowball sampling' (Dowling and Brown, 2010). Bryman (2012) describes snowball sampling as 'the researcher making contact with a small group of people who are relevant to the research topic and then uses these to establish contacts with others.' (p. 202) . Atkinson and Flint (2011) suggest snowball sampling has a number of advantages for getting access to hidden and hard to reach groups such as 'the deprived, the socially stigmatised and elites' (p. 275). I think 'snowballing' better describes the approach I used, as I was unable to secure the cooperation of the interviewees randomly from a larger population because very few people who were studying through the union were learning mathematics. I would describe the Director of Education and the ULRs as a small group of people who were essential to the recruitment process providing what Atkinson and Flint call a 'chain referral' which imbues the researcher 'with characteristics associated with being an insider or group

member which can aid entry to settings that conventional approaches find difficult to succeed in' (p. 277).

5.2.3 Characteristics of the sample

I wanted the sample to have a gender balance because I wanted the female voice to be heard in this research, as discussed earlier in section 4.1.4. (on page 44). I was very aware of the usefulness of incorporating other aspects of diversity such as disability and cultural diversity, occupational and geographical spread but having only chosen twenty people to interview this could not be claimed as representative of the population as a whole. Therefore I concentrated on trying to get a balanced sample of women and men in manual jobs learning mathematics.

Disappointingly it turned out that my sample contained mainly (eleven out of twelve) white British males although the eight women were more ethnically mixed. I explained earlier how I originally aimed to use the support of the Equality and Diversity officer in Unite to assist me gain a greater spread of people in my sample, but due to mergers and redundancies this did not happen. Therefore I had to rely on the use of gatekeepers to access the adult learners, which I argue directly influenced the balance I was able to achieve.

Initially I interviewed two females and two males in the first year of my data collection, but in the second year, due to my reliance on gatekeepers for recruitment, I interviewed eleven males but only one female. I was keenly sensitive to the feminist criticism of the absence of women from research, so I aimed for a gender balance in my final year of data collection. I returned to my early key contacts and focused on accessing women learning mathematics, eventually achieving eight women in my sample of twenty.

Thus, my sample was 40% women, a lower percentage than I had planned for, but a higher proportion than the 25% of women involved in learning through trade unions,

according to their 2012 internal statistics.[3] I attach a brief analysis of my sample in Appendix 5.2.3

The identification and recruitment of interviewees in this research therefore used a combination of purposive and snowball sampling, relying on gatekeepers to access learners. It was purposive in the sense I needed adults that fulfilled a particular set of criteria and snowball in function in that I needed key gatekeepers to agree to help me access potential participants. Sometimes I had to go through many layers of 'officialdom' before accessing the ULRs who acted as recruiters in the workplace, and I concede that this may have introduced bias into the sample I eventually achieved. However, ULRs were essential to securing learners cooperation to be interviewed, working through their trade unions and negotiating with owners and managers in their individual factories, to enable them to happen. I am grateful to all the persons who cooperated so graciously, which was an essential element to this study.

5.3 Using a grounded theory approach

When deciding which method to use to analyse the qualitative data I chose to take a grounded theory approach as my preference was to use an appropriate method that built theory from data. I wanted the words of interviewees to lead my analysis and using grounded theory was one way of getting straight into the data and encouraging me to 'follow leads what emerged out of the data collected' (Charmaz, 2006, p. 14). To aid this process researchers recommend that 'theoretical analyses of the data start from the beginning of the project' and I liked the idea of following a process that enabled me to 'follow-up on interesting data' (ibid.p.3) but at the same time to systematically build theory or ideas from data.

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[3]Unite statistics on trade union members involved in learning during 2012 show only 25% of learners are women (unpublished internal document viewed in October 2012),

One criticism of earlier grounded theory is that researchers claimed to 'suspend awareness of relevant theories' until late in the process of analysis (Bryman, 2012, p. 574) or, as early grounded theorists Glaser and Strauss (1967) suggest, 'conduct the literature review after developing an independent analysis' cited in Charmaz (2006, p. 4). But few researchers now claim this, rather they suggest using literature to 'assess and critique' your grounded ideas (ibid, p. 166) but not be led by it. Corbin and Strauss (2008) suggest using the literature to compare concepts with those found in the data while ensuring the 'concepts are truly derived from the data' (p.37). As a teacher of adults learning mathematics, a teacher trainer and a member of an international research group Adults Learning Mathematics (ALM), it would be impossible to claim I was unaware of this wider field of research. Rather I seek to use my background and past experiences to 'sensitise' me to the data, enabling my …

> …mental capacity to respond to and receive messages contained in data all the while keeping in mind [my] findings are a product of data plus what [I] the researcher brings to the analysis.
>
> (Corbin and Strauss, 2008, p. 33).

Nevertheless, using a grounded theory approach I was led into areas of research involving a conceptual understanding of emotions and motivation, a place I was certainly not expecting to go. .

Another criticism is that grounded theorists tend to disagree about process and terminology. There is confusion about what concepts and categories are and how they are developed (Bryman, 2012, p. 574). The clarification of the process for me happened during the research as it progressed, so in this chapter I discuss my personal interpretation of grounded theory and how it has provided me with the tools to analysis my data. I employ such terminology as concepts, categories and themes to show how my work links to

processes developed by grounded theory researchers (Charmaz, 2006; Corbin and Strauss, 2008). I have made use of the processes of coding, grouping ideas into concepts and using concepts with common dimensions to build categories. I found that process useful when exploring the data and developing a framework of concepts and categories that contribute to addressing my research questions in chapters seven, eight and nine.

I was able to use ground theory processes, as I understood them, proposed by grounded theorists (Charmaz, 2006; Corbin and Strauss, 2008; Flick, 2002; Birks and Mills, 2011) to help with my analysis. But as Bryman (2012) suggests there are many different interpretations of grounded theory and 'some writers have suggested [grounded theory] is honoured more in the breach than the observance' (p. 568).

I now describe my interpretation of grounded theory and how I used it to develop ideas. I also explain how I use grounded theory terminology to help my analysis and findings.

5.3.1 Coding and identifying concepts

In the initial analysis I coded data to identify 'potential indicators of phenomena' (Strauss and Corbin, 1990, p. 7) that I interpret as significant to interviewees as they describe their experiences of coming to learn mathematics while at work. When coding, I ascribed significance in different ways; sometimes it related to the number of times a phenomenon appears in interviews, on other occasions it might relate to the uniqueness of the statement to help me contrast ideas. Significance reflects my judgment of the way the interviewees suggest the importance of phenomena when describing events. So I give examples from the interview data to help describe the indicators of concepts and use them to build my overall theory discussed in chapters eight and nine.

During the analysis process I realised that I was relying on interviewees to self-report their motivations for learning and as such was not including 'unconscious' factors affecting motivation (Vygotsky, 1994; Mahn and John-Steiner, 2002; Hannula, 2006; Evans, 2000).

My data consists of the words, stories and descriptions told to me by the interviewees and I do not seek to find unconscious or 'hidden' reasons.

I used what Charmaz (2006) calls focused coding to group the 'indicators of concepts' to build concepts with common characteristics (Strauss and Corbin, 1990; Bryman, 2012). For example, when interviewees said their motivation for learning mathematics was about wanting to 'break down mental blocks' (F, 50) or 'refresh' their mathematics skills (M, 27; M, 55) I understood this as their need to develop their cognitive skills and understood this as just one dimension in a group of indicators of concepts that I labelled 'Developing Personal Skills'.

Table 1 illustrates three 'indicators of concept' or phenomena that I identified in the data, which I grouped together to build the concept 'Developing Personal Skills'.

Concept	Developing Personal skills
Indicators of concept	Keeping 'my brain' active Developing learning skills Developing Mathematical skills

Table 1

5.3.2 Building categories and developing theory

After I had identified several concepts, I re-analysed the data to make comparisons and see if there were any commonalities within the concepts identified. I used a method of analysis that can be described as 'axial coding' to do this. Charmaz (2006) uses Strauss' description of axial coding as building 'a dense texture of relationships around the "axis" of a category' (ibid, p.60). For example, I grouped the concept 'developing personal skills', with other concepts that I understood indicated respondents early motivation to learn (or engage with) mathematics. These concepts included motivation relating to work, to

children and family and to gaining a mathematics certificate. I called this first category Initial motivation.

I then repeated the process of axial coding with other concepts and eventually built five categories in total that related to my research questions, which I explain in chapters seven and eight.

Strauss and Corbin (1990) argue 'categories are the "cornerstones" of a developing theory' (p. 7) and by constructing the five categories I began to explore how they linked together, which enabled me to discuss motivation in relation to personal, social and contextual factors as well as theorise it's relationship with emotions.

For example I began to develop ideas about how particular learning and teaching approaches (discussed in category three) develop changes in learner's identities (explored in category two) that result in increased confidence (studied in category five). By connecting these categories together and after further analysis I developed the term an 'Affective Mathematical Journey' to describe how enabling changes in an adult's feelings towards mathematics influenced their motivation. I explore this notion in greater detail in chapter eight.

5.3.3 The data generation process

For me the overall cyclical process I used in this research is very similar to what Birks and Mills (2011) describe as a research 'machine' made up of three interlinked cogs, that are continually engaged and interacting, illustrated in their diagram shown in **Figure 1** below. The (first) major cog includes the data collection with concurrent research and analysis. The second cog describes a phase of theoretical sensitivity, where the researcher brings his or her own personal history and experiences to the interpretation of the data as well as research knowledge gained from trawling the wider research landscape to help identify key issues. This is also the time when data collection continues until the researcher feels the concepts and categories are fully identified. The final cog is the advanced phase where the

categories (groups of concepts) are finessed and theories are developed interpreting the concepts and categories. (Birks and Mills, 2011, pp. 9-17).

However they visualise the oil between the cogs as being the memos, which I discussed in chapter 4 and included examples in Appendices 4.3.3. But also, on occasions, it felt like the researcher was the oil, moving from research ideas to data and back again, reflecting on ideas in play and thinking about how the concepts and categories link to the research questions.

Figure 1. (*Essentials of grounded theory* Birks and Mills, 2011, p. 13)

Essentials of grounded theory   13

A grounded theory

Memos

Memos

Memos

Advanced coding;
Theoretical
integration

Theoretical
sensitivity;
Intermediate coding;
Selecting a core
category; Theoretical
saturation

Purposive sampling; Initial
coding; Concurrent data
generation and collection;
Theoretical sampling;
Constant comparative
analysis; Category
identification

5.4 Using NVivo to build concepts and categories

Several ideas emerged from the data during the early phase of collection and analysis phase but I needed an efficient and effective way of keeping track of the data, so I used the software package NVivo to help me collect and group together ideas into indicators of concepts.

Using NVivo enabled me to move coded data around and build concepts by grouping them in different ways; what Bryman (2012) calls 'interchangeability'

Initially I grouped together all of the coded data that I understood related to motivation to learn. I then began to realise that concepts relating to initial motivation to engage with classes seemed different from motivation once adults had started learning. I began to understand the 'types' of motivation varied in relation to the phases of learning, so I considered grouping them under instrumental and transformational categories as shown in the memo in Appendix 5.4a. I used the term 'instrumental' to indicate the addition of skills and transformational because of the way respondents linked learning to increased confidence to act in different ways. However I later refined this grouping, splitting the concepts into two categories that related to the process of learning and perceived changes in the learners themselves. So I grouped them as initial motivation and motivation to continue learning related to identity (See Appendix 5.4b Category one: Initial motivation mind map).

Through this process I also began to explore what 'confidence' might be. Learners spoke about developing confidence after successfully learning mathematics, so I started to see it as a notion that linked to changes in identity, motivation and emotions. I was also aware of the respondent using emotional language during interviews through the process of transcription into NVivo. So I returned to the data to explore the nature of the relationship between emotions and motivation. NVivo was really helpful here as this thinking happened over a long period of time and the software enabled me to return to the data but explore it in a different way, resulting in the development of a whole new and separate category,

'Emotions and motivation', as described in chapter eight. (See Appendix 5.4b to view all of the categories and concepts in NVivo).

In fact NVivo was essential in this process as it allowed me to change my thinking and move concepts into different categories without losing the data I used to initially build the concepts. It gave me a form of control over my data that I might have lost had I relied on purely paper-based methods. This is especially true as my research data collection and analysis started in June 2012 and my first data was recorded on paper. I commenced inputting the research data into NVivo in 2013 and as the Interview page shows in appendix 5.4c I continued to revisit individual concepts and modify my thinking until April 2016. This process was essential to the development of the ideas expressed in chapters seven and eight as it allowed me to interrogate the data on numerous occasions to ensure the quotes I used illustrated my thinking about motivation and emotions.

Concluding remarks on the practicalities of my research

In this chapter I turned to the practicalities of developing the questions that I used in the interviews and discussed the identification and recruitment phase working through trade union organisations. I discussed the need to use gatekeepers that shaped my final research sample. I then went on to explain the process of grounded theory analysis I used to develop a framework of concepts and categories in chapter seven and eight that helped me address my research questions.

In the next chapter I return to a literature review on individual motivations in relation to cognition and affect as I realised I needed to consider in more depth the relationship between emotions and motivation.

Chapter 6 Literature review into motivation and emotions in relation to learning mathematics

In Chapter two I discussed the literature found relating to motivation in trade union education and its link to empowerment and in Chapter three I reviewed offerings in what could be described as more traditional adult education settings. In Chapter three I also explored existing research into motivational factors in relation to individual self-esteem and achievement, the influence of social face-to-face groups such as experience in past learning experiences and with family connections, and the importance of achieving qualifications for a wider social purpose. This research helped inform my interview questions, prior to data collection.

In this chapter I return to the literature because through my early data analysis I realised I needed to refine my thinking about motivation. I needed to examine in more detail current research into individual motivations in relation to cognition, emotions and the notion of affect so in the first section I will concentrate on psychological and social theories surrounding motivation. However during the data collection process I also realised that when interviewees were describing their motivations to learn mathematics they often used quite emotional language, so I needed to look more deeply into the interconnections between these two factors. In section 2 of this chapter I will discuss the research literature that helped me develop a greater understanding of the relationship between motivation, emotion and cognition. In chapters seven and eight I borrow from this literature review extensively to inform my analysis of my entire dataset.

6.1 Theories of motivation
The on-line English Oxford dictionary describes motivation as the reason 'behind a change in behaviour' (Oxford University Press, 2013) while Hannula (2004) describes it as the 'potential to direct behaviour' (p.3). Both perspectives link motivation to action and in this research I seek to understand the reasons why adults want to learn mathematics and what enables them to tap into this 'potential', to learn. An adult may be motivated by a 'need or

goal' (Mcleod, 1994) identified as a personal (subjective) component, which may be supported by others (the face-to-face social context) to develop into a confidence to act in a variety of social contexts. The actual opportunity to learn is often the product of a decision made in much broader social contexts i.e. by a government or trade union. Thus motivation to act can be theorised as a 'movement' in social space, determined by the notion of individual 'choice', in the sense that the individual may, or may not, feel confident to act.

6.1.1 A brief background into research into motivation and emotions in mathematics education

Research into motivation was originally studied from psychological perspectives (Ryan and Deci, 2000; Bandura, 2004) and this approach is still influential in mathematics education (Mcleod, 1994; DeBellis and Goldin, 2006; Dweck, 2008; Hannula, 2006). However, in the mid 1990s social influences on motivation and learning began to be more widely recognised by researchers (Vygotsky, 1994; Barbalet, 1996; Lerman, 2000) and are discussed in relation to social factors in chapters two and three. Most researchers now agree that social context is influential in developing a person's learning identity and hence their motivation. However *where* motivation actually starts to develop is contentious. Is motivation an individual's subjective understanding of the social world or is an individual merely a 'reactive pawn' whose 'behaviour is determined by the more powerful [social] forces at large'? (Dornyei and Ushioda, 2011, p. 7) I see social forces as very influential but am also convinced of the existence of individual 'choice' that is related to emotions acting within that context. Hence in this chapter I focus on the psychological aspects of motivation in mathematics education not covered in earlier ones, to help explore my own understanding of these issues.

Research into the relationship between emotions and mathematics has only constructively emerged in the latter half of the 20th century. This somewhat contemporary approach may be because, from a traditional point of view, mathematics is seen as abstract, academic and an objective body of work and not one to involve subjective feelings and emotions (Mcleod, 1994). Some feminists argue that the separation of science subjects and

mathematics from the field of emotions demands an analysis into social status, power and culture (Walkerdine, 2005). They suggest men use this separation as a way to exclude women, who are allegedly more emotional and less 'rational' than their male counterparts, thereby retaining control over certain academic subjects (Hacker, 1990) and I have some sympathies with this perspective. Another reason suggested [for this slow development of research into mathematics education and emotions] is that some see research into emotions as problematic and difficult in the sense that they can cover conscious or unconscious thought,(Evans, 2006). Indeed, it might be termed a slippery subject, difficult to 'measure' and thereby problematical in its very nature. McLeod (1994) suggests it is hard to research motivation because there are so many disconnected components used in psychological research including, 'achievement motivation, social motivation, extrinsic vs. intrinsic motivation, fear of success, need for achievement and so forth' (ibid, p.586). Hannula (2012) goes further and argues that terminology used in mathematics education in relation to the domain of affect is also unclear, which hinders research.

I suspect the reason for this lack of research is a combination of all of the above but I do agree with the point about lack of clarity in terminology, which is reflected in some of the arguments I have encountered. Nevertheless, as Barbalet (2004) writes, 'the centrality of emotions to all significant social, indeed human activities is now broadly acknowledged'(p. 245) and recent research into emotions and mathematics has begun to try to unravel the relationship (Mcleod, 1994; Hannula, 2006; Evans, 2006; Debellis and Goldin, 2006; Barbalet, 2004). In this chapter I seek to clarify my own ideas on adults' motivation to learn mathematics and the link to emotions in relation to the field of research on affect.

6.1.2 Developing a theoretical model to explore motivation and emotions
I find the analysis by Op't Eynde *et al.*(2006), as illustrated by the Venn diagram (Hannula , 2012, p. 142) in Figure 1 below, useful as it helps me visualise the relationship between factors that could effect an individual's motivation within their wider social contexts. When explaining the diagram Op't Eynde *et al.* argue that motivation is based on an individual's needs and goals but develops through a dynamic interplay between cognitive and

physiological processes, acting within a social context. Figure 1 illustrates how Op't Eynde *et al.* conceptualise the close and influential relationship between an individual's cognitive, motivational and affective factors (2006, p. 193), building on McLeod's(1994) classical tripartite split of affect into beliefs, attitudes and emotions. Importantly Op't Eynde *et al.* then relate these individual or personal factors of both students' and teacher's motivations, to the wider social learning context they operate within, which is, in turn, influenced by wider socio-historical factors.

Figure 1 Peter Op't Eynde's representation of the affective domain at CERME5 (Hannula *et al..*

 2007)
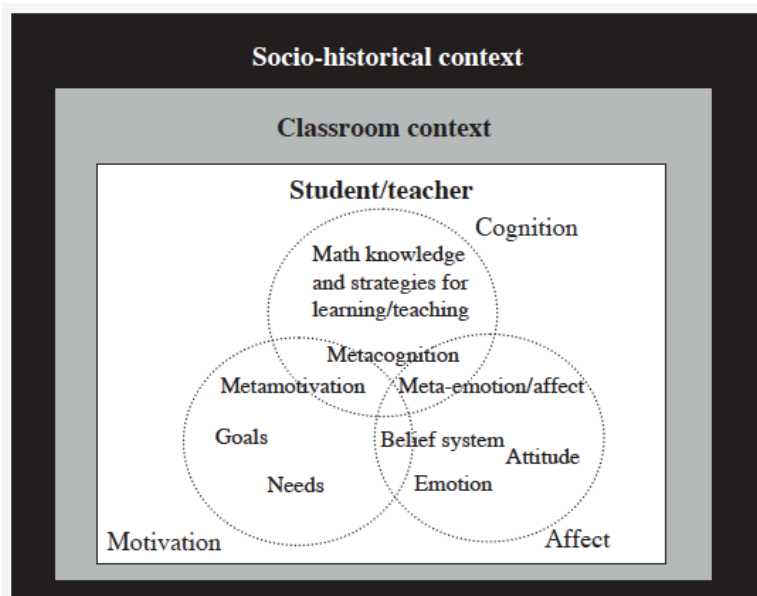
I found this visual representation useful when exploring my own model of analysis where I also used three layers of social interaction, although in my schema they relate to the individual, the local face-to-face social groups and the wider societal context. For example, the wider socio-historical context in my research is framed by learning opportunities negotiated between employers and trade unions in the early 21st Century in the UK, as described earlier in chapter two. However in my model the second layer of context, rather than being that focused on the 'classroom' is more broadly related to 'social groups or face-to-face networks. In my analysis they include: fellow learners, trade union members in

the workplace and family members.

At the individual or subjective level, unlike Op't Eynde *et al.*, I separate the student from the teacher. Op't Eynde *et al.*'s research is situated within the classroom and therefore the 'presence' of the teacher is significant (ibid. p.4). However, I place the teacher into the wider 'face-to-face' social group, being one of many important social influences on an individual's motivation. Hence I understand the learner's motivation as an interrelationship between cognition and affect and the social space in which they 'operationalise', interacting with it but not totally defined by it.

6.1.3 Exploring motivation and the domain of affect

Op't Eynde *et al.* (2006) relate motivation to cognition and affect, describing it as pertaining to a person's needs and goals. As stated they build on McLeod's (1992) definition of the domain of affect, as made of three constructs: beliefs, attitudes and emotions and I return to this idea in more depth in 6.2.1 (on page 85) when discussing emotions in relation to motivation. However, Hannula(2012) suggests motivation has a more distinctive influence and so favours a tripartite split of affect as cognitive, motivational and emotional. He argues 'cognition deals with information (self and the environment) while motivation directs behaviour (through goals and choices). Emotions give feedback about experiences that influence cognitive and motivational choices (p. 144). This description of the domain of affect is more useful for my research as it gives emotions a direct influence in motivation, which I discuss more in the next section 6.2 (on page 85).

While Op't Eynde *et al.* (2006) focus on motivation and feelings in relation to social situations i.e. the classroom, Hannula argues for a more multifaceted set of connections into learning mathematics, suggesting affect evolves through 'enactivism and system theory' (p.145). He suggests when researching into mathematics-related affect there are three dimensions to be considered. One dimension is affect, a mixture of motivations, emotions and beliefs, the second dimension relates to differing perceptions from biological, psychological or social perspectives and the third relates to whether the constructs are perceived as states of traits.(p. 137) While his analysis is interesting and identifies

important aspects to consider it is also complicated, with the development of a complex web of interactions between these dimensions. This makes my interest as a teacher trainer in the social influences on motivation less transparent, so I find Op't Eynde *et al.*'s *(2006)* focus on social contexts more useful.

In my analysis I utilise the domain of affect as cognition, emotions and motivations at the individual level, developed through complex interactions within the social face–to-face and wider societal contexts, which influence the individual but are also affected by them. So my understanding of motivation in relation to identity development is closer to a socio-culturalist perspective than Op't Eynde *et al.*'s socio-constructivist perspective. Nevertheless I feel the psychological research into motivation is compelling in my understanding of the role of the 'self' within it.

6.1.4 Exploring motivation in theories of self-concept, self-worth and self-belief

I am interested in what influences an individual's motivation to re-engage with learning mathematics at work, often after having poor previous experiences of education. This question makes the notion of self-concept, influenced by early-life memories and experiences, important in relation to the expectancy of success.

Psychological research into notions of belief in the self are theorised as self- concept, self-belief and self-worth and are most often related to expectancy of achievement. McLeod (1994) sees self-concept as a generalisation of confidence that tends to relate positively to achievement (p.584). He sees self-concept as a belief in the self that is mainly cognitive and therefore fairly stable. Earlier research by Covington (1984) relates self-belief to past experiences but suggests self-worth relates to whom or what is responsible for any past failures. If people believe their failures are related to their personal efforts, she suggests learners are more likely to continue trying and show perseverance. However, if learners believe a lack of success is related to 'external' factors, such as poor teaching at school, the individual believes success is out of their control and they are less likely to be motivated to learn (Covington, 1984).

Dweck (2008) also suggests that a learner's earlier poor experience of mathematics can be

a source of a lack of confidence that relates to poor achievement levels. However she argues that the learners' *belief* in their own abilities can be attributed to a 'mind-set' acquired at an early age. She suggests that a person with a 'growth' mind-set believes their *intelligence* can be developed, whereas a person who believes their intelligence is unchanging, has a 'fixed' mind-set and is less confident and loses motivation quickly. She suggests this relates particularly to women and ethnic minorities (Dweck, 2008, p.5).Weiner (1972) also argues that an individual's motivation relates to people's belief in themselves; suggesting those with 'high subjective achievement motivation' shows greater perseverance in the face of failure, whereas 'individuals low in achievement motivation ascribe failure to a lack of ability' (p. 208). However Hannula (2012) argues that there has been too much focus on research into (relatively stable) affective traits in relation to mathematics and more needs to be undertaken into 'rapidly changing affective states' (ibid, p.143). I would go further and suggest more research is needed into how negative 'traits' such as maths anxiety or mind-sets can be turned into positive ones, and what role teaching plays in this.

So while researchers do not agree about the causes of the relationship between a person's beliefs in their own abilities to achieve and past experiences, they make a convincing case for there being a relationship *per se*, evidence which I also unearthed during my analysis of the data and referred to in chapters seven and eight. In the next sub-section, I move on to explore how social influences can further develop an individual's motivation.

6.1.5 Relating individual motivation to social factors

I agree with Eccles, who suggests that when individuals make choices, their expectations of achievement relate to their personally held 'subjective values' and these 'subjective values' can be influenced by others, for example, parents who influence children's choices (Eccles, 2008, p. 233).

Bandura (2004) also argues that a person's self-belief is influenced by social situations, in his social cognitive theory when he links motivation to the notion of self-efficacy. He argues that self-efficacy can be developed in four possible ways, by: 'Mastery experience; social

modelling; social persuasion and construal of physical or emotional states' (Bandura, 2004, p. 79). Mastery, he posits, is when people learn through personal experience. This can either accommodate success or failure but learning is influenced through both positive and negative responses. He links this to the notion of resilience, where people develop strategies to keep learning despite such failures. The second way to develop self-efficacy is through social modelling, when a person observes others either benefiting, or being prejudiced by certain acts. The third avenue is by social persuasion, this goes beyond verbal persuasion alone because getting someone to attend a mathematics class would not be enough to develop their self-efficacy. They would also need to feel supported in order to achieve and to develop their own self-belief in their abilities. So in my research context Union Learning Representatives would have to go beyond persuading members to join a mathematics class; they would have to ensure the classes are accessible and provide a supportive environment, which would hopefully lead to positive learning experiences. The fourth way is by about how people read emotional arousal or tension in themselves as negative, especially when remembering negative emotions about learning mathematics, which might inhibit their current attempts (Bandura, 2004, p. 80). Bandura's notion of self -efficacy reinforces my understanding of how motivation associates cognitive aspects of learning to social contexts, histories and support that link to emotions. Research into trade union education (Rees, 2007; Ross *et al.*, 2011) also suggests that a mixture of social modelling and social persuasion is used to try to motivate adult learners in the workplace.

However the notion of self-efficacy has come in for some criticism. While recent research in the US points to self-efficacy as a good predictor of success when learning mathematics (Safford, not yet published), others such as Mcleod (1994) question this relationship, pointing to it being more about a good predictor of choosing to do mathematics because individuals already believe they are proficient at it, rather than being successful once they have chosen to do it. Hannula (2006) also suggests that research into self-efficacy is often related more to trying to measure achievement rather than to describing the quality of motivation. While both of these criticisms have validity, I considered the links Bandura (2004) made between motivation, cognition, and emotion in relation to social actions as

valuable when developing my own analysis and utilised his notions of social modelling and persuasion in concepts as described in chapter seven.

Even more interestingly, in his later work Bandura describes the notion of collective-efficacy, which he sees as being something that groups of people develop to overcome power relations or traditional societal practices. I interpret the notion of 'collective' action as something not normally associated with the learning of mathematics, which is more often seen as an individual activity following procedures to gain recognised qualifications (Swan, 2012) that improve the individual's own social status. Nevertheless collective-efficacy is an interesting concept to consider when reflecting on learning mathematics in a trade union context. For me, it relates the development of efficacy to the social group and reinforces the social context as important as cognition in the form of self-belief, something Bandura may not have initially intended.

Ryan and Deci (2000) suggest motivation has both intrinsic and extrinsic sources. They define intrinsic motivation as 'doing something for the inherent satisfactions rather than from separable consequence' (p. 56). Whereas extrinsic 'pertains whenever an activity is done in order to attain some separable outcome…it contrasts to intrinsic motivation, which refers to doing an activity simply for the enjoyment of doing the activity itself' (p. 60). They theorise intrinsic motivation as being made up of three needs related to: a sense of autonomy, competence, and relatedness. Autonomy is about self- belief and about being in control, or having the freedom to make choices. Competence is about having the ability or skills to do the job or the mathematics. Relatedness is about a sense of social belonging, or connectedness to a person's group or culture (ibid, p.229).

I interpret a commonality between Ryan and Deci's notions of intrinsic needs and Bandura's ideas. Both recognise the role of self-belief in motivation, Bandura through remembered experiences and Ryan and Deci through feelings of being in control. Both also see the importance of recognition of achievement, Bandura through the notion of mastery and Ryan and Deci through competence. Importantly they also recognise the influence of the social group, Bandura through notions of social modelling and social persuasion, Ryan and Deci through relatedness, or social belonging. These notions of self-

belief, recognition of achievement and influence of the social group all inform the development of the concepts and categories in chapters seven and eight, when addressing my research questions.

However I want to return to Ryan and Deci's (2000) notions of competence, and relatedness in relation to intrinsic motivation, as I also use these ideas later in my analysis. They argue that relatedness is about connecting to face-to-face social groups such as families or classmates and the comparable persons in my research would be fellow trade union learners, ULRs or family members. However, I also understand the notion of relatedness as something that is culturally related or meaningful to the individual and for a subject as abstract as mathematics this may be just relating topics to practical applications, thereby making the subject relevant to everyday life.

Competency, according to Ryan and Deci, is about feeling able to do something, but in an educational context it is often discussed in relation to its purpose argued in terms of mastery or performance. Mastery is about learning mathematical skills or becoming expert at mathematics. Performance on the other hand is related to extrinsic motivation that is demonstrating skills for an external purpose … relating motivation to a social purpose. Many researchers in mathematics education appear to value mastery over performance (Dornyei and Ushioda, 2011) but in so doing fail to recognise the effort and the emotional commitment made by adults who are re-engaging with learning perhaps for the purpose of gaining a good mathematics grade to improve their life opportunities. Indeed Ryan and Deci argue intrinsic motivation is important in education because it results in 'high quality results and creativity' (ibid. 55). However I disagree with prioritising mastery over performance as a motivational factor because it fails to recognise the perceived social and economic gains of achieving a qualification that motivates many adults to overcome personal and social barriers to return to learning. Far from creating a hierarchy of importance, Kathryn Wetzel (1992) argues that it is possible to fulfil more than one goal at the same time. For example learners in my research may wish to get a good grade (performance) to get promotion and at the same time 'learn how to do fractions' (mastery). In fact this need to prioritise mastery over performance seems to relate more to Ahl's

(2006) argument about the notion of motivation, which she argues is most often related to who identifies the problem. Is it the mathematics teacher wanting the student to learn in the classroom, or is it the adult learner wanting to re-engage with mathematics to secure a better economic future?

One final point about Ryan and Deci's (2000) research, is their notion of 'internalisation', where they argue the possibility of motivation changing from an extrinsic 'externally propelled into action' to an 'active personal commitment', where the person develops 'greater persistence' and a more positive self- assessment' (p.60). This idea informed my understanding of motivation as something that can change, which I discuss in chapter seven when separating motivation into two categories and also when discussing my idea of an adult's 'Affective Mathematical Journey' in chapter eight.

Concluding remarks on motivation

Having a perception of what motivation *is* helped me to analyse the interview data and to identify what it actually *does*. This literature helped me to better understand motivation and through this research I see a convincing case for the notion of the 'self' in relation to it, whether described as self-concept, self-efficacy or even self-confidence, that reinforces my understanding of the concept and how it links cognitive aspects of the self to social contexts and emotions.

Using these ideas and the ones I developed earlier in chapters two and three, where I discussed motivation in relation to empowerment, the self and others in face-to-face social groups, has enabled me to interpret motivation as a complex combination of how people feel, think and form intentions to act in different social situations.

I think how an individual *feels* about starting to learn is as important as the initial social reasons they may give for attending mathematics classes. So I see motivation as a function of an individual's domain of affect, which develops and is developed, by social face-to-face groups acting within a wider social context. Some may argue this is the definition of attitude but I understand attitude as problematic in that it is often used in judgement of the behaviour of others, more a *product* of motivation and affect. I understand

motivation as more cognitive than attitude because it is about forming an individual's intentions to act, rather than simply displaying behaviour.

Being motivated to do something is about action and change within a social space, so an individual must want (or desire) to make that change, which therefore links motivation with self-evaluation. On the other hand they may decide not to act. Indeed remembered negative emotions may obstruct a person's motivation. So I see motivation as inextricably linked to emotions, separate but connected. I now move on to consider research in this area.

6.2 Theories of emotions and affect

I now review literature that explores the constructs of emotions and confidence within the domain of affect in relation to motivation. It is the words such as feeling passion, fun, anxiety, frustration, fear and even 'a phobia', that were used by interviewees to describe their reasons for learning mathematics that convinced me that emotions are related to motivation.

I explore the notion of confidence because people in my research used the term to describe how their feelings had changed related to their intentions to act in the future when responding to questions about motivation to learn mathematics.

6.2.1 Emotions in the domain of affect

As stated earlier, research into emotion in relation to learning mathematics is a fairly recently developed strand of work and prior to this it tended to concentrate on psychological perspectives. Since the 1970s research in mathematics education has moved to include both cognitive and social perspectives.

McLeod (1994) made a significant contribution to research into the domain of affect in mathematics education when he theorised affect to include categories of beliefs, attitudes and emotions, which in turn relate to a person's needs and goals. He suggests these three categories are different in relation to their stability, intensity and the degree to which

cognition plays a part in their development. He claims *emotions* are the least stable and *beliefs* the most stable. Further, *beliefs* are more 'cognitive' than emotions, and take a long time to develop, whereas emotions are mainly affective and can change fairly quickly. This notion of 'temporality', variable duration or 'instability' being 'attached to emotions' may be obvious in our day-to-day lives, but Hannula (2012) suggests emotional responses to events, or signifiers, can also be 'experienced' over a long period of time. I would argue my data analysis and my own teaching experience informs me to believe that emotions also relate to long 'remembered' previous experiences of learning mathematics, which I argue later in section 6.2.3 (on page 91) are states (linked to situations) rather than (personal) fixed traits. But I do I agree with Hannula (2012) when he suggests emotions, motivation and cognition all have possible different lengths of 'duration'.

Attitude is another variable that McLeod (1994) includes in his study into affect, placing it between more stable beliefs and less stable emotions, on his linear continuum of affect. He sees attitudes developing in two ways: out of repeated emotional responses to mathematics, for example repeated problems with geometric proofs may result in a belief that an individual cannot do these problems. The second is the transference of an emotional response for one topic, for example from geometry, to another topic such as algebra. However McLeod (1994) also suggests there are problems with definitions of attitude, when he describes it as related to 'affective responses that involve positive or negative feelings of moderate intensity and reasonable stability' (ibid. p. 581) yet in the same paper sees difficulty 'in distinguishing research on attitudes from research on beliefs' (ibid, p.582) which he argues are more stable.

Hannula (2012) also sees problems when trying to define attitude, when he compares McLeod's domain of affect , comprising emotions, attitude and beliefs, to Hart's(1989) model that places attitude as a product of emotions, beliefs and behaviour (ibid, p. 140). DeBellis and Goldin (2006) add to the mix when they argue attitudes are both cognitive and affective but describe them as 'orientations or predispositions towards certain sets of feelings (positive or negative)', rather than 'the more commonly held view of attitudes as predispositions towards certain patterns of behaviour' (ibid, p. 135). This notion of attitude

linked to behaviour is what Hannula (2012) suggests makes it problematic because people use the term to try to describe another person, for example, as having a 'negative attitude towards mathematics'. This implies judgement or appraisal, linked to motivation and feelings interpreted by another through behaviour and social activity. This echoes Ahl's (2006) earlier argument about motivation, in that the notion of attitude can relate more to who identifies 'the problem' than what it is. It is this problematic interpretation of attitude that makes me cautious about using it in my research; hence I focus on motivation and emotions, although I do discuss it briefly later in the text in relation to confidence.

DeBellis and Goldin (2006, p. 135) added values to McLeod's three elements of the affective domain, and use a tetrahedral model rather than a linear one to relate the categories to each other. The differentiation between beliefs and values is sometimes seen as problematic but DeBellis and Goldin describe values as 'including ethics and morals' that help in making choices in life. While the linear relationship between beliefs, attitudes and emotions is attractive, I see the notion of values as useful in relation to motivation in the context of trade union education, which is built on particular principles and values, not held universally in UK society as a whole, and highly influential in the context of my research.

Hannula (2012) also questions McLeod's (1994) claim that affect can vary in intensity, suggesting that it does not help to separate or clarify theories of affect from one another. However, I agree with Debellis and Goldin (2006) who argue emotions are feelings, ranging from mild to intense, which can be 'rapidly-changing states of feeling experienced consciously or subconsciously during mathematical (or other) activity '(ibid, p.135). In later work Goldin *et al*. (2011) also utilise the idea of differences in intensities of feelings and relate them to learning. They argue the more intense or ' arduous the journey' the more significant the learning (ibid, p. 551). Even during my early participant interviews I heard learners use a range of emotional words when describing their motivation and learning, suggesting to me a relationship between intensity of emotions and significance of learning. DeBellis and Goldin (2006) argue further that emotional changes can serve to develop feelings of disempowerment or empowerment that either hinders or encourages

perseverance and risk-taking. I understand empowerment as a link between intense emotions and motivation that can be 'a potential to direct behaviour', (Hannula, 2006). It can happen in a trade union context when an individual may be given (or indeed take) more freedom or rights (Cambridge dictionaries, 2015), something I discussed earlier in section 2.4 (on page 19).

Op't Eynde and De Corte (2006) in their research into classroom practices focus on the 'situatedness' of emotions, describing learners' emotional responses to mathematics as social in nature but situated in broader socio- cultural histories. They link emotions to motivation through the process of self-appraisal (which may not always be observable) (ibid, p.199). Hence interpretation and appraisal is how the individual both influences and is influenced by context.

DeBellis and Goldin (2006) also see emotions as highly context-dependent and suggest changes in emotions can be understood as a learning pathway in relation to mathematical problem solving in classrooms. In my research into adults learning mathematics I also interpret a relationship between emotions, motivation and cognition in relation to mathematics that can change in relation to context, and for adults it can happen over a longer period of time, which I call an 'Affective Mathematical Journey'. This is an important concept in my research as it identifies the possibility of changes in an adult's motivation to learn mathematics, which I discuss later in section 6.2.3.(on page 91) and in section 8.2 (on page 143).

As mentioned above Op't Eynde and De Corte (2006) give the notion of self-appraisal a central role in emotions while Hannula (2006) argues emotional control is the mechanism used to direct potential behaviour, suggesting a learners' ability to control negative emotions as key to enabling motivation and learning. Malmivuori (2006) argues that emotions can also play a positive role in motivation and goes further, suggesting they have 'important organizing, motivating and regulating functions'. (2006, p. 157). Her research moves emotions into a more influential space, taking a more proactive, controlling role in decision-making and motivation. Through this research I understand the mechanisms of appraisal and controls are indeed fundamental in relation to emotions and to motivations.

To help me further explore my own understandings of the domain of affect I developed a table (referred to in Appendix 6.2.1) that includes McLeod's (1994, p. 578)notions of belief, attitudes and emotions as well as DeBellis and Goldin's (2006) notion of values. I built on these ideas in relation to my own data and literature reviews to help develop my own definitions of these terms. With the help of this analysis I understand beliefs as mainly cognitive but of variable duration, for example an individual may believe mathematics is abstract and not relevant to their lives, but this can change through social experiences. I understand value as beliefs but linked to wider social or ethical contexts, as for example, an individual's belief in the values and principles of trade unionism. The notion of attitude is more problematic, as discussed earlier because it often changes depending upon who is judging the construct. Emotions that I understand as feelings include joy, fear and anxiety. These feelings can relate to memories of previous experiences, but can also be interpreted through contemporary contexts that are influenced by face-to-face social groups. They are important as they help a person to evaluate a situation in relation to their own abilities and their willingness to act.

As a result of my literature review, I understand (in theoretical terms) that *emotions* are a range of feelings that can vary in intensity and in length of time experienced. As noted above, they are described as feelings such as joy, fear or anxiety. These feelings are important in relation to a person's motivation to learn as they help them to evaluate their own abilities and their willingness to act in certain social situations. This chapter has helped me understand emotions at an individual (subjective)level. However, I am also convinced by the research outlined in chapters two and three that individuals feel emotions in relation to social situations experienced at face-to-face group level, which in turn are influenced within a wider social, historical and cultural context. I now turn my focus to research into the relationship between emotions and learning mathematics.

6.2.2 Emotions and feelings about learning mathematics

When research into affect and mathematics started in the 1960s and 1970s it tended to focus on negative emotions, such as anxiety, and their relationship to achievement (Zan *et*

al., 2006). This strand of research began when questions were asked about why fewer women did mathematics and science as they rose through the UK and US education systems. Sheila Tobias described 'Maths anxiety' as feelings related to 'fear of failure' and later of 'panic, helplessness and paralysis'(1980) and described them as barriers to learning mathematics. While understanding that some people do have negative feelings towards mathematics, I am concerned not to blame the learner for a perceived 'emotional' deficiency or block that inhibits learning, or to attribute the emotion to women only. However, I do understand these negative feelings appear on a spectrum of emotions that people experience when thinking about learning mathematics.

Not surprisingly research into negative feelings about mathematics tends to relate these feelings to reduced motivation to learn. Covington (1984) describes fear of failure as a demotivating influence, while Eccles (2005), argues when risk of failure puts too high a cost value on engaging in an activity, that high cost value acts as a deterrent to learning. Bibby (2002) also relates negative feelings with demotivation suggesting they relate to feelings of shame, which deter learners (ibid, p 706). She suggests there is a connection between the traditional mathematics class and shame, where mathematics is experienced as a product that is often seen as right or wrong and therefore is open to public scrutiny, judgement and, if not 'correct', humiliation and shame. Wojecki calls these remembered encounters as 'wounding learning experiences' (2007, p. 170) although he posits that adults can and do get over them. Wojecki suggests that a learner telling their stories may help this recovery, but others in the field disagree, suggesting such revelations need to be treated sensitively. However, the possibility of overcoming such experiences is important, because given the right circumstances emotions can in relation to mathematics, effect motivation. I discuss the circumstances that enable change to happen in my participants in chapter seven and how feelings do change within chapter eight.

More recent research into maths anxiety *(*Whyte and Anthony, 2012) in Australia and New Zealand argues that emotional reactions to mathematics are related to social activities, at face-to-face group level (by parents and teachers) and at a wider societal level, where such myths as boys being better than girls at mathematics are still prevalent (Whyte and Anthony, 2012, p. 8). Their analysis is useful as it emphasises the importance of the social

context to emotions and motivation in relation to learning, but it is a disappointment that they focused on only negative emotions in relation to these social situations. In the next sections I discuss a range of emotions identified in mathematics education research in the classroom and possible ways that they can change and confidence can be improved.

6.2.3 Changing feelings and emotions in relation to learning mathematics

More recent research into mathematics education recognises the role that emotions play both in learning and in the creation of motivation to learn mathematics, broadening the range of emotions discussed (Zan *et al*., 2006). For example, Hannula (2006) talks about controlling emotions such as joy, as well as anger and sadness, when discussing motivation to learn mathematics (2006). Evans (2006) talks about anxiety, embarrassment and enjoyment in relation to understanding emotions as part of the process of practice. DeBellis and Goldin (2006) also talk about a range of emotions being experienced when they researched changes that happen during problem solving in the mathematics classrooms and described them as 'affective pathways'. These pathways are sequences of '(local) states of feeling experienced' when developing what they call 'heuristic problem-solving strategies'. The pathways depend on the individual's experiences and histories but one example of an 'idealised pathway of learning' is, initially a learner may feel curiosity and puzzlement about a mathematics problem, possibly leading to bewilderment and even frustration, when it is not easily solvable. Depending on the outcome of the experience, the learner may then feel anxiety and despair if they fail to understand and have no strategies to overcome it, or alternatively may feel pleasure and satisfaction on making some progress into solving the problem.(Debellis and Goldin, 2006, p. 134).

Schorr and Goldin (2008) argue it is possible to facilitate changes in emotions given the right circumstances, when they argue for an 'emotionally safe environment' (p. 131) to learn in. This is a place where it is safe to expose misconceptions and where learners' will not suffer public humiliation for getting a calculation wrong. Later they argue that a challenging, competitive environment can demotivate learners, leaving them feeling ridiculed, followed by feelings of anxiety and even despair (Goldin *et al*, 2011, p. 131). Illeris (2014) appears to suggest something different when arguing that 'transformative

learning' (discussed earlier in chapter three) happens when people are put out of what he terms their 'comfort zone'. He defines this experience as when a person's 'perspective on the situation begins to lack coherence, and the situation can no longer be foreseen and interpreted' (ibid, p 108). However, this uncertainty may be only manageable if dealt with by people who are already confident or in an 'emotionally safe environment'. In fact Illeris theorises two possible emotional responses to this uncertainty, one may be negative produced as a form of 'identity defence'. However, he posits that when learners can control these emotions, (I suggest when they are not open to ridicule but feel supported to overcome these unforeseen occurrences), then they can experience something new and better, that contributes to transformative learning (ibid, p.105). Indeed I argue in chapters seven and eight that this is one way to explain data in my research when adults experience a change in their identities over a longer period of time, after learning mathematics through trade unions.

I developed the term 'Affective Mathematical Journey 'to describe significant changes in emotions towards mathematics, that enable learners to develop confidence influencing motivation .For example, adults may enjoy some of the social aspects of learning but feel awkward about the subject itself. Indeed they may be anxious about joining a new group when they have to overcome negative memories of early learning experiences of mathematics, but may go on to feel passion for the subject, what Illeris (2014) might call transformative learning.

6.2.4 Self-confidence, confidence and trust

I conclude this section on motivation and emotions by discussing notions of confidence, self-confidence and trust. I realised early in the data collection process that respondents often spoke about feeling more confident when talking about motivation after successful learning experiences. Wider research also indicates that confidence correlates positively with achievement (McLeod, 1994; Zan *et al.,* 2006), so is important to motivation.

Hannula (2012) argues there is ambiguity in the term confidence when used in research as it is often described as an attitude, something I have already discussed as problematic earlier in 6.2.1 (on page 85). Although he suggests research into 'gender differences' have

been quite robust in relation to students' [reported] self- confidence in relation to mathematics (p. 139), with females reporting less self-confidence than males. But Boaler (2016) suggests reported gender differences in confidence or anxiety in relation to women and mathematics have a cultural influence, suggesting it occurs in some countries such as the UK and the US, but not others (ibid, p. xii). Research by Kaiamanesh (2004) also supports the idea of cultural links, when she found a lack of anxiety in women and girls who learn mathematics in Iran.

However earlier research by Barbalet (1996) asserted that 'Confidence, trust and loyalty are three social emotions necessary respectively for the social processes of agency, cooperation and organization' (ibid, p. 75). Indeed he emphasises the centrality of these emotions by claiming they 'constitute the basis of social life' (ibid, p.75).

Dequench (2000) argues 'the object of confidence is the future' and cites Barbalet (1998, p.85) to argue it is therefore essentially 'unknowable' and as such 'calculative reason gives way to emotion as the basis of action'(p. 504). Barbalet (1996) defines confidence as 'a feeling which encourages one to go one's own way' - it is 'an emotion of self-projection'. He theorises that it has 'a key role in human agency', and describes it as 'the emotion associated with a willingness to act' (p. 77).

This definition differs from McLeod (1994), who suggests confidence can be thought of as a generalisation of self-concept and thus according to his analysis is mainly cognitive. While I agree that self-belief is an important part of confidence, I agree more with Barbalet (1996) who sees confidence as a subjective experience (cognitive but emotional) as well as behavioural in its expression (being visible socially). Holbrook *et al.* (2002), also argue for a stronger social dimension when writing about 'the gift of confidence' and describes research where it was developed through collaborative learning. The teachers in their research provided caring support that makes 'human connections and develops social interdependence' within the group of learners that helps develop their confidence. In my view this does not deny the cognitive aspect of confidence but indicates that it can be developed through interactions with face-to-face social groups in particular contexts. However Wilson *et al* (2008) also found that a learner's confidence could vary in relation to context and time. Even if a learner is in the same classroom with the same people the

learner's confidence can still vary on different occasions. This notion of temporality or variation of duration in relation to confidence is something that needs further research in relation to mathematics.

Concluding remarks on emotions

As a result of this literature review and my own early data analysis, I understand emotions as an important influential factor in relation to motivation to learn mathematics. By focusing on developing an understanding of the individual or subjective aspect of emotions, based on mainly psychological research, I have begun to understand emotions in the wider dimension of affect, whereby they are seen as less cognitive than beliefs, but importantly linked to motivation. I see emotions as varying in both stability and intensity, so when linked to motivation can facilitate change.

Confidence is an important notion in relation to motivation in that it is often used in responses in my research to questions about what motivated adults to learn mathematics whilst at work.

Conceptually confidence is important to motivation because I understand it as a mixture of self-belief (cognitive), with strong links to feelings (emotions) about future possibilities, which in turn influence potential action (motivation). Yet in maths education research confidence has focused on a relationship to achievement, so I would see further research into the relationship between student's personal feelings of confidence and motivation as useful in developing wider professional practice with adults.

In the next chapter I use the understanding of motivation, emotions, transformative learning and confidence developed through my literature reviews to help analyse my data, using quotes to indicate data that helped develop my understanding of adults' motivation to learn mathematics.

Chapter 7: Answering the research questions: Findings and data analysis

I chose to use a grounded theory approach as a way of foregrounding the adult learners' ideas when addressing my research questions. However grounded theory is often critiqued for mixing up terminology and being vague on the research process (Bryman, 2012), so I have tried to overcome this by explaining my reasons for using this approach in chapter four and describing the process in chapter five. Consequently in this chapter I focus on how I use the data to address the research questions: (1) What motivates adults to learn maths at work? (2) How do adults prefer to learn maths at work? (3) Is there a relationship between learning maths at work and trade union membership?

I explore the data, concepts and categories I have used to help me develop a framework of ideas that address the research questions. I use this framework to help structure my thinking about motivation, and through it explain the reasons I have grouped certain concepts together and put them into categories that I think are important to my research questions. I utilise the literature discussed in chapters two, three and six to support the development of concepts and categories here and in chapter eight.

To help illustrate how I used the words of my respondents to build the concepts, I developed a visual representation of my framework of ideas (Appendix 7.0), cross-referencing concepts with the quotes from respondents I used to build them. In the text in chapter seven, and in the appendices, I refer to the respondents by gender and age, for example, (M, 27). This representation of the five categories I produced through my analysis (Appendix 7) covers three pages. The shaded boxes indicate sources that I found through coding the data that could be taken to indicate the concept; the symbol '1' indicates a quote I used in the analysis I report in chapter seven. On the third page of Appendix 7 you can see totals showing the number of times I used quotes from each individual respondent, and the total number of quotes I used overall for the analysis reported in chapter seven. I used 98 quotes from the 20 respondents out of a total number of possible sources of 225; 49 of these quotes are from the 12 men and 49 from the 8 women. I was hoping for a balanced contribution from both men and women but the split was based on the usefulness of the words to illustrate the concept. I undertook this exercise to ensure I used data from all respondents in the sample and to give an overview of the links between the data and

the concepts developed for the framework. Later in chapter eight I discuss one 46 year-old woman's story at length and have given her the pseudonym 'Jean'.

I now introduce the four categories that I have built from the data and which I use to explore my research questions. I include quotes from my data and discuss them in relation to ideas from the literature reviewed, which I then use to build my framework of concepts and categories.

During this process I had to make choices of how I would group indicators of ideas into concepts. Although I chose to group concepts in certain ways, the concepts themselves often relate to more than one possible grouping or category, hence I also cross-reference where I understand there are other possible interpretations of relationships between them that appear in other categories. For example, I understand motivation associated with helping children to be complex appearing as a factor in 'Initial Motivation' in concept 7.1.1.3, where it relates to helping children to better understand and integrate into the English education system, as well as influencing personal relationships within the family. It also appears as a factor in motivation to continue learning, in concept 7.1.2.3, when women spoke about mathematics developing their personal financial skills, which impacts on the economic security of the whole household. Helping children is also a motivational factor in chapter eight where I discuss Jean's 'Affective Mathematical Journey' and the influence that her increased confidence with mathematics has on her children. Indeed by using this process of building concepts and categories I have been able to understand more fully how certain factors influence motivation in different ways.

In this chapter I introduce the categories first and then the concepts within those categories, which is in a different order to that I used during the data collection and analysis phase as described in chapter five. However I choose that order here so that the reader can be aware of the logical hierarchy of my analysis and the links to the research questions. In doing this I hope to make the reading and understanding of the groupings more accessible.

7.1 Addressing the research question: 'What motivates adults to learn maths at work?'

7.1.1 Building the first category: Initial motivation.

When responding to the question what motivates adults to learn mathematics at work the adults in my sample reported reasons that I grouped into concepts relating to work, to developing their personal skills, to children and families and to gaining a certificate recognising mathematical achievement. Using grounded theory terminology I called these groupings concepts, which I then used to build the first category 'Initial Motivation'.

Table 1 below illustrates the relationship between the category Initial Motivations and the concepts I grouped within this category.

Category	7.1.1 Initial motivation			
Concepts	7.1.1.1 Working	7.1.1.2 Developing Personal Skills	7.1.1.3 Helping children and family	7.1.1.4 Gaining Certification

Table 1

In this category the concepts are built from a 'range of dimensions' or indicators of concepts (Corbin and Strauss, 2008). For example the concept of motivation related to working (concept 7.1.1.1) is built from two indicators, one associated with the company and the other with trade unions.

7.1.1.1 Related to Working

Table 2 illustrates the indicators I use to build the concept 'motivation' related to working.

Concept	7.1.1.1 Working	
Indicators of the	7.1.1.1.1	7.1.1.1.2

concept	In the company	In the trade union

Table 2

7.1.1.1.1 Working in the company.

Eleven of twenty interviewees expressed ideas that learning new mathematics skills could result in the company viewing them "more favourably" (M, 50) after they engage in learning and achieve a qualification, as they are "developing" and becoming more "open to new opportunities" (M, 35). They, in turn, feel more positive about an organisation that is willing to invest time in their personal skills development.

For example, when speaking about improving his skills one man, aged 27, linked motivation to learning directly to his job, to gaining promotion that would move him "off the crane" (this is an automated job picking boxes of foodstuff for wholesale distribution with little opportunity to use any initiative). Another 51-year-old man said:

> "…the more qualifications you have the more management look at you for promotion. If they see you are willing to learn they can take you up another notch …"

Another man described how learning had changed his opinion of the company in that:

> "… it has given me a more positive attitude towards my work in general. I felt sort of like the company is actually interested in improving its employees, which has not always been the case here ... You think well they have given me the time to improve myself as a person … although I did not set out to have a more positive attitude I have noticed it in myself …"

(Interview transcript, Male, 34)

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The quotes indicate these respondents are motivated to learn mathematics at work to help improve their job security or increase their chances of promotion,

7.1.1.1.2 Working for the trade union.
Two trade union members were also motivated to learn mathematics to help with their trade union work when negotiating with the company management. One of the women (53) explained her motivation to learn mathematics was "to know the figures that management give me are accurate". She wanted to 'use them for evidence of an issue, such as illness or noise levels'.

Improving conditions of employment is a priority for trade unions and improving their mathematics skills helped members develop a better understanding of how numbers could be used in the process of wage or health and safety negotiations, so giving them extra confidence when negotiating with management on behalf of trade union members (Lipsey, 1971; TUC, 2010; TUC, 2014).

Some adults are motivated by 'deeply held personal values'… trade union values which enabled them to make 'long term choices and shorter term priorities' (DeBellis and Goldin, 2006 p. 135) to learn mathematics. Because this concept also relates to personal beliefs and motivation to learn mathematics associated with developing confidence it relates to ideas in the fifth category in chapter 8 and the fourth category: 'Motivation in relation to trade unions'.

7.1.1.2 Motivation related to developing cognitive personal skills.
Table 3 illustrates the indicators I use to build the concept of 'motivation related to developing cognitive personal skills'.

Concept	7.1.1.2 Developing cognitive personal skills		
Indicators of concept	7.1.1.2.1 Keeping my brain's	7.1.1.2.2 Developing general	7.1.1.2.3 Developing Mathematical

	active'	learning skills	skills

Table 3

Fifteen of twenty interviewees expressed ideas that indicated their motivation relating to developing personal cognitive skills. The ideas were expressed in slightly different ways, which I grouped into three sets of indicators: firstly "keeping my brain active" which is about keeping the physical brain itself functioning, secondly, developing learning skills, which is about using the brain to develop and retain skills in general and thirdly, to developing mathematical skills.

7.1.1.2.1 Keeping my brain active

Six interviewees spoke about their motivation to learn mathematics at work as a way of keeping their brains active and not losing skills and knowledge. For example one said:

> "… I am more willing to learn. When you get to my age, they say ' you cannot teach on old dog new tricks' but I want new tricks… keeps your synapses and brain going …"

(Interview transcript, Male, 35)

Another talked about "keeping my mind fresh" (F, 31), whilst another spoke about "keeping my mind ticking over" (M, 34).

This phenomenon I see as relating to subjective or personal needs or goals pertinent to developing cognitive functions or what Eccles (2005) terms the intrinsic value of not losing knowledge and skills.

7.1.1.2.2. Developing Learning skills

Six interviewees spoke about how learning mathematics at work motivated them to continue learning in different ways. For example one 51 year-old man said:

> "… Once you get into it, you are in that learning mode you can carry on and learn anything. It's not easy to get in the learning mode but once you get in it you get a 'bit of a thirst' for more …"

Others who have English as a second language suggested … "learning maths helps you with your English" (M, 27). These quotes and other research (Swain, 2005) support the idea that personal cognitive development is a motivating factor in itself.

7.1.1.2.3 Developing mathematical skills

Twelve people spoke about simply wanting to learn mathematics to refresh their mathematical skills or improve their grades. One woman described how she was able to develop her understanding of mathematical concepts when she said:

> … "I wanted to break down my mental blocks … I realised the thing that had always fazed me as I could not link the rules. Rules had no pictures or stories, so I make up creative pictures and stories … and then I understand …"

> (Interview transcript, Female, 50)

Some spoke about having the opportunity to "refresh" their mathematics skills (M, 27; M, 55). For example, a 28 year-old male spoke about "going off the rails" at school, so it was important for him to "refresh" his mathematical skills and to get the grades.

It would be strange if wanting to learn mathematics did not appear as a motivator in this research but I interpret these reasons conceptually as subjective feelings, what McLeod (1994) might term personal needs or goals.

Indeed, I understand the whole concept of developing personal skills as cognitive development, which is supported by Ryan and Deci's (2000) notion of intrinsic motivation relating to competency and a sense of autonomy. Competency in that they want to learn to improve their skills and knowledge and autonomy because they are making a personal choice to learn.

Because this concept can also be interpreted as a change in a person's identity I cross-reference it with section 7.1.2.1 (on page 108).

7.1.1.3 Motivation related to children and family

Table 4 illustrates the indicators I use to build the concept of motivation related to children and family.

Concept	7.1.1.3 Motivation related to children and family	
Indicators of concept	7.1.1.3.1 Learning language and culture	7.1.1.3.2 Relationships with children

Table 4

Six out of the eight women interviewed spoke about their motivation to learn mathematics being related to helping their children with their education, suggesting this to be an important motivating factor that related to gender. They spoke about the importance of being able to talk to their children about mathematical concepts and about helping them through their schooling. Only one man spoke about the importance of developing his mathematics to support children. However it was suggested to me by one other male interviewees that men see the practical application of mathematics skills in the home as a better way of defining their relationship with their children and family. This is an interesting perspective that may be another way of interpreting relatedness (Ryan and Deci, 2000) or relevance discussed in relation to the importance of practical applications and everyday mathematics discussed in section 7.2.1.2.1 (on page 116).Unfortunately I found no other research to support this reinterpretation of male relationships with children and learning.

7.1.1.3.1 Learning language and culture

Two women from overseas said their motivation to learn mathematics was related to helping their children better understand the English education system, the different ways of teaching mathematics in England and the technical language used in mathematics. For example, one Polish female, aged 31 said the most important reason for her motivation to learn mathematics was her:

> "…two and a half year old son and I know soon he will go to school ... The way of teaching is different in Poland, also the language is different. Many times that [son's name] asking me, do you know what that meant? I think what is that in Polish, because I do not know the English words. So for me [it's] very good practice for when I sit down with my son and do homework."

Another woman (40), from Zimbabwe, also talked about learning mathematics to help her children, because she "realised the way they do maths here is different", although "the end is the same, the methods are different". My data and other research (Kelly *et al.* 2012) also suggests how learning mathematics helps people to support their children to learn the English language, the technical mathematical language and to better understand how mathematics is taught in UK schools.

The notion that learning mathematics can help people to learn the language and culture of another country is an important factor that can be analysed on three levels: societal, face-to-face social and individual. The women's motivation to understand the English education system points to a critical use of mathematics to support their families' integration into a different society. At a social face-to-face group level children act as a motiving factor encouraging mothers to learn, who in turn support their children's skills and knowledge development. On a subjective level, the women's aim to integrate into UK society can be described as a change in their personal identity, at what Illeris (2014) calls a 'profound' level, which I discuss further in section 7.1.2.1 (on page 108).

7.1.1.3.2 Relationships with children

Eight interviewees spoke about how learning mathematics influenced their personal relationships with their family members. One woman (35) described how her increased confidence with mathematics motivated her to help improve her children's skills, which in turn has changed their relationship. In Jean's (46) story, discussed in more detail in chapter eight, she describes how both she and her daughter have dyslexia, so one of Jean's motivations was to learn mathematics to show her daughter that even with dyslexia she could be seen to learn the subject, and enjoy it.

Nevertheless there were also examples of women and men who spoke less confidently about mathematics and the family. One 42 year-old woman said … "It helps a little bit with [child's name], she cannot laugh at mummy so much, because mummy understands". A 40 year-old man said … "I have got to try to keep up with [name of 9 year old daughter]".

One ULR tried to use it as a way of motivating male trade union members to help their children to learn mathematics. He said:

> "If you are in a one-to-one situation with your children, which is what I tell the lads, you can go home and help kids with the homework. Instead of saying keep it away from me, or giving them the wrong answer, you can actually help them and say this is what we did and how we did it …"

> (Interview transcript, Male, 51)

Overall this data indicates the importance of children as motivators to learn mathematics to women, a factor supported by other research (Swain, 2005; Coben *et al.*, 2007).

Given the significance of children and the complex and multidimensional relationship between them and a motivation to learn mathematics, it was difficult to decide where to

place this concept. I worried that putting it as one indicator within a much wider category of initial motivation did not reflect its importance, especially in relation to the significance of helping families to integrate into new societies. However, I decided to locate it there because it is important for many people as a reason to re-engage with mathematics in the workplace. Still I also believe it is a longer-term motivator as it helps develop a stronger mathematical identity in both parent and child, and reinforces emotional ties. As I discussed in the introductory section I use cross-referencing between concepts in different categories, to try to reinforce the multidimensional relationship of children to motivation.

7.1.1.4. Motivation related to gaining a mathematics certificate.

Table 5 shows only a single indicator that I use to build the concept relating initial motivation to gaining a mathematics certificate.

Concept	7.1.1.4 Gaining a mathematics certificate
Indicator of concept	Opportunities in employment and education.

Table 5

This concept has only one indicator but I see it as important because twelve of twenty interviewees spoke about being motivated to learn mathematics to improve their grades or gain qualifications. It also has a unique characteristic in that it is related to a recognition of skills development in wider society that relates to future opportunities.

One interviewee emphasised the importance of mathematics to her further education when she explained "Maths and English are the basics that you need whatever course you are doing" (F, 42) whilst a 35 year-old male spoke about getting a mathematics qualifications to help when competing for new jobs. Another man (28) said he "went off the rails in Year 10" so learning mathematics at work was "a big help to get some grades". A 51-year-old man said he was an electrician "so maths takes a rather large part in my role at work ... it is

another qualification and the way the job market is at the moment [you need] as many qualifications as possible."

The data indicates the importance of gaining a certificate as an extrinsic motivator (Ryan and Deci, 2000b) in that obtaining a mathematics qualification can increase access to job opportunities (Ross *et al.*, 2011) or improve a person's position in the job market and their financial security. The data indicates that gaining a mathematics certificate is more than just getting a qualification as a 'means to an end' it can be described as a way of securing or improving the learners' position in social space, developing what Bourdieu (1998) might call their 'cultural capital', or what Coben (2002) terms their 'exchange value' in the job market.

Indeed the link between gaining qualifications and securing a better income is well researched (Bynner and Parsons, 1997; Leitch, S., 2006; OECD, 2013). What is more often debated is where the importance of gaining qualifications sits in the extensive list of possible motivations for adults to learn. My research reinforces the notion that gaining qualifications **is** an important motivator to the adults in my study, who can be described as having had poor previous educational experiences and are in less financially secure employment.

Final observations on initial motivations to learn mathematics at work.
When considering the first research question, 'What motivates adults to learn maths at work', initial motivation as I understand it is significant because it indicates a wide range of factors that motivate adults to re-engage with learning mathematics at work. These factors include developing personal cognitive skills, helping children, their job security, and gaining mathematics qualification. Most of the interviewees spoke of more than one reason for getting involved with learning and some quoted up to three.

During the development of this category I also became aware that motivation seemed to have different characteristics in relation to different stages in learning. Dornyei and Ushioda (2011) suggest three stages in motivation … pre-actional, actional and post-actional. They argue pre-actional motivation relates to making choices and personal goals,

actional motivation relates to 'actually embarking on the task' (ibid p. 65) and post-actional is about reflecting and contemplating possible future plans (ibid, p.66).

These ideas support my findings, suggesting a similarity between what I am calling initial motivation and the pre-actional stage. I understand initial motivation is about goals that aim to add to a person's skills set. The next category 'Motivation and changes in identity' I understand as changes or transformations in an individual's identity once learning has begun, so they happen in what could be described as the actional and post-actional stages.

7.1.2: Building the second category: Motivation and changes in identity.
I developed this category, in response to the research question, 'What motivates adults to learn maths at work', when grouping together quotes where respondents reported changes in themselves and their motivation once they had started learning mathematics as, for example, when they talked about experiencing an increase in confidence, which resulted in them changing how they intended to act, or in how others saw them. In other words, in this category I identify and describe what I term are fundamental changes in the way the respondents' talk about their sense of self or their identity, what Illeris (2014) suggests results from transformative learning which creates a 'quantitatively new structure or capacity within the learner' (p. 5), which I discussed more fully in chapter three .

By linking motivation to identity it enables me to discuss how learners describe more profound changes in themselves in relation to motivation and mathematics learning experiences. To enable me to explore this category further I analysis the data on three levels: subjective, face-to-face group and societal, and use these as concepts that help build this category about longer-term motivational factors. I distinguish these from the initial motivational factors because they are more than additive skills; they point to changes in the way people feel and intend to behave in the future, going beyond joining classes and learning mathematics.

Table 6 illustrates the concepts I grouped together to build this category, 'Motivation indicating changes in identity'.

Category	7.1.2. Motivation indicating changes in Identity		
Concepts	7.1.2.1 Changes in the subjective self	7.1.2.2 Identity and the social, face-to-face group	7.1.2.3 Identity and the critical use of numbers in society

Table 6

7.1.2.1 Identity and the subjective self

In this concept I grouped together quotes from eight interviewees who said learning maths had changed the way they see themselves in relation to the subject, in that they feel more confident and are motivated to act differently.

For example, one woman (50) said that learning mathematics has had a profound effect upon her life, and what I would call her mathematical identity (Lerman, 2009). She was an active sportswoman who had an accident and was immobilised for some time. At one point in the interview she said:

> "… I had lost my identity; I was eating and drinking more wine, and feeling 'this is rubbish'. I had the chance to do the maths and it made me feel good …"

Her success motivated her to keep studying and she now teaches mathematics in a prison. She now sees herself as successful in a subject she had previously struggled with, which I interpret as a transformation in her mathematical identity.

Another man (50) talked about how learning mathematics helped him prove something to himself. As he explains:

"…I am not just a bloke at the end of a machine … I can do mathematics. I have proved to myself I can do it …"

This to me is a significant statement indicating that this person sees himself becoming more than part of a machine, he describes becoming a learning 'being'.

Another 40 year-old man, who had struggled with mathematics at school, describing the experience as "horrendous", decided he was "brave enough to put [his] results on the CV" … consequently became motivated to achieve his qualification, after which he stated "I am not as dim as I thought".

Considering these quotes and others in my data, I deduce that the learners are developing a more positive feeling about themselves throughout the process. They developed a new mathematical or learning identity. From a psychological perspective the learners' self-concept has changed, their successful performance in the examinations has 'altered their beliefs in their abilities which has influenced their feelings of self-worth and increased their motivation (Covington, 1984).

I cannot say this is a long-term change in every learner, but in the case of the female learner quoted on page 108 it definitely has had a long-term effect, in that she has become a mathematics teacher.

7.1.2.2 Identity and the face-to- face social group

In this concept I focus on motivation and the effect of learning mathematics on the learners' identities in relation to how they feel and act differently in social groups. Twelve learners described a change in how they saw themselves in relation to their fellow workers and family members. For example one woman (40), who learned mathematics to improve her negotiating skills, said that the learning experience and the way people reacted to her made her see herself differently. She said:

"…I got to learn a side of myself I did not know … I did not know I could motivate other people until I became a ULR. After that people started talking to me more and valued my opinion, which I had not experienced before …"

Another 55 year-old man spoke about feeling empowered when helping fellow trade union members to learn mathematics.

The significance of the face-to face social group giving and receiving encouragement very much relates to the influence of trade union membership that I discuss further in 7.3.1.2 and the role of families discussed earlier under concept 7.1.1.3.2.

7.1.2.3 Identity and the critical use of numbers in society
Nine interviewees spoke about how learning mathematics increased their confidence to use it "outside the classroom", which I understand as motivation related to using mathematics in a broader societal context.

Two women studied mathematics to improve their negotiating skills. One (40) explained it was important for her to understand how statistics were calculated, especially if she thought management were misusing or manipulating figures during negotiations. I interpret this as these women becoming empowered (Freire, 1981) to challenge "the social order rather than reinforcing it, transferring knowledge and hence power from the elite into the hands of the people" (Benn, p. 93).

Three women (40, 42, 31) spoke about how learning maths enabled them to understand more about England, its history and its culture, which I understand as motivation relating to citizenship and integration into society. As one of the women (42) said:

"… [It] makes me feel different about England, you know because I came to England and started working straight way. I did not have chance of visiting, of knowing the provinces…I did not have much chance to meet people, so by coming to the

learning centre, firstly for English and now Maths, it is good … it gives me a chance of seeing another side of England … seeing England with new eyes …"

Four women in the sample also spoke about how learning mathematics helped them with their personal finances (F, 49; F, 35; F, 42; F, 46). I interpret this as empowerment but at a more personal level, enabling people to engage more confidently with wider society about financial matters and feel that they have more control of their lives. While the notion of 'personal empowerment' is contentious, as discussed in 2.4 (on page 19), I feel strongly that enabling financial security can be empowering because it impacts on the economic security of a whole household. For me, and I suspect the women who talked about it, it is as important as being able to negotiate on behalf of a trade union. One woman (35) with young children illustrated this point when she spoke about feeling more "in control" of her finances and having a better understanding of her mortgage.

Finally a 55 year-old man, who was now teaching trade union members mathematics, described how he is now less likely to trust numbers given to him by the media, indicating he is developing a more critical attitude to numbers and how they are used in wider society.

In this category I relate motivation to learn mathematics to a change in identity that enables people to better understand and utilise numbers in their lives outside of the classroom, using education to develop critical citizenship (Frankenstein, 2010; Skovsmose, 2011).

Final observations on motivation and changes in identity.
As stated this category developed when addressing the first research question when adults spoke about seeing themselves differently after experiencing success after learning mathematics. Indeed in some cases, such as the 50 year-old woman who was a sportswoman but became a mathematics teacher in prisons, I would term this a profound change in identity, brought about through 'transformative learning' (Illeris, 2014).

Concluding remarks on the research question 'What motivates adults to learn maths at work'.

Through this data analysis I understand adults' motivation to learn mathematics as consisting of two phases: firstly, an initial motivation to engage in learning and secondly, a motivation linked to changes in identity bought about through successful learning experiences.

In this research the adults' initial motivations to learn mathematics at work related to securing their employment, developing their personal cognitive skills, supporting family and children as well as gaining a certificate to gain wider recognition of their achievement. The adults might have more than one motivational factor but this category related mainly to the adults cognitive development encouraged by ULRs in the workplace.

Nevertheless once the adults started experiencing success in their learning they spoke about seeing a change in themselves and described how they planned to act differently in the future in a range of social contexts, which indicated a development of their identity. They described feeling more "confident" to act, which also indicates to me that emotions have a role in motivation and consequently I discuss this in greater depth in Chapter 8 Emotions and motivation to learn mathematics.

I understood their explanations to also indicate the importance of members of their social face-to-face groups in supporting their initial and continuing motivation to learn. The adults also reported beginning to see themselves differently in relation to their fellow workers and family members, which in turn resulted in them becoming motivated to act more confidently outside, as well as inside, the classroom.

It is now of interest to consider what the characteristics of that experience or practice were that enabled this kind of learning to take place.

7.2. Addressing the research question: 'How do adults prefer to learn maths at work?'

7.2.1 Building the third category: Learning and teaching

The importance of this topic to motivation emerged during my early data collection when interviewees included descriptions of their "different" learning experiences when discussing what motivated them to learn mathematics at work. As a teacher trainer I became very interested in these descriptions as the learning organised through trade unions and delivered at the workplace was often described as "different", "better" or "easier" than previously experienced, so I wanted to further investigate what those differences were.

In chapter two I discussed the type of learning and teaching approaches that trade unions promoted and in chapter three I considered research into the field of adult mathematics education. I explored notions of formal, informal and non-formal learning approaches that are labels used to describe the variety of learning environments and pedagogies that adults experience in conventional and non-conventional education settings. I use these background ideas to look for ways in which the data indicated characteristics of learning that trade union members identified as important to their motivation, as it appeared to influence reasons to engage with and continue learning mathematics. Most interestingly these adults were motivated to take a second opportunity to learn mathematics later in their lives and outside of a conventional educational setting.

I again employed the three-level model of analysis when grouping the concepts in this category. In concept 7.2.1.1, I use the subjective or individual level to consider how the respondents reflected on their participation in learning at work compared with previous experiences. In concept 7.2.1.2, I pulled together the 'different' characteristics ascribed to the trade union organised face-to-face learning group environment. In concept 7.2.1.3, I analysed the data at a wider societal level in relation to the way national trade unions organised learning opportunities with employers that fit into shift patterns, busy working lives and family responsibilities.

Table 7 illustrates the concepts I grouped together to build this category motivation influenced through learning and teaching.

Category	7.2.1 Learning and teaching		
Concepts	7.2.1.1 Previous learning experiences	7.2.1.2 Characteristics of learning environment	7.2.1.3 Where and when learning takes place

Table 7

7.2.1.1 Previous learning experiences

Eleven of the twenty people interviewed reported their poor previous experiences had negatively affected the way they feel about learning mathematics and how this effected how they judged their own mathematical abilities and motivation to learn. This relationship accords with findings from other research (Covington, 1984; Dweck, 2008; Boaler, 2009) but what is interesting is that my data also indicates these negative feelings can and do change.

Covington holds that when learners ascribe their lack of success to 'external factors' they tend to relate that failure to their personal inability, and so it becomes 'fixed' or a 'state' that they cannot control; however, my data does not show this. For example, one woman (35) spoke about losing confidence in herself because she was put into the "wrong set" for her mathematical ability in school, an outside influence that discouraged her learning, yet she is now doing so well with her studies she is considering becoming a mathematics teacher. Jean (discussed in Chapter eight) and a 51 year-old man, both spoke about being labelled as a "thicko" by their teachers at school and yet they have overcome this experience to successfully learn mathematics later in their lives. These experiences describe people being categorised or labelled by external elements yet none of these adults in my sample display 'fixed' traits, rather their ideas about their abilities have changed as has a motivation to learn mathematics.

Dweck (2000) also relates achievement in mathematics to a learner's belief in their own ability, which she terms their 'mind-set' and suggests it is acquired at an early age. She claims people have 'fixed' or 'growth mind-sets', which influence their motivation to learn; if

they believe their inability to learn mathematics is a fixed state and their intelligence is fixed, they feel less confident and lose motivation quickly. Indeed she suggests that mind-sets play a key role in underachievement in mathematics especially in women and minorities (Dweck, 2008, p. 5). However no women or men from black or ethnic minority groups in my data sample display this. Adults in my sample might ascribe their failure in school mathematics as their own responsibility, perhaps because they "mucked about too much" at school (M, 34), were distracted by the girls (M, 35), or chose not to wear glasses and so could not read the board (F, 31), yet they were all motivated to re-engage successfully with learning mathematics as adults.

Indeed some of these theories seem to be more about labelling people than identifying how motivation can be developed and I found no indications of 'fixed' traits or mind-sets in my data sample. The theories I find more useful when analysing my data are those that look at what social groups influences the individual to learn mathematics (Eccles J. , 2005) and who or what encourages motivation to learn mathematics despite poor previous experiences.

7.2.1.2 Characteristics of the learning environment

In this concept I group together characteristics I identified when adults were speaking about their learning experiences. There are many indicators in this concept because, as a practising teacher trainer, I am keen to explore these to help inform my own practice.

Table 8 illustrates the indicators I grouped together to build this concept of, 'Characteristics of the learning environment'.

Concept	7.2.1.2 Characteristics of the learning environment				
Indicators of concept	7.2.1.2.1 Making mathematics relevant	7.2.1.2.2 Talking about Maths	7.2.1.2.3 Relaxed atmosphere	7.2.1.2.4 Small classes	7.2.1.2.5 Supportive / Collaborative learning

Table 8

7.2.1.2.1 Making mathematics relevant

Eleven of the twenty interviewees spoke about how it helped them learn mathematical concepts when they were related to practical situations and problems in everyday life. I see this as an expression of the need for the mathematics to be 'relevant' to this group of learner's experiences and understandings. This is of interest because amongst mathematics educators there is much discussion about what 'relevant' means in relation to teaching mathematics and indeed if maths concepts can be 'transferred' between different contexts, such as classroom spaces and those of everyday life and this is something I refer to in chapter three.

When considering the notion of relevance, one man spoke about the idea for a practical person like himself. He explained the difficulty he had learning at school where:

> " It was very vague. It was find the area of a triangle, why? Nothing about the 'need of it', that made sense. Whereas if you are working out the area of a piece of land, where you are putting down a shed, it's more meaningful to a practical person …"
>
> (Interview transcript, Male, 50)

Another 48 year-old male explained … "the teacher was good [because] … he put it in simple terms. If you borrow from Wonga you borrow one pound but pay back 7000 over a year …"

When discussing teaching approaches Swain (2005) describes talking about mathematics being 'meaningful when it is linked to an individual's purpose' although he argues 'making maths real does not necessarily mean [teaching] using everyday maths' (ibid, p. 86), which would appear to contradict what the adults above were saying, as their purposes appear to be related to practical and financial 'everydayness'.

Perhaps Deci and Ryan (2000) explain it better when they argue intrinsic motivation includes a notion of 'relatedness', which is a need for 'social belonging to a person's group and culture (Ibid, p.229). I observed this when a 50 year-old woman talked about teaching in prisons. She described how she was able to engage with the prisoners when they started to discuss mathematics that 'meant something' to them:

> " We saw the budget was coming in, so their tobacco was going up, so we bought in their canteen sheet … doing things that were proactive and real…and it made it fun. You can give so much more than just a maths lesson… and it opened so much more …"

She gave another example relating mathematics to the health of the prisoners. She explained that the mathematics topic related to body composition and helped a prisoner who was malnourished "to work out how much he needed to survive".

I also see mathematics topics related to 'social belonging' to the trade union cause when a woman (40) spoke about "the information we use is relevant to us. Last year we did asbestos deaths, it's relevant to us, and the workplace".

These quotes and others in my data indicate to me that 'relevance' or 'meaningfulness' related to 'everydayness' is an important motivational factor to this group when learning mathematics. Deci and Ryan's (2000) notion of social belonging is useful to help explain aspects of relevance in motivation, especially in relation to supportive face-to-face learning groups and wider trade union social and cultural values. However Swain's quote suggests to me there remains contention around the notion of mathematical relevance and teaching approaches, but I agree with Coben *et al., (*2007) who argue, 'to help with everyday things outside the classroom' is a motivational factor (p. 19).

7.2.1.2.2 Talking about maths

When describing an environment that motivated learning eight of twenty interviewees explicitly identified the importance of being able to talk about mathematics with teachers and colleagues. This builds on other research that focuses on the role of language in the development of ideas (Lerman, 2000; Evans, 2000) and in a mathematics class helps to clarify misconceptions(Swan, 2012).

A female learner said:

> "… I learn more by having classroom interaction. You can talk to people …If you have a scenario and you can't resolve it you can ask a colleague or a teacher … so we had a lot of interaction".

> (Interview transcript, Female, 50)

Another man (46) spoke about how being able to ask questions made mathematics seem 'easier' He explained:

> "…Understanding what you are doing [mathematically] is allowing you to talk about it. If you couldn't understand the way the teacher was teaching you [at school] you would not be dare talk about it …"

He said being able to talk about mathematics helped him to understand mathematics, and not "feel stupid". This phase also links to the idea of the importance of developing an 'emotionally safe environment' (Schorr and Goldin, 2008) in which people can learn (discussed more fully in chapter eight).

7.2.1.2.3 Relaxed atmosphere

In my sample seven out of twenty interviewees spoke about how the learning environment was more relaxed than previously experienced. It is interesting to note that six of the seven

who used the phrase "relaxed" are men, four of them linking this atmosphere to being in smaller groups.

One said it was more relaxed as, "there is no point in the teacher standing in front of twelve blokes…he had to make it interesting" (M, 49). This indicates the teacher had to find less traditional ways of teaching as another man (34) explained it was, "not what I would call a formal learning environment, [it was] very relaxed."

Jean (46) linked the relaxed atmosphere to the fact that, "we are adults; we are there because we want to achieve". These quotes relate the notion of the relaxed atmosphere to less formal learning approaches being used with adults, who make their own choices to attend the classes.

Jean also connected the idea of a "relaxed" environment to the physical learning space not having the feel of a traditional classroom. She suggested the learning space is:

"… Not as academic in respect of tables and chairs all facing the front. We were all sat around table, the tutor mingled with everyone. It was a relaxed environment".

The 34 year-old man quoted above supported this idea, stating he liked, "that it was in a room like this, not a classroom; it felt more like a work meeting not a classroom". These quotes reinforce the notion that the space is not a formal learning environment but is closer to a work environment, where different social rules apply.

This discussion of a relaxed approach to learning relates to the importance of experiencing different pedagogical characteristics in different physical spaces that feel less formal than the mathematical learning that often happens inside educational institutions (Boud and Garrick, 1999; Evans, *et al.*, 2013). It also points to the importance of adults having choice or autonomy (Deci and Ryan, 2000) in relation to their motivation to learn.

7.2.1.2.4 Small classes

Eight of twenty interviewees spoke about the value of being in "smaller groups". One compared the atmosphere learning at work with that of school classrooms, where " teachers had 30-40 kids in a class" and "couldn't keep control" (M, 48). Another spoke about [having] more "one-to one" (M, 35) time to talk with the tutor and colleagues whilst a 34-year-old man spoke about his experience of the "small gathering, [being] almost became a social thing".

Ross *et al.* (2012) support the finding that adults also enjoy the social aspects of learning and my participants saw smaller classes as contributing to a 'relaxed' atmosphere, where there was time to talk about mathematical misunderstandings.

7.2.1.2.5 Supportive /Collaborative Learning

Eight of twenty interviewees also spoke about the importance of having a supportive and collaborative approach to learning. They found this approach motivating especially if previous learning experiences had been poor. One 42 year-old woman described the atmosphere in the trade union mathematics class as, "more supportive than at school, in a class of thirty. If you get it wrong here no one will embarrass you like they did at school". This quote indicates a connection between the notions of supportive learning in smaller groups, which also helps develop an 'emotionally safe environment' (Schorr and Goldin, 2008) in which to learn.

Jean (46) described her experience of supportive learning:

> "… If I am struggling, the rest [of the group] would help. You never felt you were holding someone back because you didn't grasp something. The group never moved on until everyone had grasped what they should be doing. The environment and the people you were learning with made the maths a lot easier …"

Another man (46) also appreciated the support the teacher and his colleagues give him. He explained that the teacher:

"… here has more time to spend with you on it and will explain again and again..." whilst "other colleagues in the room came up with [other ideas about] how they did it, so you had multiple choices as to how you worked it out …"

He compared this approach with his school experience where, "the classes were so big … you couldn't ask questions". He said he found this approach to be more "enjoyable", which makes it seem "easier to learn".

This concept encapsulates the characteristics that contribute to learning experiences that these adults found 'different 'and 'easier', which for me indicate a cognitive change in their thinking as well as an emotional change, related to their motivation to learn. The characteristics include making the mathematical topics 'relevant', using a pedagogical approach that developed a supportive environment with collaborative group learning. They described small groups that contributed to a relaxed atmosphere where people could feel safe to talk about mathematics. This also accords with learning approaches promoted by the trade unions (Rees, 2007) and some mathematics educators (Swan, 2012).

7.2.1.3 Where and when the learning takes place
My data indicates that ease of access to learning was identified as an important factor in motivation to learn by five out of twenty learners in my sample. While the number reflecting this concept is relatively small I consider this idea significant as it is relates to adults being able to access the actual time and physical space in which they learn. The importance of accessibility is supported by other trade union research which highlights the need for learning opportunities to be flexible to suit shift patterns of working (Ross *et al.* 2011).

Jean (46) has been successful in learning mathematics through the trade union organised classes and is now a ULR. When reflecting on her experience and her current role she emphasised the importance of adults being at ease in their surroundings; she explained when encouraging fellow trade unionists to join mathematics classes they needed to feel

"comfortable" about the learning space in order for them to even consider re-engaging with learning.

Jean (46) also emphasised how learners could feel "insecure" and "lacking in confidence" when they are asked to go "out of their comfort zone" and into a college. She suggested the workplace is more accessible as it is more familiar, where the teachers must enter the learners' space rather than the other way around. This accords with recent research by Durrant (2015) who also sees the physical development of a joint 'communicative space' in the learners' vocational environment, as key to introducing more academic learning.

A 31 year-old woman reinforced the point about how having local access was essential to her learning, as it allowed her to cover childcare responsibilities. As she explains:

> "… Because I have a son, and my husband is on another shift, we are looking after our boy. I would not be able to go out to college, because I will have no one to stay with [son's name]. Here, for me, is really a great chance to study. This is the only way I can do it".

This is a very important point for those who have caring responsibilities as other research also points to childcare responsibilities being a barrier to learning for women (Ross *et al.*, 2011; Kelly *et al.* 2012) which leads to a longer term reduced potential to earn (Institute of Fiscal Studies , 2016).

So accessibility to where and when the learning takes place is important to five of the learners interviewed, learners who can already be labelled 'hard to reach'. Indeed perhaps one reason why only five people identified this as important is because ULRs have already worked hard to negotiate flexible times for them to learn in familiar surroundings, something examined in the next category under concept 7.3.1.1, when discussing using trade union negotiated time to study (on page 125).

Concluding remarks on the research question: 'How do adults prefer to learn maths at work?'

Through this data analysis I understand adults' motivation to continue learning is significantly linked to the pedagogical approach used in the face-to-face mathematics-learning group. This approach is reported as different, and more supportive and less formal than experienced at school. The respondents spoke about learning being in small, relaxed groups where individuals worked collaboratively and were able to talk about their mathematical misunderstandings. They described feeling what I understood to be an emotionally safe environment (Schorr and Goldin, 2008), where they felt they could expose their fears and mathematical misconceptions. They also spoke about the importance of having flexible time to learn and the learning being easily accessible.

The adult learners compared this approach with previous learning experiences, which often produced in them negative feelings about mathematics. This category indicates the significant contribution that a supportive social face-to-face learning group makes to the development of positive motivational learning experiences in mathematics. It also cannot be underestimated in the importance of these adults accessing the learning at times suited their patterns of work.

In the next category I identify the important role that trade unions play in providing the opportunities for members to learn and how members feel about being afforded those experiences.

7.3 Addressing the research question: 'Is there any relationship between learning maths at work and union membership?'

7.3.1 Building the fourth category: Trade union membership and motivation to learn mathematics

The concepts in this category were developed in response to the research question mentioned above. The TUC and many trade unions fund members, usually ULRs and regional officers, to negotiate with companies the opportunities, times and places for members to learn mathematics. They also organise and pay for teachers for the learning groups and celebrate success through national conferences and members newsletters. So

I am interested to know what influence membership has an individual adult's motivation to learn mathematics and, in turn, if that learning influences an adult's motivation to act in relation to trade unions. I am also interested in the influence of trade unions on learning approaches used I the mathematics sessions.

I again use the three-level model of analysis to explore the concepts that help build this category. My analysis under concept 7.3.1.1 reinforces the importance of the individuals having the time, sometimes paid for, to learn at work and negotiated by the trade unions. In concept 7.3.1.2, I discuss the significance of the face-to-face support offered by Trade Union colleagues give to individuals on their motivation to learn mathematics. In concept 7.3.1.3, I consider how adult learners reported their feelings had changed towards mathematics, and perhaps not surprisingly, how positive they feel towards the trade union organisations that had supported them. In concept 7.3.1.4, I also explore how successful experiences had increased learners' awareness of the role of trade unions in society and developed their confidence generally, motivating them to act differently on behalf of work colleagues and family members.

Table 9 illustrates the concepts I grouped together to create the category of 'Motivation and learning mathematics through trade unions'.

Category 7.3.1 Motivation and learning mathematics through trade unions				
Concepts	7.3.1.1 Using Trade Union negotiated time to	7.3.1.2 Trade union influence on motivation to engage with learning	7.3.1.3 Seeing Trade unions differently	7.3.1.4 Encouraging democratic engagement

	study	mathematics		

Table 9

7.3.1.1 Using trade union negotiated time to study

Twelve people in my sample spoke about the important role the trade union played in offering them opportunity to learn mathematics at work and negotiating the time to study. Here one 35 year-old woman explains that in her organisation:

> "… Every union member is entitled to two hours paid time off to learn Numeracy and Literacy skills, so being a union member is important because you are entitled to that time off …"

However time off to study is not always available in all workplaces, as one male aged 61 who was a ULR explained. Nevertheless where time to learn is negotiated, the members value the opportunity (F, 46; M, 34) and ensure it is used wisely. One man (51), who was also a ULR, explained:

> " … We have a chat but we are here to learn. There was one guy who was playing up a bit but he decided not to carry on …"

The trade union members who take the time to learn acknowledge the importance of the trade union negotiating time to study. Another 31 year-old woman said one reason she joined the union was to access learning while one man aged 27 explained he could not access learning until he was employed by the company and was able to join the trade union, even though he had been an agency worker for that same company for three years.

This concept shows the significance that offering time for learning has on both the individual members and the trade union as an organisation. It effects motivation to want to learn mathematics but also to become active members of the trade union.

7.3.1.2 The influence of trade union members on motivation to learn mathematics

Eight of the twenty interviewees talk about how their trade union colleagues are influential in encouraging them to engage with learning building their motivation to learn. My data indicates that individual members know and trust the person who is encouraging them to undertake learning. There is already a feeling of solidarity amongst trade union members, prior to learning and I agree with Moore and Ross (2008) that this is important when motivating people to attend mathematics classes. Barbalet (1996) says 'trust is the emotional basis of co-operation' (p. 77) and I see this trust amongst trade union members, enabling adults to take the risk of re-engaging with learning mathematics. For example one woman spoke about how others in the trade union had recognised her potential and encouraged her to learn:

> "… I was co-opted into being the Health and Safety rep, they knew I had the 'wherewithal' to stand up to management, but they also said 'You needed something to get your teeth into'. I am now studying … you don't think about studying when you have children … I have enjoyed it …"

> (Interview transcript, Female, 53)

A different aspect of co-operation was indicated when one man spoke about getting involved in learning mathematics in order to support a fellow union member:

> "… If I am honest, part of it is because [the new ULR] was organizing it. He put a lot of effort in, he was getting a lot of stick from people on the shop floor, saying 'You're wasting your time' and I said 'If you get maths going I'll put my name down and I will do it …"

> (Interview transcript, Male, 49)

Both of these quotes point to the importance of the social support of trade union colleagues when motivating individuals to learn mathematics at work. The members had already built trust in each other through trade union and work activities; this trust then helps to build the learners' motivation to take the risk of re-engaging in learning mathematics.

7.3.1.3 Seeing trade unions differently

Twelve out of twenty members interviewed spoke about how re-engaging with learning had changed their views about the trade unions. It helped them raise their awareness of the broader role of trade unions and in seven cases they emphasised how much more positively they felt towards the organisation.

All of the interviewees were members of a trade union prior to learning mathematics at work. But the learners spoke about how they now saw the union as being more than just a group of people interested in being involved in strike action to protect pay and working conditions (M, 51). They also become aware of the range of activities trade unions were involved in, including education (M, 61). One woman (53) explained:

> "…it has given me a different view. I thought they [TUs] were like dinosaurs … 'all out brothers'. The union has got a point; they are not just here for strikes, they are here to look after people …"

Jean, whose grandfather and father were trade union members, tells a similar story about how her opinion had changed. She said she thought, "if you joined the union you were on strike all of the time … If something wasn't right they would always down tools and walk out … so I did grow up with that perspective". However she has now seen "the learning side" of the trade union, which has changed her opinion. As a ULR she knows:

> "… We've got a lot of members out there that need help. You [acting as a ULR] are giving them a massive achievement in life. For some of the learners to even achieve one qualification is huge for them …"

Another 40 year-old woman, who was on a trade union course for Health and Safety Reps, found that learning mathematics enabled her to do her job better and, as a consequence, she felt more loyalty towards the union. Another man (35) said that being offered the opportunity to learn made him feel more positive about the trade union because they gave him the chance to do so whereas, "most companies won't do that, especially Maths and English. They will teach you skills for work but not Maths and English".

This concept captures the way many learners feel more positive about trade unions through being given the opportunity to learn mathematics.

7.3.1.4 Encouraging democratic engagement

When discussing motivation to learn mathematics, eight interviewees spoke about how the trade union had helped them to develop their wider skills, to become more active and aware of the role of trade unions in wider society.

For example, the 53 year-old woman who went on the course to improve her negotiating skills spoke about how she now uses the maths skills she learnt when negotiating with London Underground management on Health and Safety issues:

> "… I want to know if the figures management give to me are accurate. I want to use them for evidence for an issue, such as illnesses, noise levels. You are making the figures work for you …"

Another woman (40) on the same course explained how she uses mathematics calculations to check management figures when in negotiations about employment and redundancies. Two other members (M, 55; F, 50) continue to learn mathematics and use it to teach other members, while another (F, 35) is considering teacher training for the trade union.

The quotes discussed here and in my data generally indicate the influence that learning mathematics has on developing the individual's wider skills, giving them a stronger sense of solidarity and positive feelings towards the union and empowering some to use

mathematics (Freire, 1985; TUC, 2014)to the benefit of the trade unions through what Frankenstein (2010) and Skovsmose (2011) would call critical education.

Concluding remarks on the research question, 'Is there any relationship between learning maths at work and union membership?'

The trade union members in my research have taken up a learning opportunity at work enabled by national trade unions allocating resources to this purpose. Trade Union officers, usually ULRs, negotiate on–site opportunities with employers and the unions also fund the teachers and equipment needed to support that learning, while employers provide the physical space and sometimes time off work to learn. As a consequence, the respondents in my sample report feeling more positive about the trade unions; they feel that the union cares about them as individuals.

Fellow trade union members and ULRs play a key role in encouraging and motivating fellow union members to start learning again and in supporting and motivating adults in the classes. Consequently adults in my sample were aware of the important role that fellow members played in motivating them to learn. I see this encouragement as significant when reflecting on the difficult times many learners had in their previous experiences of engaging with mathematics and it emphasises the trust that learners must have in the person who is encouraging them not to repeat that experience. This exemplifies the role of the face-to-face social group in motivation.

I would also argue that the members who develop their mathematics knowledge to improve their negotiating skills on behalf of the union or became mathematics teachers in the unions, have become empowered (Freire, 1985) through their learning.

The influence of learning mathematics in these cases goes beyond the 'mathematics classroom' and is of interest because, within the trade union movement, collective action is viewed as the way to benefit all members. As discussed in chapter two, learning a subject like mathematics is sometimes viewed as of benefit only to the individual involved. However these examples show a wider social benefit to developing mathematics skills. While building this category I developed an understanding that learning mathematics can

increase members' confidence and motivation, empowering them to act on behalf of other trade union members.

Not surprisingly, the role of the trade union in encouraging and supporting their members to engage in learning mathematics illustrates the strong relationship between the individual and the social group. This category is important in my research into motivation to learn mathematics because it links to all of the other categories in my findings. Trade union Representatives (ULRs) encourage members to re-engage with learning, their initial motivation discussed in the first category, in sustaining motivation to learn discussed in category two, by providing a supportive and relaxed atmosphere for that learning as detailed in category three. In addition the experiences can also be linked to the fifth category as described in the next chapter, when I discuss how adults develop confidence through learning mathematics.

Conclusions on the research questions

In this chapter I explained how the grounded theory process of analysis helped me group the data into concepts that I used to develop a framework of categories to address my research questions about motivation. During the analysis I also explored the data at an individual, social face- to-face and wider societal or organisational level when developing complex concepts such as initial motivation. This analysis helped me refine the categories and increase my understanding of motivation of adults in this sample in a more systematic way.

In response to question one: 'What motivates adults to learn maths at work?', I developed two different categories of motivation; firstly initial motivation to join the classes and secondly motivation linked to continuing learning, which included the importance of the learning approach but also related to a more fundamental change in their identity, which was seen as giving people more confidence to act in different ways. These two categories developed because the adults who experienced successful learning through the trade

union, reported a change in how they saw themselves. They reported an increase in confidence and becoming motivated to act differently in a wide range of social contexts, some of which I would call transformational. This increase in confidence I understood as how emotions playing a key role in motivation and so discuss this finding in greater depth in chapter eight.

In response to my second research question: 'How do adults prefer to learn maths at work?' I analysed the data to explore the learning and teaching approaches that trade unions members favoured and I identified these as contributing to adults' motivation. The adults interviewed often stated they had poor previous learning experiences, so the current practices needed to be different but also flexible for ease of accessibility when working long days or on shift patterns.

They talked about the importance of learning mathematical topics relevant to their lives, in small-relaxed groups where individuals could work collaboratively to develop their mathematics skills. They explained how the support of others in the class was important, as they needed to be able to share their ideas, often misunderstandings, with people they could trust.

In response to my third research question: 'Is there any relationship between learning maths at work and union membership?', the response was a very strong, positive one on many levels. All of the respondents were trade union members and they all recognised and valued the learning opportunities offered by their trade unions. Respondents were aware that trade unions not only funded their time and place for study but they also funded ULRs whose job it was to encourage ordinary members to take up the learning opportunities offered The learning support and opportunities offered by the trade unions encouraged members to view the organisation more positively, seeing the trade unions as more interested in them as individuals. The members also spoke about the importance of the support fellow members gave before and during the learning experience, which helped them see themselves differently, becoming more confident or even empowered to act.

This research shows the significant contribution that trade unions make towards helping people improve their mathematical skills, not only through their investment in people and resources but also in the significant development of members and through this the wider contribution they give to supporting others to develop their skills.

In chapter eight I discuss a further category, which I call 'Emotions and motivation to learn mathematics' that emerged during my data analysis. I realised interviewees used emotional language when responding to my research questions and the phrases suggested to me that emotions played a role in motivation,

Chapter 8 Emotions and motivation to learn mathematics

In the previous chapter I coded transcripts from twenty interviews, identifying concepts that I used to build a framework of categories to enable me address my research questions: 'what motivates adults to learn mathematics at work', 'how do adults prefer to learn mathematics at work' and 'is there any relationship between learning mathematics at work and union membership'. I used three levels of analysis to explore the data and relevant research literature, which enabled me to increase my understanding of the notion of motivation by building the following framework of four categories:

- 1. Initial Motivation

- 2. Motivation and changes in Identity

- 3. Learning and teaching approaches

- 4. Trade union membership and motivation to learn mathematics

However, during this process of analysis I realised that emotions formed part of the phenomena I was aiming to describe in each of the categories. For example, adults' initial motivations to learn mathematics in Category 1 are driven by personal needs and goals related to work, developing personal skills, the family and gaining qualifications but also depended on their personal self-confidence and trust in others to re-engage with mathematics. In Category 2, learners' talk about how they overcome negative memories when successfully engaging with learning mathematics, making them feel more confident about themselves. This in turn influences their motivations to act differently both inside and outside the mathematics classroom. In Category 3, the adults' talk about their emotions, when they describe feeling more relaxed about learning with a group of adults who work collaboratively and encourage each other to learn. In Category 4 the respondents speak about having trust in their trade union colleagues, who encourage and motivate them to re-engage with learning.

Although emotions appeared to be of secondary importance they began to increase in significance as I developed my understanding of the connection with motivation. As a consequence I develop this fifth category: 'Emotions and motivation to learn mathematics', which I explain later in this chapter.

I also developed a term to use to describe significant changes in emotions expressed by adults in relation to their motivation to learn mathematics and their feelings towards the subject, which I call an Affective Mathematical Journey (AMJ). During the data collection many adults described significant changes in their feelings when discussing their motivation, and I use the term AMJ to label this notion and use one learner's story, I call Jean, to help illustrate the concept.

8.1 Building the fifth category: Emotions, confidence and motivation to learn mathematics

In order to explore emotions in relation to motivation I returned to the data and used a similar process of analysis to that described in chapter five to identify indicators that enabled me to build concepts related to emotions and confidence.

I coded words and phrases I thought indicated emotional responses, such as "braver", "passionate" or "rubbish", terms that interviewees used when describing their various experiences of learning mathematics throughout their lives. However research in relation to emotions and mathematics, especially with adults, tends to concentrate on negative feelings, which I discussed in chapter five. But my data also indicated positive feelings towards the subject, particularly after good learning experiences and consequently, I wanted to include this phenomenon in my analysis. Hence I grouped into concepts words that indicated to me feelings or emotions, I put negative words in one concept and positive into another.

Through this process of coding I also became aware of adults using the word "confidence"

when discussing motivation to describe emotional changes in themselves and how they intended to act in the future. As my analysis progressed the notion of confidence in relation to motivation took on significance, especially when I realised that eleven of the twenty respondents actually used that word to describe their changes in feelings. As research into building adults' confidence in mathematics was limited, as discussed in chapter six, I used the three levels of analysis model to further explore the complex relationship between motivation and confidence in this sample of adults.

Table 10 illustrates the concepts I grouped together to create the Category of Emotions and motivation to learn mathematics.

Category: Emotions and motivation to learn mathematics			
Concepts	8.1.1 Negative feelings about learning mathematics	8.1.2 Positive feelings about learning mathematics	8.1.3 Confidence- a link between emotions and motivation to learn mathematics

Table 10

8.1.1 Negative feelings about learning mathematics

When discussing their motivation to learn mathematics eight of twenty adults spoke about having negative feelings after experiencing difficult previous learning experiences. When describing those experiences they used words such as "hate", "horrendous", "phobia", "fear" and "frustration" that indicated a range of negative feelings about learning maths. For example, a woman described her fear of learning mathematics:

> "If I am brutally honest it [mathematics] has always been a block, a barrier and a massive fear for me. Maths was something you would mention and I would come out in a cold sweat".

A 42 year-old woman spoke about her continuing unease about mathematics, saying she felt 'insecure about maths' and that "I only like it a little because I do not feel confident about it. I do not understand it much". Whilst another 49 year-old woman spoke in even stronger negative terms about mathematics, she said she was re-learning the subject but:

> "…just basic maths, an introduction to maths. After you have left school and to get you back into maths… You know the phobia… well you know it is a bit of a taboo, not exactly everyone's strength".

Jean (46) said "mathematics was my black hole" and she thought learning mathematics again would be "daunting" and "a struggle". One of the men (55) also talked about "maths scar[ing] the living daylights" out of him at school when he tried to learn more abstract mathematics at A level, so he had to overcome this barrier to learning.

My findings are supported by research into previous poor mathematics learning experiences and their link to negative emotions (Covington, 1984; Dweck, 1996) and what Evans *et al.*, (2006) might describe as emotions related to individual's 'histories and experiences', resulting in 'maths anxiety' (Tobias, 1978). However what is of interest in my research is illustrated in the next two sections, as the data shows that despite these negative feelings and difficult memories the adult learners are still motivated to re-engage with mathematics and go on to achieve a qualification with high social recognition, and consequently feel differently and more positively about the subject.

8.1.2 Positive feelings related to learning maths

Significantly eighteen out of the twenty people used positive words and phrases to describe their feelings about learning mathematics during the interviews.

For example a 28 year-old man explained how "It made me feel better about myself; in a way … I do have a grade now whereas before I didn't…so that's it". A 42 year-old woman whose words about negative memories were quoted in the previous section, described how learning mathematics was now making her life "a bit easier" because she was now able to understand her finances better. While one 61 year-old man said successfully learning mathematics had "lighted a spark to go and help others with it" and was considering training to be a teacher. In the [extended] case study reported later in this chapter Jean, who had described mathematics as her "black hole" talked about how she has developed "a passion" for mathematics.

My data shows that when adults are able to successfully re-engage with mathematics they can also develop positive feelings towards the subject.

8.1.3 Confidence - a link between emotions and motivation to learn mathematics

When describing their motivation to learn mathematics eleven of the twenty trade unionists used the word confidence when talking about a change in how they feel about themselves and their intentions (or motivation) to act in the future. This indicates to me that for this group of learners the word confidence links together emotions and motivation.

 Indeed I find Barbalet's (1996) definition of confidence as 'a feeling which encourages one to go one's own way' or 'an emotion of self-projection' or even 'the emotion associated with a willingness to act, or self-confidence' (Barbalet, 1996, p. 77) describes precisely how my participants used the word.

I now analyse my data on the three levels used previously and use this process to indicate the influence that confidence has on motivation for this group of adult learners.

Table 11 illustrates the indicators I grouped to analyse and build the concept of Confidence – a link between emotions and motivation to learn mathematics

Concept: Confidence – a link between emotions and motivation to learn mathematics

Indicators of concept	8.1.3.1 Developing confidence at an individual level	8.1.3.2 Developing confidence at a social face-to-face level	8.1.3.3 Developing confidence to act at a societal level

Table 11

8.1.3.1 Developing confidence on an individual level

In her interview the 35 year-old woman who had previously spoken about her negative feelings about mathematics used the word confidence seven times when describing being able to control her emotions and becoming motivated to act in different ways such as supporting her children's development and planning to teach her fellow workers mathematics. While some researchers (Zan and Hannula, 2004) see emotions controlling motivation driven by personal needs, I also see this woman describing a form of self-belief (Ryan and Deci, 2000) in her abilities.

Other adults also talked about their confidence increasing after improving their mathematics skills. For example, one 49 year-old woman explained "It allowed me to build my confidence after doing that short course and I say [to other people] 'yes I can do math's at a basic level". Another man (49) ascribes his increase in self-confidence directly to being able to do particular mathematical topics, exemplified for me in the phrase "sit up a bit straighter". He explains:

> "... but it all came down to confidence. I am already a confident person but, for instance, when I learnt to do percentages you sort of sit up a bit straighter.

> It gave me the confidence to think, well, if I learned that, I can learn this. Maybe it is a stepping-stone, or the bottom rung of the ladder, but I want to creep up…"

A 61 year-old man talked about confidence in relation to developing of skills in a more general way saying "Doing maths is a confidence booster… getting rid of the stigma. People are frightened… they say I'm no good at fractions".

I see these and other quotes in the data as adults using the word "confidence" to express a positive change in their feelings about themselves and their motivations.

8.1.3.2 Developing confidence at a social face-to-face group level

Adults also talked about their confidence developing through the encouragement of others to attend classes and when receiving positive learning support that enabled them to pass mathematics examinations. This experience then made them feel more confident and motivated them to act differently within various social groups.

Jean (46) talked about the importance of what she called a supportive learning environment. She described when she had difficulty understanding a concept the rest of the group would wait for her and try different ways to help her tackle a problem. She said "the difference is you are doing it with people you trust, because they work with them, they are colleagues and friends". Barbalet (1966) asserted that trust was one of three social emotions 'necessary for the social processes of agency, cooperation and organization' (ibid, p. 75) and it appears key to Jean's motivation to learn mathematics.

Another man (55) linked his increased confidence to developing his conceptual knowledge of mathematics by being able to talk about the subject with his teacher and his peers during the learning process. He explained "…with this teacher you can ask any questions. He doesn't mind what questions you have got. He makes it interesting. He explains so you understand…you don't feel stupid". He later said "Understanding what you are doing [mathematically] is allowing you to talk about it. If you couldn't understand the way the teacher was teaching you, you would not be daring enough to talk about it". This quote illustrates the importance of talking with others about mathematical ideas, linking to the important role social groups play in learning and motivation.

The data indicates a wide range of social face-to-face groups have a strong effect on motivation to attend the classes, to engage positively with learning and in making use of

the mathematics learned. This data also suggests self- efficacy can be developed through social modeling and persuasion (Bandura, 2004) and also points to the importance of confidence, trust and loyalty (Barbalet, 1966) in social co-operation and motivation, discussed in more detail in chapter six.

8.1.3.3 Developing confidence to act at a societal level

This concept relates to a group of eleven participants who associated their increased confidence after learning mathematics to becoming motivated to act differently in their social face-to face groups that are influenced by and connected to wider society. For example, feeling more confident to act as trade union negotiators, gaining teaching qualifications in mathematics, becoming more confident in dealing with financial matters.

Two women spoke about gaining confidence to act in trade union negotiations and as one woman (53) explained learning mathematics "…has given me more confidence in the fact that I am willing to challenge management. It gives you that extra assertiveness". The other woman (40) said something very similar:

> "It does strengthen your arguments during negotiations because what tends to happen is the company will quote percentages to you, and you try to figure them out. So if you know maths you can easily challenge them, and if they are trying to manipulate the figures you can easily pick it up. It adds that boost of confidence when you are having any negotiations with the company".

Research by the TUC (2010) also suggests education and training they offer "improved relationships with management" (p. 6) by developing the confidence to take part in consultations and "to speak with authority because of gaining the knowledge and qualifications" (TUC, 2014, p. 37).

Four people related their successful mathematics learning to them being more confident to teach mathematics. One 50 year-old-woman explained how developing her mathematics skills and knowledge had:

"… been massive, it enabled me to teach in the prison, and very successfully for a number of years. It's given me opportunities to help people unlock the barriers, because I was able to do it they can.be motivated to do so …It gave me the confidence to go for the level 5 teaching qualification, never thought I would achieve that".

Four women also talked about feeling more confident in relation to their personal finances. As one woman explained:

> "I can manage my money, I feel braver. I feel like I am more in control, especially with the house. I now feel I have an understanding of what I am letting myself in for, the amount of money, how it interlinks. I understand the ways of the world".

(Female, 35)

I see this as describing a form of empowerment using their mathematics in a critical way to help families to become more financially secure within the complex financial context of the UK, (which I also discussed in the literature review in chapter two). Identifying financial confidence as empowerment may be controversial. Freire (1985) would argue it is not empowerment because it is not about challenging social norms and existing power structures; rather it is about enabling individuals to survive and become economically secure within the current economic system. But I think that enabling people to engage more confidently about financial matters within a wider society allows them more control of their lives and is very important. To enable those in less secure jobs, or in low-paid or zero-hours contract employment, if applying mathematics skills to finances provides them with the abilities and strategies to avoid loan sharks and understand the longer-term implications of pensions and mortgages must be seen as advantageous to those in that vulnerable group of workers and for the better good of society as a whole. This, for me, links mathematics to social and economic empowerment.

Finally, one 55 year-old man linked his increased confidence to his ability to critically assess the accuracy of information in different social contexts, such as the media. He explains after learning more mathematics and statistics:

"… You look at things in a different way. When you read the paper, when the government tell you stuff and give you figures, I then want to know where did those figures come from. Show me the research ... reading newspapers you read '50% of such and such do this' and you think, well, how did they get that? It's made me question things more, and do I trust things any less? Yes probably …"

This data points to mathematics education as developing critical minds (Freire, 1985; Frankenstein, 2010; Skovsmose, 2011), which relates to the purpose of trade union education discussed in chapter three.

Concluding remarks on emotions, confidence and motivation to learn mathematics.
Through the analysis of this data, informed by my literature research, I have built concepts that have enabled me to better understand the role of emotions in motivation in relation to this group of learners.

I realised the participants expressed a range of emotions during the interviews and as existing research into mathematics education focuses on the negative I decided to build concepts that indicated positive as well as negative responses. Through this process I began to understand they also reported changes in their emotions towards mathematics as they lived through positive learning experiences. As their feelings became more positive they reported feeling more confident in themselves and their mathematical abilities, which in turn motivated them to continue learning. This indicated to me a strong link between emotions and motivation.

By analysing the feeling of confidence at three levels I understood it to influence adults' motivation through their belief in themselves but also being driven to learn by having confidence and trust in fellow trade unionists and learners though their support. Having a better understanding of mathematics also gave them a "boost of confidence" and motivated them to act in different ways; for example to negotiate with company management on pay and health and safety issues or become teachers of mathematics themselves. So I understood the way adults spoke about increased confidence was to express a change in their feelings (or emotions) that affected their beliefs in themselves (cognitive), which encouraged their motivation to act differently, linking emotions, motivation and cognition.

8.2 Defining an Affective Mathematical Journey (AMJ)
The idea of an AMJ emerged while analysing my data when I found that eight out of twenty respondents described how:

- they initially had negative feelings towards mathematics, but their feelings towards mathematics change and became more positive
- their belief in themselves and their mathematical abilities increased after successful learning experiences, facilitated by a supportive learning environment and others in their wider social networks,
- they described this change as becoming more 'confident '(or motivated) to continue learning mathematics but also to use it in other aspects of their lives

These characteristics relate to my earlier findings when individuals report a change in their feelings about mathematics discussed in section 8.1 (on page 134); as well as an increase in self belief discussed in section 7.1.2 in answer to the question what motivates people to learn mathematics linked to changes in identity (on page 107). The interviewees relate the change in their feelings and motivation to experiencing "different" learning experiences. The characteristics of those experiences I discuss in section 7.2 (on page 112) when answering the question 'how adults prefer to learn?'. Other researchers, such as Illeris (2014) also claim that 'transformative learning' can bring about a change in identity

(discussed on page 34). The consequence of this change in identity is often described by the interviewees as an increase in confidence, discussed in section 8.1.3 (on page 137) and appears behaviourally in at least two possible ways: either the adults continue to attend classes and learn more mathematics - in some cases they may even become teachers -, or they intend to use mathematics in different ways outside the classrooms, for example, in trade union negotiations or to help with personal finances.

I understand the change in feelings towards mathematics and the changes in their motivations as indicating an affective mathematical journey (AMJ). The notion of the possibility of an AMJ further contributes to the idea that 'maths anxiety' is not fixed but can be changed into something more positive through certain types of professional practice.

When developing the term Affective Mathematical Journey I use the word 'Affective' to link motivation to emotional and cognitive changes in individuals through learning. This reflects Hannula's (2012) proposition that the research Domain of Affect comprises of three aspects: cognitive, motivational and emotional (p. 143). I prefer this to McLeod's classical (1994) 'umbrella' Domain of Affect which he defines as a mixture of beliefs, attitudes and emotions, because I see the notion of attitude as problematic, as discussed in section 6.2.1 (on page 85). My analysis also concentrates on the relationship between motivation and emotions to learning mathematics and so relates better to Hannula's proposition.

When considering possible changes in affect McLeod (1994) argued beliefs are more stable than emotions but Hannula (2012) argues that there has been too much focus on research into 'relatively stable' affective traits in relation to learning mathematics, for example 'maths anxiety' (Tobias, 1978), and more needs to be undertaken into 'rapidly changing affective states' (p.143). I would not argue that my research shows 'rapidly' changing states, but it certainly indicates changes in people's feelings about themselves and mathematics, overcoming sometimes long-held, deeply embedded and strong negative feelings.

I use the term Affective Mathematical Journey to indicate a change in affect and build on Debellis and Goldin's (2006) idea of 'affective learning pathways', where learners

experience changes in emotions when undergoing mathematical problem-solving in classrooms, (discussed in detail in section 6.2.3, on page 91). But my data comprises reflections from adults indicating changing emotions over a longer period of time, sometimes over several classes, sometimes over several years. Consequently I argue against the terminology of 'fixed' traits (Dweck, 1996) or 'mind-sets' (Boaler, 2016) which I think are less helpful and instead prefer to explore the possibility of changing adults' emotions and beliefs in their abilities in mathematics. As a practicing teacher trainer I chose to focus on the possibilities of developing 'the gift of confidence' (John-Steiner and Mahn, 1996) through particular social experiences, enabling what Illeris (2014) terms 'transformative learning' through mathematics.

I also use the word Journey because the changes are remembered and often experienced over a period of time. I use this term because like most journeys they involve encounters with a variety of people and experiences. As Ross *et al.*,(2011) suggest 'Learning journeys start from different points and social locations' but for many of the people learning through trade unions their journeys had 'stalled'. However, Ross *et al.* argue 'learning inspires a journey' which could be motivated by 'instrumental factors' like improved job prospects but they posit many adults found the learning 'transformational' and valued the experiences as such (p.26).

I obviously include Mathematics in the phrase AMJ because I am focusing on changes in feelings, emotions and confidence in relation to learning mathematical topics. From my professional perspective this is important for the practice of teaching adults, as it shows even adults with long held negative feelings about mathematics can be motivated to re-engage with the subject and change their feelings towards the subject. Learning mathematics can increase adult's self-confidence not only to learn more mathematics but also to use the mathematics in different social contexts. As one 50 year- old man explained learning mathematics increased his belief in himself

> "…I am not just a bloke at the end of a machine … I can do mathematics. I have proved to myself I can do it …"

Learning mathematics has enabled him to see himself differently, not to just part of a machine, to me this indicates a change in his identity.

8.2.1 Jean's Affective Mathematical Journey

Using a grounded theory approach to research is often criticised for breaking up people's stories into small pieces of data (Bryman, 2012) so I now discuss an example of an AMJ in a more holistic way. This is one of many stories in my research that I understand as AMJs but I chose this example because the interviewee uses words and phrases that provided a rich source of data to help me to further describe and analyse the notion.

I gave this interviewee the pseudonym Jean. Through the analysis of her words I discuss how she described her feelings about mathematics becoming more positive. This happens though her experiencing different ways of learning and with the support from the wider social face-to- face groups she encounters, including her trade union colleagues and her family. Jean's AMJ links changes in her feelings towards mathematics to her 'different' learning experiences in trade union classes. She reports what I understand as a greater belief in her own abilities when she describes her confidence and motivation to learn mathematics increasing, influencing her role as a mother and a ULR.

8.2.1.1 Changing feelings and emotions towards mathematics

At the time of the interview Jean was 46 years old. She states she decided to start learning mathematics at work because her job as a Union Learning Representative involved her encouraging other members to upgrade their skills, so she thought she should 'practice what you preach'.

However, she had to confront negative feelings about learning mathematics, as well as the conceptual challenges involved, because she declared she is "severely dyslexic, so the maths was daunting and I really did struggle". She talks about her early experiences at school

"I am 46 years of age, so when I was at school dyslexia was not [recognised] … so I was a 'thicko', a troublemaker. I didn't want to do anything and I was labelled at school. I did have a really bad experience. So even when I left [school] I thought [I would] never learn anything again, it was a non-starter. I had parked that and I did not want to go back to it again".

Her negative experiences left her with little belief in her abilities and lacking in motivation to learn mathematics, which reflects research findings by Covington (1984), Dweck(1996) and Boaler (2000) on the influence that past experiences of learning have on self belief. She continues to describe her struggles and frustrations and resulting lack of motivation when she reflects on trying to understand mathematics at school.

"I remember at the maths classes at school and it was the board rubber [thrown at] at the back [of the class] all the time. Some people can look and just see the equation, whereas I never saw it. I got quite frustrated and the support was not there so the easiest thing was to sit back and not do it".

At this point Jean might be expected to exemplify Dweck's (2008) notion of a 'fixed' trait developed through early learning experiences, especially when she describes herself as deciding to 'park' the learning and 'sit back and not do it'. However, far from being fixed Jean goes on to describe how and why her feelings and motivation to learn mathematics changes, using a variety of very emotional words. It is through this use of emotional language that I infer the importance of emotions in relation to motivation to learn mathematics as well as the significance of emotions to the concept of an AMJ.

She speaks about mathematics being her "stumbling block" so

"Achieving Level One (A Numeracy Qualification) made me realise I can achieve an awful lot more…it's like your worst fear…if you overcome it then everything else is a lot less daunting…maths is the 'black hole' to me".

Her use of the words "stumbling block", "worst fear" and "black hole" to describe her feelings indicates strong negative emotions towards mathematics, yet she reports how "achieving level one" qualification helps her to overcome her fears. I understand this as Jean linking her achievement in her mathematics qualification to her increased belief in herself and her abilities, especially when she says now "everything is a lot less daunting". McLeod (1994) and Zan *et al*. (2006) also found research that indicates a positive correlation between confidence and achievement when researching motivation to learn mathematics, although there is still debate about which comes first, confidence or successful learning.

For Jean it is the learning experience that changes her feelings and she describes becoming "more passionate" about mathematics and now even enjoys encouraging others to learn mathematics. These changes in feelings and motivation reflect my earlier findings where successful learning experiences enabled adults to develop their identities in relation to learning and using mathematics, as discussed in section 7.1.2.3 (on page 110).

8.2.1.2 The supportive learning environment and the wider social network

It is interesting to explore Jean's explanations of her previous "difficult" experiences and those she encounters when learning as an adult. This is important, as it is the difference in learning experiences that helps facilitate what I term her AMJ.

When asked what the 'difference' was she explains how she was initially "egged on by her [TU] colleagues" to improve her maths skills and to re-engage with learning. She reports being able to overcome her negative memories when she feels more "relaxed" and "supported" by her colleagues.

She says "the difference is you are doing it with people you trust, because they work with them, they are colleagues and friends". This notion of trust in her social group of learners is key to her motivation to learn because she feels able to openly admit she had not "grasped" a mathematical concept and the tutor and the rest of the group will try a variety of different strategies to help her learning. Jean explains

"If I am struggling, the rest [of the group] would help. You never felt you were holding someone back because you didn't grasp something. The group never moved on until everyone had grasped what they should be doing. The environment and the people you were learning with made the maths a lot easier".

Jean links the support of the social group to the idea of maths becoming "easier", indicating a cognitive influence. Mathematics educators and researchers such as Lerman (2000), Boaler (2000), Winbourne (2008), and Swan (2012) promote more collaborative approaches to learning, arguing that encouraging discussions between peers in mathematics groups helps learners develop a shared conceptual understanding of topics and possible solutions.

Jean's description of learning in the trade union classes could also be termed what Schorr and Goldin (2008) call 'an emotionally safe environment' where colleagues support each other to learn and do not experience 'humiliation' if they are open about their misconceptions.

Jean also argues it is important for adults to feel comfortable in the learning environment, or physical space, when she argues they need to be

"…in their comfort zone. In their workplace they are comfortable. I find a lot of adult learners the first time they are taken into a college it's like walking over that threshold; it's a massive step for them to go back into that environment".

She connects the idea of a "relaxed" environment to the physical learning space because it does not have the feeling of a traditional classroom when she suggests the learning space is

"not as 'academic' in respect of tables and chairs all facing the front. We were all sat around table, the tutor mingled with everyone. It was a relaxed environment".

So, Jean ascribes successful learning to a "relaxed" environment promoted by a supportive learning group in the comfort of a non- traditional learning space. The difference between her previous experiences and the learning approach promoted by trade unions appears to be the key to Jean's ability to undergo her AMJ and reflect my findings discussed in section 7.2 (on page 112) when interviewees described how they preferred to learn mathematics.

Jean also relates her change in emotions and feelings of confidence to other social face-to -face groups when she talks about the influence of her family and her trade union colleagues. She describes the significance of receiving an award as a tutor for her trade union, Unite. She describes acting as a role model to her children who also have dyslexia, when she explains it as:

> " The biggest thing for me was [when] I actually did my teaching qualification [4]and at the end got my cap and gown. That was massive for [my children] … To actually watch mum crying every weekend and achieving that at the end … maths was part of that … so it's been a good journey … so far".[5]

This reflects one aspect of Bandura's (2004) notion of 'social cognitive theory' where he argues self-efficacy or self-belief is developed in social situations, for example, when 'seeing people similar to oneself succeed by perseverant effort raises observer's beliefs in their own abilities' (p. 79).

Jean also speaks about how learning through the context of the trade union influencing her motivation. She describes how her trade union colleagues initially suggest she becomes a ULR and negotiate with her company to release her from work to enable her to go on the courses. This motivates her initial interest in learning because

> "That was a challenge, but once it [the learning] got hold of me that was it. The learning took off. I did course after course, as I said I had never had so many qualifications…and if it hadn't been for the union I would never have done it".'

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[4]I am not sure when she achieved this qualification as it is now a requirement to have level 2 mathematics in order to achieve a teaching diploma.

[5]I am not sure when Jean achieved this qualification as it is now a requirement to have level 2 mathematics in order to achieve a PGCE

Clearly the family and trade union colleagues also play an important role in Jean's affective mathematical journey. Again this reflects the findings discussed in earlier sections in relation to motivations to learn mathematics in relation to both trade unions, discussed in section 7.1.1.1.2 (on page 99) and in section 7.3.1.2 (on page 126) and families discussed in section 7.1.1.3 (on page 102).

8.2.1.3 Developing confidence in relation to mathematics
Like many other interviewees Jean also uses the word confidence to indicate a change in her feelings and motivations. She talks about having "confidence" (or trust) in her colleagues, her husband and her tutor because she knows they will support her as they share her goal "to get me through the level two".

She also uses the word "confidence" to indicate changes in her own feelings in her abilities in mathematics. As she explains

> "After passing the L1 maths, which was a massive stumbling block for me as an individual, [I feel] a lot more confident because [mathematics] was my weakest area in any of my learning. My goal is now to achieve Level 2".

This single statement exemplifies an AMJ. Jean describes feeling more positive about her "weakest area" and becoming "more confident" in herself and her mathematical abilities after achieving a qualification. Successful learning, recognised through the achievement of a qualification in her "weakest area", helps motivate her to continue learning to "achieve level 2".

Barbalet (1996) argues 'confidence, trust and loyalty' are the 'three basic social emotions 'that builds 'the social processes of agency, cooperation and organization' (ibid, p. 75). Jean's AMJ certainly links motivation to her increased confidence, developed by working with trusted colleagues and supported through trade union classes and by her family as do many others discussed in section 8.1.3 (on page 137).

In fact to emphasise the usefulness of the notion of changes in confidence to the idea of an AMJ I include another short example of 35 year-old mother of two young children who used

the word 'confidence' seven times during her interview to describe how her feelings about mathematics and her motivation to learn has changed during her life.

She spoke about changes in her feelings in relation to her confidence levels decreasing after early learning experiences at school because she reported being put in the wrong set, but her confidence increased after successfully learning mathematics through trade union classes. She talked about how she now felt more confident when teaching her own children and when dealing with her personal finances, including her mortgage. She said simply "I did my numeracy and it built up my confidence". In fact she now planned to embark on a PTLLS [6] course to train as a mathematics teacher. I understand her changes in feelings and confidence as indications of her AMJ.

Concluding remarks on an Affective Mathematical Journey (AMJ)
When adults in this research report overcoming sometimes long-held negative memories to re-engage in learning mathematics and describe feeling more positive, or confident, after successful learning experiences, I wanted to recognise this change in their feelings and motivation, so I developed the term Affective Mathematical Journey (AMJ).

The significant change in feelings towards mathematics bought about through 'transformative learning' Illeris (2014) argues develops 'a qualitatively new structure or capacity' (p.39) within learners indicating a change in their identity, which in my research results indicate adults becoming motivated to learn and use mathematics differently.

I used Jean's story to exemplify an AMJ, and to try to make a 'holistic' description of the findings discussed in chapter 7 and in the early part of chapter 8. She started describing her relationship with mathematics when she experienced "failure" at school and developed negative feelings about mathematics. Her feelings towards mathematics and her motivation to learn began to change when she experienced support and encouragement from her colleagues at work to re-engage with mathematics as part of her developing her

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[6](Preparing to Teach in the Lifelong Learning Sector, an initial teacher training qualification, studied at QCF Level 3 or 4)

role as a Union Learning Representative. The trade union organised classes provided her with a "different" learning experience; in a supportive environment with people she trusted which motivated her to "struggle" and achieve a mathematics qualification. The qualification was not at a high level but it was the first she had ever achieved and so her feelings (emotions) about mathematics began to change and with it her belief in her own abilities and her motivation to encourage others to learn.

The important role of the social face-to-face group in her affective journey is a significant piece of learning for mathematics practitioners who work with adults. The importance of the teacher in ensuring the classroom learning experience that was "different" from previous mathematics classes cannot be underestimated. Nevertheless the support of Jean's fellow learners and trade union colleagues was also important, as well as her being motivated to learn to act as a role model for her own children. So as well as the learning environment being supportive it is also important to recognise the influence of the wider social face-to-face social group on motivating and supporting learning that 'inspires' a journey.

Jean was just one example of an adult who had changed her feelings towards mathematics and increased her confidence after successful learning, as I indicated by linking her story back to previous findings. However, one 49 year-old man described it more succinctly when he said "I learnt to do percentages and [now I] sort of sit up a bit straighter".

Concluding remarks on emotions, confidence, motivation and an AMJ
While the notion of an Affective Mathematical Journey (AMJ) is secondary to the research aim of exploring motivation, it nevertheless reinforces the importance of emotions in relation to motivation to learn mathematics. It further emphasises the importance of bearing in mind the emotional connection to motivation and cognitive development when considering professional practice and possibility of influencing a learner's motivation.

Chapter 9 Conclusions

In this concluding chapter I discuss my research questions in the context of previously articulated theory and methods of analysis of my data to conceptualise my findings. Following this I discuss how my work makes a unique and valid contribution to knowledge in the field of mathematics education. I finish by discussing a critique of my work and considering its limitations and then offer suggestions for further research that could usefully follow these findings.

In my study I investigated factors affecting adults' motivation to learn mathematics in the workplace. I used an inductive approach to analyse qualitative data, employing grounded theory to enable me to generate concepts that I then developed into five categories to address my research questions and conceptualise motivation as it related to social contexts and the domain of affect. The adults in my sample were a hard to reach group of active trade unionists who are learning mathematics up to GCSE level, while in work, through opportunities funded and negotiated by trade unions and employers. This means they may have unique perspectives to offer and any inferences I make are *moderatum* generalisations (Williams, 2000) in that they are moderate in scope, open to change and may be tested by further research.

9.1 Addressing the research questions
Question one: What motivates adults to learn maths at work?

My analysis shows that the adults in my sample indicated that their initial motivation was:

- related to individual needs and goals such as: improving job security, filling a perceived personal knowledge or skills gap, helping their children and or gaining public recognition of their knowledge or skills through certification.

- supported and encouraged by significant social face-to-face groups such as work colleagues, Union Learning Representatives (ULRs), fellow members, other learners and family members.

- enabled in the wider social context by opportunities to learn, funded and negotiated by trade unions and employers.

My evidence also suggests that motivation to continue learning points to the significance of:

- on-going support provided by a wide range of social face-to-face groups including teachers, fellow learners, family members and close work colleagues but also:

- experiencing different ways of learning to those previously undertaken.

However my data analysis also shows that adults in my sample who achieve in a subject that has high social value such as mathematics, develop positive feelings towards the subject that can have an influence on their identities. The effect can result in them being motivated to act more confidently outside as well as inside the classroom, for example:

- when negotiating on behalf of fellow trade union members.
- with their finances, enabling them to better support their families.
- becoming teachers of mathematics.
- supporting the integration of newly arrived children into the UK education system.

My analysis has enabled me to understand motivation as far more complex than I first thought and the process of grounded theory has helped me to explore this in relation to different stages of learning, as well as its relationship with emotions and cognition in the domain of affect.

Question 2: How do adults prefer to learn maths at work?

My research and subsequent analysis indicates that the participants were motivated to continue to learn by the support of their fellow learners. They talked about the importance of experiencing different ways of learning to those previously experienced.

They perceived the learning to be:

- more collaborative than previously experienced.
- in smaller classes.
- in a relaxed atmosphere.
- where they felt they could talk openly about mathematics and their problems , and …
- more relevant, in the sense that mathematical topics (where possible) related to practical applications (such as building shed or tiling rooms) or everyday life (such as interest rates on loans) or linked to trade union issues (such as Health and Safety in the workplace).

I had not originally considered fellow learners as motivators, focusing more on individual motivation to re-engage with learning and this was a finding that arose from the adults' responses. However, my original belief that the adults preferred the mathematics topics to be relevant to their life experiences was confirmed.

Question 3: Is there any relationship between learning maths at work and trade union membership?

The answer to this is positive on many levels. Adults were enabled to learn mathematics through the trade union allocating resources for this purpose: by officers negotiating on-site opportunities with employers, providing the teachers and equipment needed to support the learning and through funding ULRs, who encouraged and helped to initially motivate fellow

union members to start learning again. Members were also supported and motivated to learn mathematics by fellow affiliates in the classes. After experiencing encouragement from trusted fellow members and a supportive 'collective' learning environment adults reported feeling differently towards the trade union body and in some cases were motivated to be more active on behalf of fellow members.

9.1.1 Secondary finding

A finding that emerged from my data analysis, initially not anticipated, was the important role that emotions play in influencing motivation and how adults use the word 'confidence' to describe changes in their 'feelings' and 'beliefs' about their abilities in relation to a motivation to learn mathematics. This is an important finding as it relates to all of the research questions in that emotions can be seen to either support or hinder motivation.

This relationship grew in importance, as I considered how adults spoke about their increased confidence to act differently (described above) and when they used emotional language in response to questions about their motivation to learn mathematics, for example:

- Some adults had negative memories relating to previous mathematics learning experiences.
- Most (18 out of 20 respondents) spoke positively about mathematics during the interviews.
- 12 out of 20 used the word *'confidence'* in relation to their motivation and intentions to act differently in the future.

This suggested to me that emotions are an important factor in motivation and as a consequence I developed the idea of adults experiencing an Affective Mathematical Journey (AMJ), a term I use to describe significant changes in feelings in relation to mathematics linked to a motivation to learn. The changes can happen over a period of time, in some cases years, and may be developed through different learning experiences.

9.2 Making a contribution to knowledge.

In this section I give an overview of my contribution to research knowledge and in the next section 9.3 I conceptualise the ideas in relation to current research.

1. Research into adults' motivation to learn mathematics is limited. This was especially true of research into hard-to-reach groups of adults who take the opportunity of a second chance to learn the subject in the workplace. My research contributes significantly to this body of knowledge because it is conducted with members of trade unions, who are learning mathematics to gain a formal qualification but in a non-traditional setting using informal pedagogical teaching approaches to learning. This work breaks new ground in a context previously under-researched in relation to mathematics education.

2. My research explores adults' motivation to learn mathematics but finds a difference between factors that influence initial engagement and continuing learning. Factors influencing initial engagement are strongly influenced by a range of social, economic and cultural factors, discussed in section 9.3.1.1, whereas motivation to continue accruing knowledge is also influenced by the learning experience, which can have a significant effect on a learners identity, which I discuss in sections 9.3.1.2. and 9.3.1.3. I believe my research adds to new ways of thinking about motivating adults to learn mathematics.

3. Motivation related to continue learning mathematics is linked to having positive social and emotional encounters in the classroom whilst experiencing a pedagogy that is 'different' from that previously undergone, which I discuss in section 9.3.1.3. I believe these findings to be important for teachers of adults in *any* context.

4. My research also offers a new focus on the importance of building adult learners' confidence in mathematics. The exposure to 'different' learning experiences that lead to achievement can, for some adults, be 'transformational learning' (Illeris, 2014) which generates changes in the learner's identity, discussed in section 9.3.2. The significance of confidence in relation to motivation is reinforced by an adult's use of emotional language when reporting changes in feelings towards mathematics.

5. There is also limited research into the emotional influences that are present when adults learn mathematics. My research contributes new thinking into how emotions influence adult's motivation before, during and after learning experiences, as discussed in section 9.3.3. My research indicates that even long-held negative feelings towards mathematics can become positive and influence motivation. I call this experience an adult learner's Affective Mathematical Journey.

6. This research also increases our understanding of the positive contribution made to teaching and learning through trade union sponsored activity. Most of these adults had been previously unsuccessful in learning mathematics through traditional educational routes, so their ability to succeed in trade union sponsored classes provides us in mainstream education with some valuable lessons.

9.3 Conceptualising my analysis in relation to the wider research context

Throughout this process of research, I read ideas from a wide range of theoretical perspectives, from individual-focused psychology to collective-minded socio-culturalism. To help me analyse my findings from these different perspectives I decided to use a model that allowed me to look at data on three research levels: individual, social face-to-face group and societal, similar to approaches used by FitzSimmons and Godden (2000) and Schoen (2011), discussed in chapter four. I recognise my analysis is only one possible conceptualisation, or worldview, but using this process enabled me to understand an individual's motivation, emotions and cognition, as both a product and a shaper of the

social context, which itself is a product and shaper of the wider society.

I used this 3-level analysis building on Op't Eynde, De Corte and Vershaffel's (2006) argument that motivation is based on an individual's needs and goals but developed through a dynamic interplay between cognitive and affective processes, acting within a social context. However I conceptualised the individual level differently, preferring the domain of affect to include motivation, emotions and cognition, as described by Hannula(2012). This enables me to reflect on how motivation, emotions and cognition influence each other in the development of the individual, determined by local social face-to-face groups shaped by the wider socio-historic context.

For me the wider context is important in my research as the adults in my cohort have the opportunity to learn, through local groups in the workplace, as a direct result of their trade union membership. This membership is significant in that it funds local ULRs, who encourage individuals to re-engage with learning and allows for the negotiation of time for individuals to learn (Ross *et al.*, 2011).The trade unions also provide classes that promote collaborative approaches to learning (Rees, 2007).

9.3.1 Motivation

My analysis suggests motivation can be characterised in two stages: Firstly initial motivation to engage with learning and secondly motivation to continuing learning linked to changes in an individual's identity developed through the learning experience.

Dornyei and Ushioda (2011) suggested initial motivation has a 'pre-actional' phase, which in my research could be related to the personal goals or needs of the learners, such as securing employment. However, in my research I understood motivation to continue learning as being linked to changes in an individual's identity. Once the adults started experiencing success in their learning they spoke about seeing a change in themselves

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and described how they planned to act differently in the future in a range of social contexts, which suggested a change in their identity. This single phase includes both the 'actional' and a post-actional phase of learning, suggested by Dornyei and Ushioda.

Ryan and Deci (2000) suggest changes in motivation can happen through a process of 'internalisation' changing from extrinsic to intrinsic motivation (discussed in chapter six). However my understanding is that motivation to continue learning can be intrinsic and extrinsic at the same time; for example, it can be about improving personal mathematical skills that enable an individual to gain a qualification that can help secure employment.

During the motivational phase that encouraged continuing learning adults also reported feeling more confident about themselves and more positive about learning mathematics, which related to the idea of identity development at a 'profound' level. What Lerman (2009) might call developing a mathematical identity resulting from what Illeris (2014) terms 'transformative' learning experiences, discussed later in the next section 9.3.2. The conjecture is that feelings towards mathematics can change and effect an individual's motivation and this concept contributed to my idea of an adult experiencing an Affective Learning Journey (AMJ), where their beliefs, motivation and feelings about mathematics can change. This was discussed in chapter eight.

9.3.1.1 Initial motivation to learn

My analysis indicates adults' initial motivation to learn mathematics relates to personal goals such as adding to their skills set, securing employment, gaining qualifications for a longer-term benefit or to help the family. Research by Coben *et al.*(2007), Ross *et al.* (2011) and Swain *et al.*(2005) reinforces these findings and also suggests motivation can be 'varied and intricate'. However Swain *et al.* (2005) argue, as I discussed in chapter three, that 'utilitarian' reasons to obtain a qualification such as furthering their career or

coping better 'with the mathematics they come across in their lives outside the classroom' were 'usually comparatively minor incentives to attend classes' (ibid, p.44). On the contrary my research indicates securing jobs or safeguarding family finances are important motivators for my participants to both attend and persevere with mathematics classes. While Swain *et al.* (2005) do recognize the importance of education in relation to social mobility (p. 31) they fail to link this notion to financial security. In the context of my research into trade union members' in relatively low-paid jobs and their motivation to learn while in work, I see this as an omission. Obviously my work was undertaken post -2008, after the collapse of world economic activity that became known as the 'Great Economic Recession'[7] so financial and economic security was on the minds of most people during such a period of uncertainty and vulnerability. But I argue that given the current continuing uncertainty in the world economic situation, financial security acts as a strong motivator to do many things, not just learn mathematics.

9.3.1.2 Initial and continuing motivation to learn.

My data also shows that helping children with their skills development is an important motivator for adults, particularly females, findings supported by research by Desforges and Abouchaar (2003), Swain *et al*., (2005) and Coben *et al*.,(2007).

However my findings also show that children are important in that they act as both an initial motivational force and a reason to persevere with learning mathematics because it was conceived as a positive contributor to a better functioning family in both economic and social terms. For those adults who are newly arrived in the UK, with English as their second language, children can also contribute to supporting integration into the wider 'home' society.

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[7]Strauss-Kahn (2009), "Crisis Management and Policy Coordination: Do We Need a New Global Framework?" Speech given at the Oesterreichische Nationalbank. Cited in

Arpaia and Curci, 2010, EU labour market behaviour durng the Great Recession, European Commission, available at http://www.imf.org/external/np/speeches/2009/051509.htm accessed on 26 August 2016

My research goes further and shows that receiving support from a wide range of social face-to-face groups is important to an adult's motivation. Initially adults in my research are motivated to learn mathematics by fellow trade union members, such as ULRs and potential fellow learners (Ross, *et al.*, 2011) as well as family members. These people are important, especially if potential learners have had poor previous learning experiences, as they must trust these people to support them if they experience more difficulties in the process. This builds on research by Barbalet (1996), who argued that emotions such as trust are important in motivation, a theme I return to later in section 9.3.2.

9.3.1.3 Motivation to continue learning related to pedagogical approaches used in the learning group

The notion of a different type of motivation developing when adults start having successful mathematical learning experiences relates to a more fundamental change in how learners see themselves or their identities as discussed above. In my research adults' motivation to continue learning was also directly related to the on-going social support received from wider social networks as well as from the new teaching and learning group.

My findings in chapter seven indicate adult's motivation to learn mathematical concepts is linked to the use of particular pedagogical approaches, when they are able to discuss ideas with each other, in a relaxed manner, in an 'emotionally safe environment' (Schorr and Goldin, 2008). In the data adults reported their new learning experiences as 'different' and 'easier' than previous ones. The pedagogical approach promoted by trade unions and described by adults in the sample was more relaxed, more social and supportive; closer to notions of informal or non-formal (Coben *et al.*, 2007; Evans *et al.,* 2013) ways of learning. The practice included using collaborative approaches to problem solving in the classroom, building on the learner's previous and current experiences in life and work (Rees, 2007). Mathematics educators and researchers also promote this approach and argue that encouraging discussions between peers in mathematics classes helps learners develop a shared conceptual understanding of topics and possible solutions (Lerman, 2000; Boaler, 2000; Winbourne, 2008; Swan, 2012).

However it was also important for adults to find 'relatedness' (Ryan and Deci, 2000) or relevance to the mathematical topics being taught, and it helped if they were able to relate them to practical situations or problems found in everyday life. Swain argued against concentrating on 'everydayness' such as reading gas bills when teaching mathematical topics, but I found adults needed to make connections between mathematics and their own life experiences. The importance of discussion and making the mathematics relevant to life experiences links to notions of 'social and cultural belonging' (Deci and Ryan, 2000) or what Coben, *et al. (*2007) argue 'help with everyday things outside the classroom' (discussed in chapter six).

9.3.2 Developing confidence and identity through transformational learning

My research shows that successful learning experiences, especially after previous 'failures', lead to changes in how adults see themselves. The experience of achieving a qualification, which has wide social recognition as an indicator of intelligence, can increase their reported self-confidence, which can influence their motivations to continue learning and transform their intentions to act in a range of social situations.

Research into achievement in mathematics reinforces the idea of a positive correlation with self-confidence, or self-concept, and motivation (McLeod,1994; Zan *et al*. 2006). But I agree with Hannula (2012) when he argues that this correlation is likely to indicate a reciprocal influence because my data suggests that achievement increases self-confidence.

Confidence emerged as important in my research because (as discussed in chapter eight) adults used this word to respond to questions about their motivation to learn mathematics in the workplace. But the significance of confidence in relation to motivation was reinforced

by the adults' use of emotional language when reporting changes in their feelings towards mathematics.

Although theoretically confidence is a problematic concept when used to judge others, in my research I understand that adults use the term to describe their own beliefs and feelings about themselves, in a way that Barbalet (1996) suggests it as an 'emotion of self-projection' (p. 77).

McLeod (1994) argues confidence is mainly cognitive but while it has cognitive aspects I also see it in relation to motivation as Barbalet (1996) argues it 'is an emotion associated with a willingness to act' (p. 77). Mahn and John-Steiner (2002)maintain it also has a strong social dimension that can be developed through social activities. So I interpret the use of the word confidence by adults, as indicating links between motivation, emotions and action.

Hence I understood confidence, when used by the adults in my research, as a term that influences their motivation. I describe it as a change in feelings (or emotions) that effects an individual's belief in her or himself (cognitive), which then encourages motivation to act differently. I believe this adds a new way of thinking about confidence as a way of expressing adults' personal motivation linked to positive emotions about a belief in their mathematical abilities.

Increased confidence, in my research, is developed through 'transformative learning' (Illeris, 2014) experienced in trade union organised classes, after having previously 'failed' to learn in traditional education settings. The adults develop new mathematical identities (Lerman, 2009) through their social experience of learning in face-to face trade union learning groups, increasing their motivation and confidence to learn mathematics as well as act in different ways.

Hannula (2102) may question the usefulness of researching varying intensities of emotions when researching affect, but in my research I see intense feelings indicated through the emotional language used by adults, when describing their learning experiences, bought about through what Goldin *et al.*, (2011) describe as an 'arduous' learning journey (p. 551), which I discuss in chapter eight.

Indeed the way the trade unionists describe their increased confidence, I understand as a form of empowerment. The 'transformative learning' (Illeris, 2014) and the 'arduous learning journey' (Goldin *et al.*, 2011) enables adults to develop confidence in themselves which motivates them to act in significantly different ways, for example to become trade union negotiators, teachers of mathematics, financially more capable or by helping recently arrived children to integrate into the UK education system.

9.3.3 Affective Learning Journeys

Using a grounded theory approach in my analysis enabled me to recognise and further explore the role of confidence as a way of expressing changes in emotions that influence motivation and cognition. But adults in my research can experience those changes over a long period of time and often in different contexts. I use a new term, an Affective Mathematical Journey (AMJ) to describe these changes in emotions and motivation that adults can experience towards mathematics over many years.

Debbelis and Goldin (2006) also suggested learners can experience a range of emotions but they see them happening over a shorter period of time, when undertaking problem solving in mathematics classrooms. They call the changes 'learning pathways', which they understand as highly context-dependent. My idea of AMJs relates to changes in emotions happening over a longer period of time and changes that are influenced by personal memories and significant others in face-to-face social groups within many different contexts.

While I agree with McLeod(1994) that emotions are less cognitive than beliefs, he argues they are also less stable but I think emotions vary in 'duration' and as already suggested previous experiences, especially if they were unpleasant, may also be remembered or 'experienced' (Hannula, 2012) over many years. Indeed Hannula (2012) argues that emotions control motivation, but I understand them as an influencing force rather than a controlling one

9.4 Critiquing of the research
I now critique my data considering the uniqueness of sample collection, the research approach taken and possible limitations to the generalizability of the findings.

One critique of this research could be the characteristics of this group of adults learning, in work, but through the auspices of trade unions, may limit the generalizability of the findings. But I argue the uniqueness of the sample adds to a wider understanding of possible successful learning approaches that can be used with other adults.

The adults were learning in a specific cultural context as members of trade unions that mainly represent people working in non-professional trades. The members subscribe to particular values and viewpoints and are learning through the auspices of their trade unions; hence the findings may be critiqued as representing a biased perspective. However I would argue that the adults in my sample have been able to overcome learning barriers, motivated by fellow members. Indeed trade union membership and associated collective learning activities reported in the data make a significant contribution to the adults' success in learning mathematics and I believe they have a valid perspective that teachers of adults in mainstream education may find useful to consider.

Another critique might be the limited size of sample, however having to rely on trade union goodwill and volunteers to find people for me to interview made the task of recruiting larger numbers of participants particularly challenging. They had to identify adults who fitted into my specific criteria: learning mathematics below GCSE level, who are already limited in number, and then convince those learners to be interviewed by me (a mathematics teacher). It required me to reassure the adults of my intentions to give a realistic interpretation of the situation, to negotiate agreements with trade union officials and to travel to various parts of the country to interview often very small samples. Nevertheless I believe the sample to be credible as I was able to carry out in-depth interviews with twenty adults and used respondent validation wherever possible to ensure my findings 'resonated' and had credibility with them as trade union learners.

Because the interviewees were difficult to reach I had to negotiate my way through several layers of 'gatekeepers' to access them, not all of who responded to my requests. This process is explained in chapter five but it did mean that during the identification and recruitment phase I relied upon trade union officers and ULRs to identify people for me to interview and it is likely that they may have engaged in *impression management* (Atkinson, 1986, p. 66), hoping, quite naturally, to give a good impression of the work they did and the results they achieved. Reliance on 'gatekeepers' is a common challenge when accessing hard-to-reach groups, however I would argue that regional officers and ULRs in my research were more interested in guiding me to learners who had successfully achieved their qualifications through the trade unions. Thus I understood them to be more interested in giving the impression of successful learning, whereas I was focused on the relationships between motivation, pedagogy and emotions. However the fact remains that the selection of interviewees was 'controlled' by 'gatekeepers', so some form of impression management was likely.

I also used grounded theory, which is criticised for not really producing theory, but using a 'rigorous approach to the generation of concepts' without a theory to explain the concepts

(Bryman, 2012, p. 574). Charmaz takes on this criticism discussing the different conceptions of theory but in the end argues 'theoretical treatment is analytic and abstract' (2006, p. 133). I admit that the writing up of the grounded theory process and findings has not been easy but my supervisors and I have devoted much time to ensuring my explanation of the process does not distract from addressing my research questions but, indeed, helps to clarify the development of the ideas put forward.

Grounded theory is also critiqued for the variety of descriptions of data collection processes recommended by researchers(Bryman, 2012). I have been guided by my understanding of processes recommended by Charmaz(2006), Corbin and Strauss (2008) and Flick (2002) utilising the language and building on the approaches they recommend to analyse and develop my own findings.

The research also uses qualitative data and so my findings are interpretivist and my analysis may be critiqued for being biased by my own personal political history and values. However my openness about my own history, as a trade union activist, politician and mathematics teacher committed to vocational education, ensures the reader is aware of my perspective in this work. Indeed Corbin and Strauss (2008) argue that being close to the data allows for 'sensitivity' to 'relevant issues', 'events' and 'happenings' in the data. I agree with Dowling (2010), who suggests my findings are 'representations' created by my interviews with trade unionists learning mathematics at work, overlaid with my own interpretations based on my experiences.

9.5 A limited claim to generalisability

Using a grounded theory approach to data collection and analysis I sought to develop a theory about the motivation of a particular group of adults. Through the analysis of my data, informed by my literature research, I have produced a framework of concepts and categories that may be high in validity, but low in reliability (as discussed in chapter four),

because of this I make limited claims about any transferability or generalisability of findings and claim my findings are *moderatum* generalisations(Williams, 2000). That is they are moderate in scope, open to change and 'testable propositions that might be confirmed or refuted through further evidence' (also discussed in chapter four).

9.6 An agenda for further research

Through the planning, organisation and undertaking of this research I was able to answer each of my three research questions. My findings indicate that adults' initial motivation to re-engage with learning mathematics can be understood differently from their motivation to continue learning and it would be useful for practitioners in education to carry out further research to test this hypothesis.

My findings also indicated that trade union membership is very influential with this group of learners, as it offers adults both opportunities and support to learn mathematics in the workplace, which adult learners certainly value. It also shows a positive relationship between the development of personal mathematics skills and a willingness to become more active on the part of the union. I believe it would be useful for trade union organisations to undertake further research into the relationship between the development of members' personal skills and increased confidence in relation to empowerment and trade activism.

The importance of having a 'different' experience that enables learners to develop confidence in their abilities is essential, especially when that previous experience was unsuccessful. Interviewees in this research expressed preferences for collaborative learning approaches, but these may relate more to them holding values and beliefs that accord with those held more widely in trade unions. Further research into what adults report as 'different' learning approaches that lead to increased confidence would be useful to consider for professional practice with adult groups.

Following on from the above point, the strong relationship between emotions and motivation would also be useful to explore for professional practice. The importance of developing confidence with mathematics using 'different teaching approaches' that develop in an 'emotionally safe environment' (Schorr and Goldin, 2008) would be very useful. This is particularly so for teachers in Further Education in the UK who have to teach 16-19 year olds, as well as older learners, who have already failed to learn GCSE mathematics at least once. The possibility of identifying an approach to teaching, which helped the learner's to experience an Affective Mathematical Journey (AMJ), which results in them feeling more positive towards mathematics, more confident and motivated to learn, would be very useful.

I firmly believe this research has focused on a special group of learners that gives us a real insight into ways that adults' motivation and confidence to learn mathematics can be developed. It foregrounds the important role that social face-to-face groups play in supporting learning as well as the influence of a wider social context, in this case trade union membership. It also highlights the important role personal emotions play in a motivation to learn, especially with adults who have previously had unsuccessful experiences.

52887 words

Appendices

Appendix 4. 2. a- Letter giving ethical approval to my research

London South Bank
University

Direct line: 020-7815 6024
E-mail: dippenas@lsbu.ac.uk
Ref: UREC 1204

Beth Kelly
10 Park Meadow
Old Hatfield
Hertfordshire
AL9 5HA

Dear Beth,

Learning maths at work: why and how?

Thank you for submitting this proposal and for your response to the reviewers' comments.

I am pleased to inform you that ethical approval has been given by Chair's action on behalf of the University Research Ethics Committee to extend your study.

I wish you every success with your research.

Yours sincerely,

Sharon Dippenaar
Secretary, LSBU Research Ethics Committee

cc:

Prof Joan Curzio, Chair, LSBU Research Ethics Committee

Appendix 4. 2. b -Letter to Unite Officers about the research 2011

M C

Education and Development Organiser

North East Yorkshire and Humberside

Unite the Union

55 Call Lane

Leeds

LS1 7BW

Dear Mr C

Re: Doctorate research into learning mathematics at work

We have discussed my doctorate research in the past and I am now writing to ask for your support to enable me to engage in research with union members who are learning mathematics while at work.

I am currently entering my third year studying for my doctorate at London South Bank University and my research interest is how mathematics is taught and learned in vocational and workplace settings. I am interested in undertaking research with your members to contribute to the general debate about the value and purpose of learning at school, college and at work. This research is underpinned by the notion that learning is a form of empowerment whether it happens at school, college or work.

I am interested to explore the value of learning at work and to identify the value of that learning to the individual. I also want to analyse notions of transference of skills and knowledge, the relationship between understanding mathematics in one context (workplace) and another (education). The research will seek to explore these ideas in relation to theories of learning and to contribute to teacher education in the UK.

On a personal note I have been a member of a union since I first started teaching in 1981 but have been a member of the Transport and General Workers union, and later Unite, since 2004. I have been politically active in the Labour Party at a local, national and regional level since 1984, but have reduced my activity recently to enable myself to concentrate on my research.

I have had my research proposal accepted by the university and am currently seeking approval from the London South Bank University Research Ethics Committee to ensure I follow the appropriate procedures during my research project.

I have also had an opportunity to discuss the research proposal with two other Unite colleagues: DD , Learning Development Coordinator Equality and Diversity and EE, Life Long Learning project manager. Both of whom expressed interest in supporting the research.

I would be happy to discuss the research in greater detail with you to ensure that ethical and transparent procedures are followed during the research so that members' confidentiality is maintained, data protection procedures are followed and findings are shared with Unite on a regular basis.

I will be happy to meet to discuss the procedures with you and other colleagues and how we can take this work forward. I hope you would find the research useful and look forward to having the opportunity to work on this research with you and your colleagues.

Yours sincerely

Beth Kelly

Appendix 4. 3. 3.a.i- A selection of quotes collected in Nvivo related to emotions

Quotes and extracts indicating emotion related to mathematics

<Internals\\interviews\\Female (2) ,49> - § 2 references coded [5.47% Coverage]

Reference 1 - 3.04% Coverage

Somehow managed to get my level 2 qualification, don't know how I did that because I did not know what I was doing , if I am brutally honest. And it was always a block and barrier and a massive fear for me. Maths was something you would mention and I would come out in a cold sweat .

Reference 2 - 2.44% Coverage

I still have the fear there, as soon as I put the pressure on myself i go into default mode and i think I can n't do maths can't think and the brain goes into meltdown. If I take my time , I am o If I get too excited I also mess it up.

<Internals\\interviews\\Female, 31> - § 1 reference coded [5.19% Coverage]

Reference 1 - 5.19% Coverage

My mum when she heard I was doing maths she said what? You? doing maths?

She said you hate maths and I said maybe I will discover it from the beginning.

I am going to do maths. Because everyone new I terrible with maths, trust me I was a typical humanities students, I was brilliant at Polish and history but the maths it was the biggest disaster of my life. And if you have trouble with maths you have trouble with science. So everyone knew laughing – its your own choice? Its my own choice.

<Internals\\interviews\\Female, 35> - § 3 references coded [13.00% Coverage]

Reference 1 - 1.85% Coverage

I'm in a position now to support other learners, really rewarding to see how other people are learning because I am learning and I really enjoy it.

Reference 2 - 5.64% Coverage

It also means I have the skills to sit with my children and help them with their homework, which before I would not have had the confidence to do. And how when they come home and need help 'I don't know how to do it, well I can help you and it is their faces when they say-well thank you I can understand that now mummy. They know how to do things before they are being taught things at school. It is a brilliant experience passing on your skills.

Reference 3 - 5.52% Coverage

Because I enjoyed doing my numeracy class so much it has made me want to go on and do more. I am half way through my ECDL. To become a ULR traveling to London on my own for 5 days on my

I remember the maths classes at school and it was just a board rubber at the back all the time. Some people can look and just see the equation where as I never saw it, got quite frustrated and that support was not there so the easiest thing was sit and not do it.

I am passionate about it now and I would love to pas my level 2. And move forward with it.

Part of its time. My job – I push everyone else to do it and I've got to do it……

Reference 8 - 0.92% Coverage

I think is a lot more difficult with people. I have a better understanding of it.

And I have not got a fear of maths anymore whereas I did have a fear of it before.

Reference 9 - 1.09% Coverage

achieving L1 made me realise that I can achieve an awful lot more.. It s like your worst fear.. If you can overcome that then everything else is a lot less daunting….Maths is the black hole to me

Reference 10 - 0.74% Coverage

For me -It was one I had to achieve, a goal, the difference was it was fun. …. In the manner that the tutor made it made it that way.

Reference 11 - 2.27% Coverage

I have had people that can't even read and write. The first gentlemen that I dealt with, it was quite upsetting, he had gone most of his life and could not read and write. He had always put mechanisms in place, so it was never an issue for him. The first time he wrote me a little Christ card, I cannot explain it …. It upset me …the emotion that gave,…… I get upset even now, cause he still sends them now.

<Internals\\interviews\\Female, 49> - § 1 reference coded [4.67% Coverage]

Reference 1 - 4.67% Coverage

just basic maths, an introduction to maths after you have left school and get you back into maths You know the phobia. Well you know it is a bit of a taboo, not exactly everyone's strength, so I took it on to get an extra course I did it to get and get the endorphines going again

<Internals\\interviews\\Female, 53> - § 1 reference coded [4.07% Coverage]

Reference 1 - 4.07% Coverage

I was getting to the stage where , ok I love my job but I was getting bored, doing H&S thing has made me 'hold on that doesn't look right and challenge the management that is fun. Oh that is fun.

They look at me differently now they say Here she comes the rottwieler.

<Internals\\interviews\\Male, 40> - § 1 reference coded [1.75% Coverage]

Appendix 4. 3. 3.a.ii- Mind map of early groupings on motivation
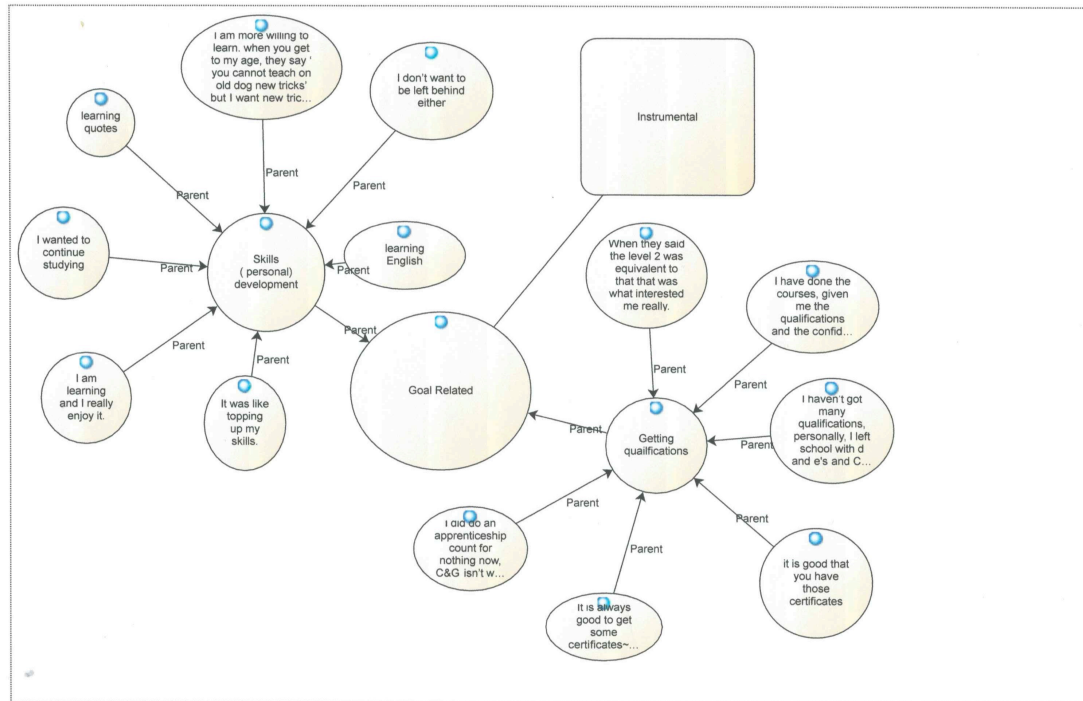
Appendix 4.3.3. b.i- Memo to self

Early thinking about different types of motivation 2012

Send Notes to Peter

April 7[Th]

After reading *Using computer-assisted qualitative data analysis to develop a grounded theory approach* (Bringer, Hailey, & Brackenridge, 2006) I realise that my research process IS grounded theory as I am moving backwards and forwards from the data I have collected in the research to the research literature and back again. It seems even more likely that I will start to use Nvivo soon as this software enables the process of development to be documents and creates an audit trail.

Thinking about the Emotional category

After preparing and re-listening to the interviews I have recorded to go into Nvivo I also realise that I have to think a bit more about the emotional categories . I think I may change them to positive and negative as there are a lot of emotional words attached to the first two interviews 'I love pie' I felt frustrated" . There is also a fair amount of self-analysis on how to control their feelings of shyness to take on challenges- this links with emotional control (Hannula) so I need to show this factor somehow. Is it positive or negative ? Positive as it enable s learning but linked to negative as it overcomes emotional blocks to learning.

Another category developing

Also another interviewee speaks about feelings of more belonging to England through learning. This is linked to transformational and the self and reminded me of other research I was involved in investigating the impact of a European funded programme on Bangladeshi women's feelings of integration. 'A variety of interpretations and perspectives on integration were identified by the participants in the research, but shared territory includes a sense of 'belonging' and the importance of developing confidence, skills and knowledge in relation life in the UK, the social aspects of everyday life' (Kelly, Moon, & Dudley, 2012, p. 12)I will add this factor to the diagram 'belonging and integrating into UK society'

Interviews at Smurf Kappa in Northhampton 11 April , -

An automated packaging manufacturer.
Organised by the ULR on site and the HR manager. A really good example of where both the unions and the management think they are getting good value added from providing learning for the employees.
I interviewed 5 people. There is definately something about a community of practice here. The guys were talking about getting ribbed about learning as well in other words being different from the rest of the workforce. Although they also acted as role models in the sense that they encouraged others to start learning again. They liked sitting talking about maths _ Lerman – language of Cop .

Identity   1988- *Lustman/Wedson*
                        -L

Appendix 4.3.3.b.ii - Memo to self

Beginning to conceptualise early ideas about instrumental and transformational motivation

17 Dec 2013

Memo

Developing a theory from the research.

Instrumental and Transformational

The research identifies an instrumental and transformational aspect to motivation. Instrumental, in the sense that there are reasons to that encourage learning based on gaining an artefact that represents social recognition of the effort of learning, such as a qualification. This may be for personal recognition 'filling a gap' left by a poor experience at school, or for a current or prospective employer, linked to job security.

Transformational, in the sense that once the person experiencing the learning learning gains some form of success this person then starts to recognise the changes the learning makes on themselves. They start to talk about changes in their own 'confidence' when doing the learning or supporting others. This description relates to how the learner sees them selves changing, thus linked to a deeper change in their own identity.

The instrumental and transformational aspects of motivation seem to be cyclic, reinforcing each other but may have a temporal feature. During the interviews the learners usually speak about the initial motivation being to gain a qualification perhaps to make their employment more secure. However, if they did have a transformational experience, in the interviews they very quickly start to speak about the changes in themselves or their lives that the learning has enabled. If they have not had a transformational experience the discussion about motivation just stops.

However when discussing the motivation to learn the trade unionists also described two other very important aspects to that learning; the way the learning happened in the workplace and the emotional way that the learning was described.

The words used by the learners to describe the learning included teachers treated an adult, supported by peers, trusting their learners and teachers being relaxed and being able to ask questions without being embarrassed.

Appendix 4.3.3. b. iii - Memo to self
Visualisation of early thinking about motivation and emotions 2013

Diagram of network analysis for learning maths at work

Factors   categories

- Instumental
  - Keeping a job
  - work related
  - goal related
- Transformational
  - self
    - increased confidence and self esteem
    - given a second chance
  - others
    - encouraging others(outside the family)
    - helping family
    - promoting democratic engagement
- Emotional
  - learning maths
  - learning maths in the workplace
  - learning in general

Appendix 5.1.a- Interview Questions

Research project: Learning maths at work: why and how?

Questions for research: Are mathematics skills transferable between school and work? What is the value of learning mathematics at work?

Research Interview

Name……………………. Date............................

The focus of this research is learning at work. In particular it is about developing your mathematical skills at work.

What motivates adults to learn maths at work? Exploring the value of developing these skills, your attitudes and feelings about developing mathematics at work

Exploring any links to learning mathematics at school

Does union membership in any way influence learning maths at work?

How do adults prefer to learn or use maths at work?

1. Do you currently take part in training or learning at work?

2. Have you recently undergone any mathematics or numeracy training at work? If so please describe it

2 a

Why did you decide to start learning maths?

This section is about any maths training you have undertaken recently at work exploring the effect and value of your maths learning on different aspects of your life.

4a) What effect do you think developing mathematics skills at work has on **your job**?

4b) What effect do you think developing mathematics skills at work has on your **career opportunities?**

4c) What effect do you think developing mathematics skills at work has on your relationship with **family, children and grandchildren**?

4d) what effect do you think developing mathematics skills at work has on your how **you** feel about yourself?

4e) What effect do you think developing mathematics skills at work has **on your taking more education courses?**

4f) What do you think about learning maths at work in relation to the **your union membership?**

4.g) Do you think developing mathematics skills at work has any other effect on your life/ community?

5) Talking about learning maths at prior to learning at work.

- Have you used the maths you learned at school, or college, at work? What is it that was different?

What did you like?

Anything you didn't like?

The next section is about your membership of a union

6. Were you a member of a union before you became engaged in workplace learning?....

7. Did being a member of the Union effect your learning in any way? (E.g. influence you to start learning, ULR?)

8. Has engaging in learning at work changed your opinion about the union?

ABOUT YOU - Confidential

Year of birth…....................................

Male		Female	

1. Which sector do you work in?...
2.

3. What type of work do you do? Please tick

Engineer	
Technician	
Fitter	
Clerical	
Administrative	
Retail	
Other (please explain)	

4. What is your job title?..
5.

   .

6. Please describe your role and the work you do?

7. Type of work

fulltime		part-time		Voluntary		Other	

8.   When did you last undertake maths training?

Within the last 7 days		Within the last month		Within the last 6 months		Within the last year		Over a year ago	

7 What is your highest maths qualification achieved at school?

Title	
When did you achieve it	
Where did you achieve it	
Level of achievement	

8. What is your highest maths qualification achieved since school?

Title	
When did you achieve it	
Where did you achieve it	
Level of achievement	

9. If you are currently or have you recently undergone training to develop your mathematics skills at work please give more details (if not already given)

Title of programme	Numeracy
Length of course	
Level	
Qualification title (if applicable)	

10. Who provided the training?

A local College	

Union Learn	
A private training provider	
Other	

Any further comments you would like to make?

Thank you for your time in contributing to this research

Appendix 5.1.b- Linking interview questions to research questions and possible factors

1. What motivates adults to learn maths at work?
2. How do adults prefer to learn maths at work?
3. Is there any relationship between learning maths at work and trade union membership?

The table below shows thinking behind the interview questions linking them to research questions and the range of possible concepts identified through the pilot research and the literature review.

Links to questions: How or why learn /use maths? Also is membership influenced by learning or vice versa	Variable	Factors
1. Do you currently take part in training or learning at work?	Learning at work	Course, programme or experience
2. Have you recently undergone any mathematics or numeracy training at work? If so please describe it 2a . Why did you decide to the start training/ learning maths ? (Q. 1, 2,3)	Motivations/ triggers to learning /using	Work, personal, family, economic, learning gap, empowerment
Do you enjoy leaning at work Think it is useful (1, 2)	Emotions and attitudes	A lot, some, a little , none at all Very useful, useful, not very useful, not at all

Feel about maths Is maths useful at work 1,2	Emotions and attitudes	(As above)
	The learners' personal feelings and understanding of both mathematics and learning at work:	Their own feelings, skills and knowledge,
	Sense of self	
What effect do you think developing mathematics skills at work has on:	your job (1,2, 3)	Redundancy, up skilling
	your career	Promotion, new job
	your relationship with your children , family	More positive, helpful
	on you	Sense of self , changes Community, family, union member
	on taking more courses	More Learning , none
	union membership	None, not sure, more positive

used the maths you learned at school, or college, at work?	Some	Addition , subtraction , money
How is it different to ways you learnt maths before		Collective , supportive, positive, encouraging
Union member Did being a member of the Union affect your learning in any way?		Being given the opportunity to learn.
Has learning changed the way you feel about TUs		Importance of membership in relation to learning; Community; empowerment
demographics	Gender/ diversity	Male, female, age, ethnic origins, work , pt/ft

Appendix 5.1. c- Letter to potential interviewees
Research: Learning maths at work: why and how?

Can you help?

I would like to invite you to take part in an investigation into learning maths at work. **Your views are very important.** I want to find out why and how you learn maths while you are working.

If you agree, what will I ask you to do?

I will ask you to:

- discuss the research and sign a consent form (if you want to take part)
- take part in an interview or focus group to find out about:
    - your experiences and feelings about maths
    - what motivated you to learn mathematics while working
    - what difference learning mathematics has made to you
    - any link between union membership and learning mathematics

The research interview or focus group should take place in **February 2014,** and will last about one hour and be recorded.

Will what you say be anonymous and confidential?
Yes. I will not use your real name in any report or article and only I will listen to any recordings.

What will happen to the results of the research?
I will use the results to contribute towards my doctorate studies. The results will be reported to Unionlearn and will be published in academic journals.

If you agree, can you change my mind later?

Yes, you can change your mind at any time before **30th April 2014**, and do not have to say why.
Just e-mail me at beth.kelly@learningunlimited.co

Why is this research important?

I think that it is important for teachers to understand the value of learning mathematics at work as well as at college or school. It is important for them to hear your views. I hope that you will find it interesting too.

Who has approved and funded the study?

London South Bank University has approved the research.

If you have questions or would like more information, please ask me. I attach a consent form to sign, if you agree to take part.

Beth Kelly   February 2103

Appendix 5.1. d- Research Consent Form
EdD Research project: Learning maths at work: why and how?

Research consent form

Research study: why and how you learn mathematics or numeracy while working.

- I have read the information sheet on the research. I have a copy to keep.

- I have asked questions if I wanted more information.

- The researcher has explained the research, and its purpose. I think I understand it.

- The researcher has explained that the interview will be recorded (audio digitally or on tape)
- I understand that what I say, and my work, will be anonymous and confidential.

- I understand how the researcher will use the interview

- I understand that I can change my mind, at any time, before **30th April 2014**, about the researcher using interview data. I know that I do not have to give a reason if I change my mind.
- I freely agree to be part of the research.

Participant's name (**BLOCK CAPITALS**):

....

Participant's signature:

....

Date:

....

As the investigators responsible for this investigation we confirm that we have explained to the participant named above the nature and purpose of the research to be undertaken.

Investigators' names:

....

Investigators' signatures:

....

Date:

....

Appendix 5.2.1.a - Examples of communication with gatekeepers

E-mail introduction to a ULR from contact at National Institute of Adult Continuing Education (NIACE)

On 30/05/2012 13:07,

Dear both,

I have great pleasure in introducing you to each other. I am sure adult numeracy will benefit!

A; thanks so much for getting back to me; you were so fast I think the ether has been warped. Beth, A runs a Learning Centre at a Sainsbury's Distribution Centre, and incidentally has himself a very interesting maths history.

Enjoy your conversations!

Beth, you can contact M or 0199245XXXX

Slán go fóill,
B

Email to ULR

Date: Wed, 30 May 2012 17:12:57 +0100
Subject: Re: Ph D research on maths in workplace

Dear A

B has kindly put me in touch with you in relation to my research.

The research I am hoping to do is investigating why people learn maths at work: what are their motivations and what maths they use at work.
I am particularly interested in speaking to people who have been developing their maths or numeracy skills through the skills for life strategy and I am hoping to carry out short interviews with trade union members.

Initially I had interviews organised through the education dept in Unite but my contacts have all been 'restructured' so I am looking for new contacts.
I am keen to work with unions as there is relatively little research in this area and from what I have read so far people in unions appear to have a broader set of motivations than those accessing education through more conventional routes. I am also a lifelong union member myself, and have been active in the past, so I am always interested to work with other members.

I am currently two years into my doctorate studies, based at London South Bank University and I have my submission for research currently going through the University Research Ethics Committee.

I wonder if you would be able to help me contact some people who may be interested / put up with being interviewed for the research.

I do hope you can help.
Please phone me on 0793988XXXX or e-mail with any further information you may wish to know about.

All the best
Beth Kelly

Final confirmation of interview venue and time from ULR

July 12 2012

Hi Beth
We are at Rye Park Learning Centre.
It is part of
Sainsbury's Rye Park Distribution Centre
Normandy Way
Hoddesdon
Herts EN11 0EZ

How does 11.00am sound?
You can access the site from the 5th floor of the multi-story car park at Rye Park. You will need to press the button on the turnstyle to inform security that you are here to see us. I will tell them to expect you. (you can park anywhere in the car park)

My Mobile number is 0797369XXXX. (Just in case you need further directions)
Look forward to meeting you too!
Have a good week

Regards
A

Sainsbury's Learning Centre

Appendix 5. 2.1. b - Another example of Communication with gatekeepers Follow-up e-mail and response from Director of Education, Unite the union with a request to find more women to interview

From: Beth Kelly <mail.bethkelly@gmail.com>

Subject: Re: Update on Research into why people learn maths at work

Date: 1 November 2013 11:01:44 GMT

To: "Mowatt, Jim" <Jim.Mowatt@unitetheunion.org>

Cc: "Brown, Chantelle" <Chantelle.Brown@unitetheunion.org>, "Barron, Kenny - Head of Lifelong Learning" <Kenny.Barron@unitetheunion.org>

Dear Jim and Kenny

I thought I should just let you know my progress on the research and let you know about another piece of work I have been involved with NIACE.

I firstly want to thank you very much for your support last year in contacting learners. I am now (hopefully) in the final year of research for the Doctorate. I have carried out 15 in depth interviews with union members and been analysing their responses. I have some interesting statements linked to the changes in

- increased confidence in themselves and interest in developing more of their skills (not just maths skills)

- feelings about the union:

  ◦ becoming more positive

  ◦ not just taking subs but being interested in them as individuals (to help develop their skills)

  ◦ being more aware about what the union does

  ◦ really appreciate the time off work to learn negotiated by the unions

  ◦ knowing more union members

These are not yet written up in a formal way, this is part of my work this year, but I thought you might be interested in these early findings.

However I really do need to interview more maths learners and wondered if you could point me in the direction of someone who would know more women learners. I need to get a gender balance in my interviewees.

I am also going to send you information about some online maths resources I have been involved in developing this year with NIACE and Jisc which may be of interest . We working with the CAB, Homelesslink, Family Learning organisations, the WI and colleges to develop the resources.

Many thanks again for your support and look forward to hearing form you.

Beth Kelly

On 1 Nov 2013, at 09:36, Mowatt, Jim wrote:

Congratulations Beth on your progress

Delighted to help you further

Let's linger in a latte with our National Equalities tutor Chantelle

Please send me some dates for which we can dovetail into our diaries

For a meeting soon

All the best

Jim Mowatt

UNITE   the   union

Director of Education

London   WC1X   8TN

Appendix 5.2.3 – EdD Learning Maths at work: sample recruitment and diversity

1. **Recruitment schedule**. The table below shows the number of males (M) and females (F) interviewed in 2012,2013 and 2014, the organisations involved and the layers of contacts / gatekeepers used to access the people learning maths at work.

Year	People interviewed		Union / organis ation	First contact	2nd contact	3rd contact	4th contact	5th contact
	M	F						
2012	2	2	TUC NIACE USDAW	TUC Union development manager	NIACE programme manager	ULRs	Interviewee	
2013	10	1	UNITE	Director of Education	Head of Lifelong Learning	Regional Organiser	ULRs	Interviewee
2014		3	TUC/ union learn	TUC Union development manager,	TU Education Manager	Teachers	Interviewee	
		1	NIACE	Teacher	Interviewee			
		1	USDAW	ULR	Interviewee			
Totals	12	8						

2. Diversity – Age and Gender

In my sample there were 40% women and 60% men. A majority (70%) of the men and women were aged between 25-49.

Age	Female	Male	No of interviews by age
0-15	0	0	0
16-24	0	0	0
25-49	6 (30%)	8 (40%)	14 (70%)
50+	2 (10%)	3 (15%)	5 (25%)
undeclared		1 (5%)	1 (5%)
Total	8 (40%)	12 (60%)	20 (100%)

3. Diversity by ethnic origin

In my sample 30% were in the Black or Ethnic Minority (BME) category.

Age	No of interviews	BME	UK	Undeclared
0-14	**0**	**0**	**0**	
15-24	0	0	0	
25-49	14	6	8	
50+	5	1	4	
undeclared	1			1
Total	20 (100%)	7 (35%)	12 (60%)	1 (5%)

5. Occupational and geographic spread

I interviewed people working in :

- the retail distribution sector in Hertfordshire

- a company that makes cardboard boxes to hold goods and food in Northampton

- a company involved in road maintenance in Birmingham

- a bus company in Sheffield

- HMRCin London

- c2c Rail in London

- London Underground

- Prison Officers Association in Nottingham

6. **Through an internal trade union document** (unpublished), I obtained statistics about people involved in learning through the union from April to June in 2012. The report contained information on 7274 new leaners.

The gender breakdown for learners was 25% women 75% men.

The age profile was 16-24 4%; 25-49 33%; 50+ 12%, however 51% did not declare their age.

6.3% identified themselves as in the Black or Ethnic Minority (BME) category, but 53% of the respondents were undeclared.

Appendix 5.4. a- Developing early concepts and categories in relation to motivation

Concepts   Categories

Goal related

                                                instrumental

Work related

Increase in confidence
/ self esteem
                        self

Helped /encouraged
by others
                                                transformational

Helping/ encouraging
family members
                        others

Encouraging others
outside work
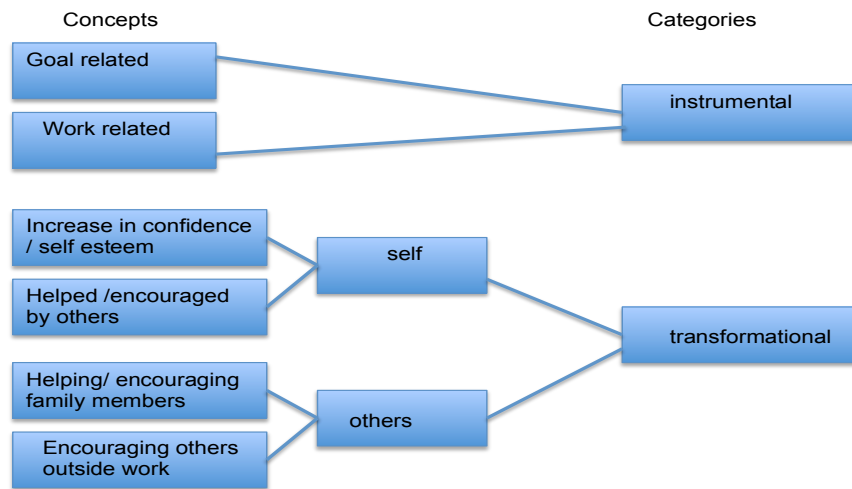
Appendix 5.4. b - Initial Motivation (category one)- mind map in NVivo

I am more willing to learn. when you get to my age, they say ' you cannot teach on old dog new tricks' but I want new tric...

I don't want to be left behind either

learning quotes

I wanted to continue studying

Parent

Parent

Parent

learning English

Parent

When they said the level 2 was equivalent to that that was what interested me really.

I have done the courses, given me the qualifications and the confid...

Parent

Parent

Parent

Skills (personal) development

Parent

keep learning

I did do an apprenticeship count for nothing now, C&G isn't w...

Parent

Getting quailfications

Parent

I haven't got many qualifications, personally, I left school with d and e's and C...

Parent

Parent

I am learning and I really enjoy it.

Parent

Parent

it is good that you have those certificates

Parent

Parent

Initial Motivation

Parent

Parent

It is always good to get some certificates~...

Benefit to the company

Parent

Parent

relationships with family

communication at work

children and family

Parent

Related to work or jobs

Parent

language and culture

company negatives

Parent

Parent

Parent

Parent

Performance and promotion

using in trade union negotiations

Nodes

Emotions about maths

Name	Sources	References	Created On	Created By	Modified On
	9	22	09/09/2013 12:20	BK	27/01/2016 13:50
Confidence	12	18	09/09/2013 10:45	BK	26/01/2016 13:00
learner journey	7	10	19/11/2014 15:02	BK	26/01/2016 12:31
Negative feelings -insecure, anxious,	8	12	25/09/2013 16:48	BK	01/04/2015 15:18
positive emotions	18	23	19/11/2014 14:54	BK	01/04/2015 15:28

Identity and Motivation

Name	Sources	References	Created On	Created By	Modified On
	1	1	03/01/2015 15:56	BK	27/01/2016 13:53
IDENTITY- impact on self	10	19	05/09/2013 13:33	BK	16/03/2015 18:31
IDENTITY and the social group	12	25	03/01/2015 15:24	BK	16/03/2015 18:37
critical citizenship	3	8	09/09/2013 12:23	BK	03/01/2015 15:18

Initial Motivation

Name	Sources	References	Created On	Created By	Modified On
	0	0	20/06/2014 09:48	BK	27/01/2016 13:51
children and family	8	8	13/03/2015 15:42	BK	13/03/2015 15:51
Getting quaiifications	11	18	25/09/2013 16:24	BK	13/03/2015 15:08
Motivatio definition	2	2	20/11/2013 16:56	BK	25/01/2016 16:02
Related to work or jobs	5	5	30/10/2013 11:30	BK	03/01/2015 15:30
Skills (personal) development	14	35	30/10/2013 11:33	BK	29/03/2015 12:58

Learning - Teaching situation

Name	Sources	References	Created On	Created By	Modified On
	13	23	08/12/2013 12:21	BK	27/01/2016 13:51
collaborative learning	8	19	05/01/2015 10:35	BK	29/03/2015 16:07

Nodes

Name	Sources	References	Created On	Created By	Modified On
Learning maths- approaches to	5	9	09/09/2013 12:34	BK	14/11/2014 10:07
maths relevent to learners lives,	12	28	25/09/2013 16:27	BK	29/03/2015 12:05
Previous education experience prior to learnin	10	12	05/09/2013 13:30	BK	28/03/2015 12:33
Relaxed environemnt,	9	13	25/09/2013 16:30	BK	29/03/2015 13:07
Smaller groups, more one-on-one, individually	8	10	21/10/2013 17:23	BK	29/03/2015 15:53
Talking about maths	11	16	25/01/2016 17:21	BK	27/01/2016 13:47
Where the leaning takes place	5	12	20/11/2013 17:50	BK	27/01/2016 13:39

Name	Sources	References	Created On	Created By	Modified On
TU- motivation and learning	1	1	28/05/2014 12:08	BK	27/01/2016 13:51
accessing the opportunity to learn mathemati	12	18	31/03/2015 10:10	BK	27/01/2016 13:31
developing social and critical awareness	8	13	28/05/2014 12:42	BK	27/01/2016 13:31
Seing the TU differently	12	33	28/05/2014 12:40	BK	13/02/2016 10:06
union influence on motivation to learn	10	17	21/09/2013 12:10	BK	27/01/2016 13:32

Appendix 5.4d – Interview data and dates modified (for example to change names)

interviews

Name	Nodes	References	Created On	Created By	Modified On
Female (2) ,49		20	33 08/05/2014 17:04	BK	13/03/2015 14:44
Female, 31		25	35 03/11/2014 17:56	BK	03/11/2014 18:42
Female, 42		26	32 20/09/2013 09:25	BK	13/10/2014 16:00
Female, 49		19	26 08/03/2014 12:00	BK	13/10/2014 15:53
Female, 53		22	31 28/04/2014 17:30	BK	31/03/2015 12:43
Jean, 46		46	122 06/11/2013 14:01	BK	25/01/2016 16:09
Male , 61		13	17 08/12/2013 12:10	BK	13/10/2014 16:33
Male 51,		28	36 28/10/2013 17:33	BK	13/10/2014 16:31
Male(2), 49		12	20 25/09/2013 16:14	BK	09/01/2015 17:17
Male, 27		12	21 20/09/2013 09:26	BK	09/01/2015 17:17
Male, 28		10	19 28/04/2014 17:34	BK	05/01/2015 17:18
Male, 34		23	31 21/09/2013 12:03	BK	13/10/2014 16:01
Male, 35		15	19 21/10/2013 17:14	BK	13/03/2015 15:30
Male, 40		24	34 08/12/2013 12:09	BK	29/03/2015 12:20
Male, 48		6	7 24/09/2013 13:26	BK	09/01/2015 16:42
Male, 49		18	28 23/09/2013 17:12	BK	09/01/2015 16:42
Patrick,45		24	54 27/09/2013 14:20	BK	25/01/2016 16:11
Sandra, 40		25	36 28/04/2014 17:36	BK	25/01/2016 16:10
Susan, 35		27	56 05/09/2013 13:11	BK	26/01/2016 12:45
Tom, 55		24	52 05/09/2013 13:11	BK	25/01/2016 16:09

Appendix 6.2.1- Memo: Building on the McLeod's Domain of Affect (1994, p. 578)
 (1 of 5 pages)

'Beliefs, attitudes and emotions are used to describe a wide range of affective responses to mathematics.

Affect			
	(Mcleod, 1994)	Understandings (Kelly, 2014-16) (TU Adult research)	Texts from my data that I interpret as indicating the terms
Beliefs	Mainly cognitive, fairly stable Relates to individual	Mainly cognitive, fairly stable	
• **About maths**	Maths is based on rules	Maths can be relevant to life	At school it was very vague "find the area of a triangle?" Why? Nothing …made sense. Where as if you are working out the area of a piece of land where you are putting down a shed it is more meaningful to a practical person.' (M,55)

• **About self**	I am able to solve [8]problems	I am more confident now I can do percentages	All the time it's working towards bettering yourself, just continual improvement, your mind is ticking over not getting stuck in a rut.' (M, 34)
• **About maths teaching**	Teaching is telling	Teaching is less formal	'The teachers have moved on such a lot, from the archaic way they used to have, more relaxed plus the classes are smaller"(M, 48)
• **About the social context**	Learning is competitive	Learning is supportive	"More supportive than at school in a class of thirty. If you get it wrong here no one will embarrass you.' (F, 53)
• **About others (Kelly, 2014)**		Learning with and from others	I learn more by having classroom interaction. You can talk to people. If you have a scenario and you can't resolve it you can ask a colleague or the teacher. So we had a lot of interaction with the teacher, you could convey any issue you had." (F,49)
Attitudes	McLeod,1994)		
	E.g. Dislike of geometric proof Enjoyment of	Both cognitive and affective becoming visible through behaviour	

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[8] February 2015

problem solving Preferences for discovery learning	Can be a behavioural manifestation of motivation	
	Problematic (Hannula, 2012) - Often implies judgement or appraisal, linked to their motivation and feelings, but interpreted through behaviour and social activity	
Trust		
	Emotion and cognition – felt and believed about others	'Putting your trust in someone' 'You are doing it with people you trust because you work with them, they are your work colleagues and your friends.' (F,47)
Confidence		
	Emotion and cognition related with a *potential* to act (Barbalet, 1966) can become visible through	I have changed I used to be quite a shy person…with more confidence at work you can switch it off, or put it to the back of your mind. You know how to transfer your

		social activity	feelings, everyone is shy at some point, just try switching it off. (F,35)
		Controlling emotions-Hannula(2012)	
Emotions	(McLeod, 1994)		
	Less stable than beliefs and attitudes 'Hotter than cool beliefs'	Varying in stability and intensity – some long and some short term.	'I have always been insecure about Maths' (F, 42)
	Joy (or frustration) in solving non-routine problems Aesthetic responses to mathematics	Emotion is a feeling i.e. feeling guilty, joy, afraid, worried, anxious, unsure, pleased, more confident . Feelings that can relate to memories, interpreted through current contexts that are influenced by social groups. They help a person to evaluate a situation in relation to their own abilities and their willingness to act	'Achieving level 1 made me realise I can achieve an awful lot more. It's like your worst fear, if you can overcome that then everything else is a lot less daunting.' (F,47) 'I love Π(pi), I remember Π, don't know why. I love the absolute importance of it and the absolute nonsense of it as well.' (M, 55)

Values	(DeBellis and Goldin, 2006)		
	related to ethics, morals, 'personal truths'. May be highly structured (Mcleod, 1994)	Individual beliefs related to wider social belief systems e.g. Economic value	I know maths is important if you want to move to other jobs, say on computers and make sure you are getting your right amount of wages.' (M, 28)

Shared normative emotional expectations, attitudes, beliefs and values with social groups and context i.e. teachers, peers, parents, society	Maths qualification in society	I haven't got many qualifications. Personally I left school with d's and e's and CSE's and I am very lucky to have a job.' (M, 49)
	Related to trade union values of collective action	'It does strengthen your arguments during negotiations because what tends to happen is the company will quote percentages to you, and you try to figure them out. So if you have a knowledge of maths you can easily challenge them, and if they try to manipulate the figures you can easily pick them up' (F,40)
	Personal value	'I don't want to get left behind either' (M, 49)
		'Bragging rights-I purely did it for myself.' (M, 40)

Appendix 7.0 Concepts of and Categories cross-referenced with respondent quotes (2 of 3)

Concepts and categories	M 46	M 45	M 49	M 48	M 40	M 35	M 34	M 28	M 27	M 50	M 51	M 61	F 53	F 49	F 46	F 42	F 40	F 35	F 31	F, 50	Quotes	Possible sources
Addressing the research question: what motivates adults to learn maths at work?																						
7.1.1 Building the first category: Initial motivation																						
7.1.1.1 Initial motivation related to working																						
7.1.1.1.1 In the company						1	1		1	1	1										5	11
7.1.1.1.2 In the Trade Union													1				1				2	2
7.1.1.2 Developing Personal Skills																						
7.1.1.2.1 Keeping brain active							1	1											1		3	6
7.1.1.2.2 Developing learning skills										1		1									2	6
7.1.1.2.3 Developing mathematics skills		1							1	1										1	4	12
7.1.1.3 Initial motivation related to children and the family																						
7.1.1.3.1 Learning Language and culture																1		1			2	2
7.1.1.3.2 Relationships with children					1						1				1	1		1			5	8
7.1.1.4 Gaining certification																						
7.1.1.4.1 Opportunities in employment and education							1	1			1					1		1			5	12
7.1.2: Building the second category: Motivation and changes in identity																						
7.1.2.1 Changes in the subjective self							1			1										1	3	8
7.1.2.2 Identity and the face-to- face social group		1															1				2	12
7.1.2.3 Identity and the critical use of numbers in society		1														1	1	1			4	12

	M 46	M 45	M 49	M 48	M 40	M 35	M 34	M 28	M 27	M 50	M 51	M 61	F 53	F 49	F 46	F 42	F 40	F 35	F 31	F 50	Quotes	Possible sources
Addressing the research question: 'How do adults prefer to learn maths at work'?																						
7.2.1 Building the third category: Learning and Teaching																						
7.2.1.1 Previous learning experiences						1	1				1							1	1		5	11
7.2.1.2 Characteristics of learning environment																						
7.2.1.2.1 Making mathematics relevant				1						1							1	1	1		5	11
7.2.1.2.2. Talking about Maths	1																		1		2	7
7.2.1.2.3 Relaxed atmosphere		1				1								1							3	8
7.2.1.2.4 Small classes			1			1	1														3	8
7.2.1.2.5 Supportive / Collaborative learning	1												1	1							3	8
7.2.1.3 Where and when learning takes place												1						1			2	5
Addressing the research question,' Is there any relationship between learning maths at work and union membership?'																						
7.3.1 Building the fourth category: Trade union membership and motivation to learn mathematics																						
7.3.1.1 Accessing opportunities to learn						1		1		1	1		1				1	1			7	12
7.3.1.2 TU influence on motivation to learn maths			1								1										2	10
7.3.1.3 Seeing TU differently	1					1				1	1	1									5	12
7.3.1.4 Developing social and critical		1									1					1	1			1	5	8

	M 46	M 45	M 49	M 48	M 40	M 35	M 34	M 28	M 27	M 50	M 51	M 61	F 53	F 49	F 46	F 42	F 40	F 35	F 31	F 50	Quotes	Possible sources
Building the fifth category: Emotions, confidence and motivation to learn mathematics																						
8.1.1 Negative feelings about learning mathematics		1													1	1				1	4	8
8.1.2 Positive feelings related to learning maths							1				1				1	1					4	18
8.1.3 Developing confidence.																						
8.1.3.1 Developing confidence on an individual level			1								1	1				1					4	4
8.1.3.2 Developing confidence at a social face-to-face group level		1												1							2	2
8.1.3.3 Developing confidence to act at a socie	1											1				1	1			1	5	5
TOTAL	3	7	3	2	2	6	6	3	4	3	6	4	6	1	8	6	7	8	6	7	98	225

KEY

  shaded square: indicates a quote from that personthat I take to be related to that concept

  1 indicates a quote used or refered to in the text.

Jean is F, 46

Quotes	
Female	49
Male	49

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