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Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety, and examination grades

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Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety, and examination grades.

Jennifer Mary Stacey

A thesis submitted in partial fulfilment of the requirements of

Sheffield Hallam University

for the degree of Doctorate in Education

October 2023

CANDIDATE DECLARATION

I hereby declare that:

I have not been enrolled for another award of the university, or other academic or professional organisations, whilst undertaking my research degree.

None of the material contained in the thesis has been used in any other submission for an academic award.

I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all other published or other sources of material consulted have been properly and fully acknowledged.

The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.

The word count of the thesis is 65298.

References: 4939. Appendices: 4036

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ACKNOWLEDGEMENTS

This thesis is the culmination of over 20 years of part time association with Sheffield Hallam University, as a part-time PGCE student from 1999 to 2001, a master's degree candidate from 2008 to 2014, and finally a Doctorate in Education candidate from 2018.

I would like to thank all the inspiring lecturers and supervisors I have met in that time, including Dr Hilary Povey, Dr Gill Adams, Dr Caron Carter, Dr Karen Daniels, and especially Dr Iain Garner and Dr Peter Rowlett who have supervised this thesis. Their contributions have always been stimulating and informative.

I would also like to thank my previous supervisor for the master's dissertation, Sylvia Ashton, who encouraged and supported the development of my love of research.

I trained to teach in the Primary sector, have supported students in Secondary schools, and since 2004/5 I have worked as a teacher in an FE college. Teaching mathematics in Further Education has been a joy, often a challenge, but never less than absorbing and interesting. My thanks go to all the colleagues I have had the pleasure to work with over the last 20+ years, and to the learners, both 16–18-year-olds and adults, who have been participants in my mathematics and ESOL classes. I have learned so much from all of you and will always be grateful.

My thanks are particularly due to all the participants in this research, both in the pilot study and the main data collection, who shared their perceptions of mathematics and examinations with me.

Finally, my love and thanks go to my family, without whose support this thesis would have been impossible, namely, Andrew, Jessica, and Peter Stacey.

ABSTRACT

Title: Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety, and examination grades

This research sought to establish whether there is a link between self-efficacy or anxiety and final examination grades for adults taking GCSE mathematics. In England in 2020, 30,650 adults (19+) were registered to take this Level 2 examination, traditionally for 16-year-olds in schools. Twenty-one adults on non-traditional pathways in education participated in this mixed methods study.

The study used a questionnaire with comments sections, distributed to participants on two occasions, and a semi-focussed interview. Statements on the questionnaire were divided into three sections: course content, classroom dynamics and assessment.

Main insights on perception: Timed testing emerged as the most significant challenge for participants. Whilst some participants expressed anxiety and low self-efficacy with all tests and examinations, for others it was specifically mathematics examinations that prompted negative responses.

Main insights for outcomes: The principal insight of the research is that whilst most learners with high self-efficacy and low anxiety reached the required grade, most of those with lower self-efficacy, higher anxiety, or both generally did not perform as well. Self-efficacy for these participants was a better marker for success than anxiety.

Findings were evaluated by gender, age, and ethnicity. Stereotypical assumptions about adult learners drawn from previous research were challenged by this study, as males had similar outcomes to females, older participants were less anxious than younger ones, and those whose first language was not English were just as likely to perform well as English speakers.

Original findings emerged from individual statement responses, such as participants who were unable or unlikely to ask a question in class, and that word problems matched algebra as a significant topic in terms of course content. Additionally, one participant out of the ten who responded twice became more anxious and had lower self-efficacy as the examinations approached, with a potentially detrimental effect on their grade.

The findings of this research are exploratory and indicative due to the sample size, but they have implications for research and practice, as they have highlighted differences between FE adult populations of mathematics learners and other FE and adult students. In addition, they have indicated a need for practitioners to gather information from adults to enable them to better support their learners in fulfilling their aspirations of a GCSE in mathematics.

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SUMMARY OF ABBREVIATIONS

ABE: Adult Basic Education

ALM: Adults Learning Mathematics

BCME: British Congress for Mathematics Education

BSRLM: British Society for Research in Learning Mathematics

CAGS: College Assessed Grades; used for GCSE examination results in summer 2020

CfEM: Centres for Excellence in Mathematics

CERME: Congress of the European Society for Research in Mathematics Education

DfE: Department for Education

DfEE: Department for Education and Employment

DfES: Department for Education and Skills

EAL: English as an Additional Language

ELL: English Language Learners

ESOL: English for Speakers of Other languages (used exclusively for adults)

ETF: Education and Training Foundation

FE: Further Education

FMS: Fixed mindset

FS: Functional Skills

GCSE: General Certificate in Education

GMS: Growth mindset

HE: Higher Education

ITE: Initial Teacher Education

ITT: Initial Teacher training

LLL: Lifelong Learning

MiFEC: Mathematics in Further Education Colleges

MMR: Mixed Methods Research

NANAMIC: National Association for Numeracy And Mathematics In Colleges

NATECLA: National Association for Teaching English and Community Languages to Adults

NCETM: National Centre for Excellence in Teaching Mathematics

OECD: Organisation for Economic Cooperation and Development

PGCE: Post graduate Certificate in Education

PIAAC: Programme for the International Assessment of Adult Competencies; run by OECD every 10 years, due 2022, includes literacy, numeracy, and digital skills.

PISA: Programme for International Student Assessment; run by the OECD every 3 years; tests 15-year-olds skills in science, mathematics and reading

RME: Research in Mathematics Education (the journal of BSRLM); also, Realistic Mathematics Education

SET: Society for Education and Training (part of the ETF)

SHU: Sheffield Hallam University

TAGS: Teacher Assessed Grades (used for examination results in summer 2021)

TIMSS: Trends in International Mathematics and Science Study; every 4 years, latest 2019; school aged children, Year 4, and Year 8 (approx. 9- and 12-year-olds)

WEA: The Workers Educational Association; a charity that supports lifelong learning for adults.

ZPD: Zone of proximal development

1 CHAPTER 1: INTRODUCTION

1.1 THE RESEARCH

The focus of this research has been on adult GCSE mathematics learners in England. These learners, who numbered over 30,000 in 2020, and who were 19 years or more, have engaged with mathematics classes after the time when study of mathematics was compulsory, so they have opted in to these classes. I have gathered data on a sample of 21 participants' self-efficacy and anxiety levels by questionnaire, using attitude scales with comments, and interview, and compared these to their examination results. Hence it was mixed methods research. Mixed methods research designs can either use both quantitative and qualitative data in various ways or, as in my study, can describe research which interrogates some of the qualitative data in a quantitative way to yield additional insights (Guetterman, Plano Clark, & Molina-Azorin, 2024), and integrates both through thematic analysis (Braun & Clarke, 2013).

The field of adult education that involves mathematics teaching and learning is often viewed as second chance in the subject, to gain a qualification that has an exchange value, as it is seen as a marker qualification for HE or promotion at work (Gal, Grotluschen, Tout, & Kaiser, 2020; Norris, 2023), but for some learners, it can be an opportunity to challenge previous experiences and perceptions, or to improve their skills, and thus has a personal or utility value (Norris, 2023).

The lack of research in the field of adult education has been identified by sources as one that requires addressing, as European economies and technologies are changing quickly and the numerical requirements of living and working have changed with them (Hoogland, Kelly, & Diez-Palomar, 2019). In addition, Ramirez et al consider that the greatest concentration of learners with anxiety could be found in community colleges, the USA equivalent of FE colleges in the UK, thus "an optimal subpopulation for study" (Ramirez, Shaw, & Maloney, 2018, p. 159). Over half of their surveyed population showed moderate to high anxiety levels about mathematics, which correlates with my own findings from the 2014 to 2016 academic years (Stacey, 2017).

This research has filled the qualitative gaps identified by my previous largely quantitative and other research as it has addressed the question of whether or how much anxiety and self-efficacy matter for participants in terms of examination results. It aimed to

make a useful contribution to our understanding of how some adults (19+) in FE feel about mathematics and examinations and identify whether, for these participants, there were links between their self-efficacy, anxiety, and examination grades.

The focus on adult learners, who are at the forefront of the research, is an original aspect of the thesis, as other recent work has largely focussed on the much larger populations of 16- to 18-year-olds in FE (Hough, Solomon, Dickinson, & Gough, 2018; Noyes & Dalby, 2022).

In the next section I expand further on my personal motivations for engaging with this research.

1.2 RESEARCH MOTIVATION AND MY JOURNEY

The motivation for this research is perhaps best explained by a short recap of how and why, after a career in finance, in industry, and after running my own business for almost 20 years, I retrained for a career in teaching. A career change to teaching fitted better with caring responsibilities I had acquired and fulfilled a long-held wish to re-engage with mathematics. This desire arose due to a chequered career in mathematics classrooms from a personal perspective, due to frequent changes of residences and primary schools up to the age of 11. Secondary education, including A levels at an FE college, and an undergraduate degree in Philosophy and Government followed.

After my degree I spent time studying and working in Paris, France, which gave me an appreciation of the challenges faced by non-first language speakers in a foreign country. A career in finance and industry followed my return to the UK. This involved more studying for examinations in accountancy and marketing. In my own time I was also studying for qualifications in the horse industry, as I hoped to run my own business at some point. An offer of a redundancy package led to an opportunity for this to happen.

Throughout this time, I had also been teaching, whether this was to nurses on hygiene in dental surgeries or teaching people to ride. A passion for teaching and learning emerged and, though I had not heard the phrase at that time, I was clearly becoming a lifelong learner!

I joined SHU as a part time student on a PGCE in 1999. After graduation in 2001 as a Primary teacher with a Numeracy specialism, and some short-term contracts in the

Primary sector, I relocated to teaching adults in an FE college and obtained the additional qualifications in mathematics that were required. I was confident that the FE provision would be a happy place to teach mathematics, as I completed my 'A' levels in a college, and appreciated the important contribution they can make to learners' lives.

During my time teaching in an FE college, I have taught 16- to 18-year-olds and adults (19+) mathematics, and English for Speakers of Other Languages (ESOL) learners both English and mathematics. Mathematics courses in Adult Basic Education (ABE) have come in many guises over the years, and I started with Key Skills, then taught Basic Skills and ESOL Maths, then Functional Skills, at all levels, from Entry 1 up to Level 2. Since 2014, I have taught GCSE Mathematics mostly, but not exclusively, to adults.

I became very interested in the experiences that my learners brought to the classroom, and how those experiences might impact on their ability to engage with the content of the courses, whether those were academic or emotional in origin. This led to an interest in research as a way of understanding their voices, and a desire to benefit these learners' communities. I completed a dissertation for a master's degree in education in 2013, which evaluated 5 years of data for a correlation between ESOL learners' English language examination results, and whether they had studied mathematics classes in addition to their ESOL provision (Stacey, 2016).

One area of concern for me was that in the adult English speakers' mathematics classes, there was clearly much anxiety and fear, particularly at the start of courses. As a result, I started to gather data on both how confident and how anxious learners felt about mathematics and examinations in the first few weeks of GCSE mathematics classes and was astonished at the responses in terms of the depth of feelings (Stacey, 2017). This data was collected on a simple questionnaire with two questions: 'How do you feel about maths?' and 'How do you feel about exams?'. Responses prompted a fervent desire to contribute to an understanding of how these learners see mathematics and examinations, to better inform the teaching and learning of GCSE mathematics for adult learners in FE classrooms.

The learners in my early research were given the opportunity to make comments, and some covered both sides of an A5 piece of paper with their responses. Verbal comments were made about how cathartic it was to share this information, as a process that could

enable learners to distance themselves from previous experiences, identified by a number of researchers as an important factor for adults re-entering mathematics classrooms (Benn, 1997; Lisciandro, Jones, & Geerlings, 2018). I felt that this distancing from previous experiences could encourage learners to engage with the course content and be retained in the class, which could in turn improve both results and retention.

The data collected over a three-year period was shared in a paper published in the ALM conference proceedings (Stacey, 2017). However, whilst the findings and information were very useful for me as a teacher, there are limitations with the format in terms of its academic rigour. These experiences have led to the doctoral thesis you are reading today.

As this doctoral journey has taken place during the Covid 19 pandemic, in the next section I will briefly outline some of the negative and positive impacts that the pandemic has had on this researcher.

1.3 IMPACT OF THE COVID 19 PANDEMIC ON THE RESEARCHER

The doctoral journey has been acknowledged by researchers as being part of a messy journey with research rarely going exactly to plan (Potter, 2006; Billo & Hiemstra, 2013), but this doctoral journey has been messier than most due to the impact of the pandemic. I completed the first two taught years of the EdD programme pre-pandemic, including a successful pilot study (Stacey, 2022), and it was my intention to take a sabbatical from work for one academic year to recruit learners onto the data collection cycle, to counteract the potential objection of a biased sample.

The pandemic arrived in March 2020, and I was involved in the process of replacing the examinations in May and June of that year with 'college assessed grades' (CAGS). In September 2020, whilst on the sabbatical, I was unable to visit colleges to recruit participants as all teaching and learning was being conducted online. I approached colleges with a PowerPoint presentation (see Appendix 8.3) to be shown in the online classes, but the number of participants from whom I collected responses was five, and only two participants responded twice. This number was below my original intentions.

As my research objective was to obtain a range of views and opinions to compare, I extended the deadlines on the ethical approval applications to include the following 2021/22 academic year, and to use a mix of my own and other colleges and teachers'

students. The result of this extension meant that the data collection now included an analysis of 21 participants' views over 31 responses to the questionnaire. The 31 responses included 10 participants who responded twice, which have been analysed to see if and how participants' views changed over time. As will be seen in Chapter 4, the extension has given a wealth of quantitative and qualitative data to work with.

The use of a mixed methods study which includes quantitative to qualitative data has enabled me to develop a more nuanced approach to research, and to value the impact of specific examples and explanations. This contrasts with my previous research work, with its greater emphasis on quantitative data collection and analysis. Thus, the Covid 19 pandemic had a positive impact on my development as a researcher, as it involved a move away from a largely positivistic perspective.

In short, I have moved from a position where generalisations drawn from data was the position that I valued most, to one where the qualitative outcomes are now taking precedence, and I can see the dangers of taking a generalised approach. In fact, for adults learning GCSE mathematics in colleges, I would suggest that a much more nuanced approach for this diverse group should be the aim.

The impact of the pandemic will be considered again in Chapter 3. In the next section of this introduction the research aims, subsequent questions and an outline of the research structure is described.

1.4 THE RESEARCH AIMS AND QUESTIONS

1.4.1 Research aims

The aims of this research project were broadly to address whether levels of self-efficacy and/or anxiety mattered in terms of participants' final grades. To address this issue the research aimed to:

1) Establish an understanding of adults' feelings or perceptions of mathematics and examinations, and if those perceptions changed during the courses that they undertook in colleges.

2) Establish if there was a relationship between levels of self-efficacy and anxiety about mathematics and examinations, and the grade that adult learners achieved in the end of year exams.

The aims of the research were developed into a number of research questions, which are contained in the next section.

1.4.2 Research questions

In order to address the aims of the research, a number of research questions were developed, and these were:

1. What were participants' perceptions of mathematics and examinations when they engaged with GCSE classes in colleges?
2. Did the courses in the FE colleges change adult participants' perceptions of mathematics and examinations and, if so, how?
3. Did these perceptions differ by age, gender, or whether the learner is a first language English speaker, or not?
4. Was a positive level of self-efficacy necessary for, or related to, examination success? Was there a point at which too high a level of self-efficacy was detrimental to examination performance?
5. What levels of anxiety were present in the adult mathematics learners participating in the study, and were anxiety levels also related to examination success?
6. What other findings emerged from the data?

The next section contains a brief outline of the research methodology and design which were used to address the research questions.

1.4.3 Outline of the research

This research was a mixed methods study which used two attitude scales on a questionnaire, one for self-efficacy and one for anxiety, on a total of 15 statements. In addition, it included opportunities for comments on each statement, at the end of the questionnaire, and in semi-structured interviews.

The investigation undertook to separate out the factors influencing performance by thematically analysing learners' responses using three overarching themes, namely classroom dynamics, course content, and performance issues. By comparing participants' responses both generally and thematically against examination grades it sought to evaluate the importance of these learners' feelings about mathematics for examination grades in this under researched group.

Individual statements contained in the questionnaire have been analysed as sub-themes to evaluate for contributions to our understanding of how the participants' priorities were situated, and how these may have altered over time.

Twenty-one participants contributed to the data gathering process, which was a small sample from the total population of over 30,000 learners. Hence this research has been exploratory, the findings are indicative, and it could be considered as an attempt to establish whether research with a larger percentage of the population could be valuable.

1.5 DEFINITION OF TERMS

'Adults': Learners who are 19 years or more. A mix of adults returning to education and mathematics often after a break. Includes some HE students on Foundation degrees. The study excluded any who have medically diagnosed anxiety.

Affect: An affect in the context of this research is a descriptor for an emotional response to a stimulant, such as looking at a fraction calculation, or thinking about a test. This contrasts with an effect, which is what happens because of the affect, e.g., if looking at a fraction calculation leads to a positive or negative emotional response this is an affect; if the emotional response means that the calculation is wrong, or not attempted, that is the effect: the outcome of the affect.

'GCSE Mathematics': Qualification that is seen as the 'gold standard' in terms of Level 2 qualifications, and a critical marker for university entrance. Adults undertake a one-year course for this qualification which would be delivered in three years in schools, so the pressure on the qualification is two-fold for the learners, as it is high in terms of the content that needs to be covered in a restricted timeframe, and often vital for their plans. A grade 4 is usually the required grade for university entrance and is equivalent to the previous C grade. The grading system of A*, A, B, C, down to U, unclassified, has been replaced by grades 9 as the top grade, down to 1, and then U, unclassified. To achieve a grade 9 a student would need to be familiar with some of the AS, the first year of the 'A' level, material that has been introduced into the GCSE curriculum.

'Further Education' (FE): Refers to college provision for GCSE mathematics courses, which in Britain are positioned between schools and Higher Education (HE). Students can choose to leave at 16 years old to go to college, or onto apprenticeships. Sixth form colleges tend to have 16–18-year-olds; FE colleges also cater for these learners, and for

many adults (19+) returning to education. In addition to colleges, local authorities, the WEA, private providers, and trade unions can also offer this qualification.

'Self-efficacy': Described by Bandura as "beliefs in one's capability to organize and execute the courses of action required to produce given attainments" (1997, p. 3), thus a person's belief in their ability "predicts the goals they set for themselves and their performance attainments" (p. 11). In addition, self-efficacy gives a feeling of control to individuals, which can lead to a self-fulfilling prophecy (Skemp, 1987; Bandura, 1997): we believe that we can, so we do. An individual's self-efficacy levels will affect how confident they feel in certain situations, as those who believe that they can achieve a certain goal "approach potential stressors or threats with the confidence that they can exercise some control over them" (Bandura, 1997, p. 39). This may not always be the case as we may believe that we can but be wrong, but the implication is that we are more likely to be correct, and that self-belief will have a positive effect on performance.

'Confidence': Described by Skemp as signalling "competence: ability to move forward to a goal state" (Skemp, 1987, p. 193). This definition fits with a post-task view, as the student, rather than demonstrating self-efficacy by believing that they can do something, is now seen as competent and able to progress. This definition of confidence has been used by researchers who looked at how sure students were about answers to questions after testing (Swan, 2006; Foster, 2016). The word 'confidence' does occur in this investigation, but in conjunction with 'in their ability', which shows that it is self-efficacy that is under review.

'Anxiety': For many researchers anxiety is an all-encompassing description for a range of negative feelings, which can include fear, anxiousness, and/or insecurity generated by a lack of control over a situation (Skemp, 1987). This lack of control is also discussed by Bandura, who defines anxiety as "a state of anticipatory apprehension over deleterious happenings", and "as an emotion of fright indexed by … subjective feelings of agitation (Bandura, 1997, pp. 137-138). The physical and mental responses caused by anxiety can interfere with the cognitive process, positively to a certain point, but after that in a negative way (Yerkes & Dodson, 1908; Skemp, 1987; Wang, et al., 2015).

'Examination grade': Refers specifically to the grade that adult learners achieve overall in the GCSE mathematics examinations, either in November or in May and June, which

can be seen as a performance. Performance, as defined by Bandura, is differentiated from 'outcome', which is what occurs because of the performance (Bandura, 1997). For instance, the outcome of a grade 4 for many of these adult learners is progression onto a university course.

1.6 PHILOSOPHICAL UNDERPINING OF THE RESEARCH

The philosophical perspective which underpinned this thesis is Critical Realism, which fits well with both my personal and professional perspectives. Dictionary definitions of 'critical' refer to both the negative aspect, namely that it can mean severe or negative judgements, and the more positive academic definition, which will be used here, that it means to evaluate carefully and analytically. 'Realism' is defined as the acceptance of the physical world, facts, and events within it as real- it is a practical awareness of life and a pragmatic view (William Collins Sons & Co Ltd, 1985). Thus, 'critical realism' fitted my world view, as I retained a practical, pragmatic perspective through much of the theoretical necessities of doctoral study, as I aspired to influence and improve the praxis of teaching and learning mathematics for adult learners (Scheiner, 2019).

Critical Realism from a philosophical perspective adds depth to this view, as it states that individuals on the one hand, and societal institutions and organisations on the other are in constant discussion or negotiation, with each acting upon the other. This is labelled by Bhaskar as the 'transformational model of social activity' (TMSA) (Bhaskar, 2020), and it means that due to human agency, there is a constant possibility of change and development as each interaction takes place (Archer, Bhaskar, Collier, Lawson, & Norrie, 1998; Collier, 1994). Human agency involves motivations and reasoning, which allows for either support or change of the current system, although the speed of change could vary across different political, social, economic, and educational systems.

According to the work of Bhaskar, who worked mainly with the physical sciences, a theory is 'realist' if it strives for or achieves objectivity, whilst acknowledging that the knowledge acquired is fallible, because other information may emerge which changes the theoretical stance (Collier, 1994). This view of knowledge as a 'work in progress' follows the thinking of Kuhn in his work on scientific change, as he saw the development of theories as a process of trial and error, where models are adopted, adapted, or discarded (Kuhn, 1970). Interestingly, Kuhn likens this process to changes in societal and political institutions, and this model can also be applied in education, as can be seen in

research programmes which employ a Randomised Control Trial model (RCT), which is more often used in medical trials: in FE, researchers have compared the results of colleges that have introduced interventions with those in a control group (Dalby & Noyes, 2019), in an application of the RCT model, to enhance objectivity and thus validity.

The movement from describing what is found to testing changes, from description to prescription- from 'this is what we find' to 'this is what we should do about it'- assumes that we can use facts to derive values (Bhaskar, 2020), and this is implicit in this thesis, even though it could be argued that we can only infer the feelings of others (Wittgenstein, 1968), and that our knowledge is therefore subjective and should be described as belief (Kuhn, 1970).

The contribution of Critical Realism to this debate about knowledge and belief is that, whilst acknowledging that experiences and causal mechanisms are not the same, they are connected, and that from examining experiences researchers can infer connections. Researchers can then collect evidence to evaluate whether the connections are common and occur in a repeating pattern. From this, researchers can start to build a picture of whether those connections are in a relationship which can be considered causal, so that generalisation becomes feasible (Collier, 1994), although there are recognised dangers for generalisation in the social sciences, as they can tend towards behaviouristic approaches (Hempel, 1966).

There are overlaps between Critical Realism and other theoretical constructs, for instance in Adaptive Theory a key facet is a desire to use the knowledge and understanding gained from the research to generate an intervention that can be used to help learners by improving outcomes, thus generating a solution to an identified problem (Layder, 2018).

Drawing on the work of Tashakkori and Teddlie (1998, p. 23), Critical Realism felt the best fit, rather than Adaptive Theory, as I accepted an external reality, and was likely to choose explanations that could produce the desired outcomes (improving grades for adults in GCSE mathematics examinations), and believed that I could analyse certain relationships, such as that between anxiety or self-efficacy and examination results. This

indicates a Post-Positivism and Pragmatism way of thinking (Biesta, 2010; Scheiner, 2019).

To counteract this quite positivistic view there is an interpretivist view, that knowledge is socially constructed, or created from experience, due to the importance of context (Burgess, Sieminski, & Arthur, 2006). This is relevant here as this research was based on peoples' opinions and placed value on their accounts or stories (Sfard, 2013; Thomas, 2013). An interpretivist view accepts a fallibility with socially constructed knowledge which differentiates it from scientific knowledge, but that does not prevent its usefulness, if the findings are sufficiently convincing due to their depth, or apparent lack of bias (Thomas, 2013; Munn-Giddings, 2017).

The implications of this Critical Realist perspective for my research can be interpreted as positive as, situated as I am within time and space, my work could contribute to generating change (Biesta, 2010; Greene & Hall, 2010). If the changes are effective, then my work may cease to be relevant in that version of the future (Lawson, 1998). Educational research does not always challenge the status quo, as it could support it, but in this case, I believe that it does challenge it in several ways by emphasising the affective domain and identifying specific aspects of the course content less considered by other researchers, such as word problems. Their inclusion into the data collection process arose because of personal knowledge and experience of the curriculum, and an understanding of the difficulties experienced by learners in mathematics classrooms.

I have a long-standing underpinning philosophical and practical belief in the importance of language as a method of communication, which must be mutually understood to be effective, otherwise it becomes a private language (Wittgenstein, 1968). This may seem to be a statement of the obvious, but mathematics has some language of its own, and employs 'normal' words, such as 'table', 'product' and 'change', in particularly mathematical ways. Learners need to have an understanding of the language of mathematics, whether they are ESOL learners or not (Stacey, 2018).

Other aspects of mathematics, in addition to the language, can be equally challenging for learners. For instance, the complexity of the interpretation of two-dimensional (2D) shapes, and 2D representations of three-dimensional (3D) objects (Wittgenstein, 1968),

requires that these aspects must also be taught if learners' interpretations are sufficient to be successful in examination questions.

This research has not challenged the underpinning structures of the content of the mathematics GCSE course, its relevance for onward journeys into changing career paths, or the examination system, but has examined how those structures could impact on learners who experienced them and sought ways that could mitigate any negative effects. For example, I am not suggesting that we drop word problems from the examinations because learners find them challenging, but that the teaching profession becomes more aware of the impact of word problems on examination results and explores or adopts ways that help learners succeed.

1.7 CURRENT CONTEXT

Further Education is a sector of education in England that in the 2019/2020 academic year included a range of 244 colleges, such as FE, Sixth Form, vocational, e.g., those that specialise in agriculture, or art and design, and other specialist colleges, such as those for students with SEND requirements, e.g., autism, or visual impairments. In 2019/20, 168 of these 244 colleges were general FE colleges (Association of Colleges, 2024). This thesis has drawn participants from adults in local general FE colleges in the East Midlands and South Yorkshire.

Learners who re-engage with learning as adults are referred to as lifelong learners (Bélanger, 2015; Safford-Ramus, Misra, & Maguire, 2016). Lifelong learners return to education after a break, sometimes of many years, so they are also known as learners or 'mature adults' who are on non-traditional pathways in education (Dodd, 2016), compared to the traditional pathway students, whose pattern of attendance is school, 6th form school or college for A levels or equivalents, and then to university.

The Department for Education (DfE) and the Education and Skills Funding Agency (ESFA) produce a series of reports each year to show the number of learners at colleges in England. In the 2019/20 academic year 30,650 adult learners were on GCSE Mathematics courses (Gov.UK (1), 2020), and although over the last 10 years numbers have fallen from approximately 40,000 (Gov.UK (2), 2020), adult learners still made up about 10% of those sitting GCSE mathematics annually. Two thirds of these adults were

female and one third male, and, analysed by age, 45% were aged 19 to 24 years, and 55% were 25 or over (Gov.UK (1), 2020).

The majority of adults (19+) were re-take students who have not achieved a grade 4 (equivalent to the 'C' grade) in previous examination attempts, but adult numbers will include those who have not taken the examination previously, such as those who left school early, or migrants who need UK qualifications for life and work in England (Oughton, 2013).

The examination for GCSE Mathematics consists of two or three papers taken over a period of four to five weeks in May and June, or over one week in November each year. The grading system at the time of writing was from 1 to 9, where 1 is the first grade above unclassified, and 9 is the top grade.

University entrance, which is the motivation for re-takes in many cases (Barton & Stone, 2013), for most courses require a grade 4, which is equivalent to the lower two thirds of the previous 'C' grade (AQA, 2018). Some popular courses, such as Midwifery, or courses with a greater requirement for mathematical skills, such as Engineering, can ask for higher grades. Motivations will be covered in more detail in Chapter 2.

At the time of writing examination papers are split into two tiers, Foundation and Higher. The potential maximum grade on Foundation papers is a grade 5, which has been considered by some universities as a grade B, as it includes the top third of the C marks and the bottom third of the B marks in the 'old' system. Learners who want or need a higher grade must take Higher tier.

The next and last section of Chapter 1 includes an outline of the remaining chapters in this thesis.

1.8 OUTLINE OF CHAPTERS

This last section of my first chapter contains an outline and summary of subsequent chapters, namely the literature review, research methodology and design, data analysis, discussion, and conclusion.

The literature review in Chapter 2 contains sections on learning theories, self-efficacy and anxiety definitions, details of researchers' existing scales, including research that combines self-efficacy and anxiety, and learners' motivations and characteristics. It also

has a section on a review of publications that have included interventions for adult learners, where these include aspects relevant to the thesis.

Chapter 3 on methodology contains sections on mixed methods and insider research, as these underpinned the research, which was conducted in the FE educational sector and has gathered qualitative data using a questionnaire, analysed descriptively by quantifying responses to the attitude scales. It includes the research design for the pilot study, phase 1 and phase 2 of the main data collection, the development of the questionnaire, a methodological justification for the inclusion of interviews, and a section on thematic analysis, which has been chosen for the data analysis. Finally, the methodology chapter has a section on ethical issues.

In Chapter 4 on the data analysis, the themes explored include course content, classroom dynamics, assessment, and, in section 4.6, some additional sub themes that emerged from the analysis, such as the impact of time pressures and the importance of a sense of community to participants. To facilitate the development of themes the data were analysed as both case studies and using quantitative techniques to ensure that a complete picture was in place, and these were summarised thematically for presentation in this thesis.

In addition, the data was reworked using a group or multiple case study approach, to evaluate whether any patterns emerge when the focus is on learner characteristics such as age, gender, and first language. Finally, self-efficacy and anxiety responses have been compared to ascertain which might be the most effective when data gathering from groups of adult learners. Chapter 4, section 7, also includes a review of the attitude scales used in the questionnaire.

Chapter 5 contains reflections and discussion on the findings, structured by the research questions, and reflections on the methodology and methods used for the data collections and analyses.

Finally, Chapter 6 summarises the key findings, investigates the implications for further research and for teaching, if substantiated by a larger scale study, and acknowledges the limitations of the study. Chapter 7 contains references, and Chapter 8 has appendices with information relevant to the research.

2 CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this literature review, I have drawn on those publications and papers that relate to adult learners, particularly, when available, on learners within adult basic education provision. I have also included research on undergraduate populations, where they are reported as experiencing similar challenges with the mathematical content of their courses as the ABE learners. For example, Gal (2024) surveyed 22 journals for references to adult mathematical learning and found only 39 references to adults in 2,300 papers. He noted the need for more studies on the practice of adult mathematics education, which seemed to be relatively poorly researched, despite increasing evidence from many sources on the ability of numerical knowledge to transform lives. However, Gal does note that university studies were not included in his references count, because the students differed in fundamental ways, such as traditional vs non-traditional pathway learners, and lifelong learning, but that research on these can be useful (Gal, 2024). I have focussed on those studies that focus on non-traditional pathway learners who were obtaining help with mathematics in remedial type settings that were useful.

Whilst this research has concentrated on the relationship between self-efficacy, anxiety and performance for adult learners studying GCSE mathematics, these aspects can be seen as forming some parts of a very complex picture, in which there are also working and long-term memory, motivations, past experiences, perceptions of education, examinations and mathematics, current psychological, social, and economic states, mathematical resilience issues, and personality traits, such as persistence. Many researchers have engaged with various facets of this complex picture, with participants of different ages, genders, and ethnicities.

I have covered learning theories, especially as they relate to adults, further education research, and scales that have been developed for both self-efficacy and anxiety, as revised scales have been used in this research. Self-efficacy studies, anxiety studies, and some research which covers both self-efficacy and anxiety will also be reviewed, in addition to interventions that have been devised to help adults engage with aspects of mathematics learning. Throughout particular attention will be paid to the research from these areas which discusses aspects of performance in relation to mathematics

especially for adults, although some research, included due to its relevance to this thesis, may have taken place with younger learners.

It has been necessary to be selective about whose work from these vast and complex fields to include, but this does not reflect negatively in any way on the quality or content of the enormous body of work omitted.

The focus of the next section is learning theories.

2.2 LEARNING THEORIES

In this section, I have included examples of the learning theories that have informed my approach to adults' teaching and learning. This is not an exhaustive list of learning theories, but they are some of those that I have encountered through teaching training and my research journey, and which are relevant to the thesis and my thinking.

GCSE mathematics courses involve a substantial amount of learning for adults, and while many of the 120 topics will have been taught in schools, adults may have either struggled to learn them at the time or have forgotten much of what they knew since. This forgetting can be because of a lack of relevance of the topics to their lives, whether that was perceived or actual. It is likely that some topics, such as money and time, will have been retained due to their relevance, whereas others, such as algebra, may not be remembered.

There has been a debate about whether adults returning to education after a break learn differently from children, but this theory was largely discarded by some researchers who found similarities in how learning happens (Rogers, 2003). Thus, learning theories can apply regardless of the age of the student in most situations, although adults could have developed their own preferences for ways of learning which need to be considered by teachers, such as rejecting manipulatives if they are considered 'childish' by learners, and adults may prefer a negotiated, rather than a prescriptive way of working (Rogers, 2003). In addition to ways of working, there are other aspects that differentiate adults from children, such as their motivations for learning, summarised by Knowles et al, which led to a label of 'andragogy', rather than the 'pedagogy' applied to children (Knowles, Holton, & Swanson, 2015).

Andragogy contrasts with pedagogy due to the differences between adults and children, as adults bring different and more substantial experiences to the classroom, along with a need to know about the subject that they are studying for either intrinsic or extrinsic reasons (Safford-Ramus, 2008). These reasons for study mean that adults are motivated and ready to learn in a way that children, who are required to accept compulsory education until a certain age, are perhaps not. Adult learners are also prepared to be self-directed in their study outside of classrooms, and may have orientated themselves towards the learning, to strive to reach an end point, whether that be onward study, or for personal satisfaction (Knowles, Holton, & Swanson, 2015).

Andragogy, whilst it is a useful and instructive way for teachers to think about and evaluate the differences between adults and children (Safford-Ramus, 2008), seems to describe the differences in the approach to learning, rather than the way learning takes place, and it is this difference which means that traditional approaches to pedagogy, or learning generally, also have a place in this thesis.

The learning theories of Piaget and Vygotsky, two of the most influential early thinkers and observers of development in children and thus in the field of pedagogy, differ in some respects, such as the way they believe learning is acquired- the former believing that the development of the mind occurs when it is stimulated by new information that stimulates the construction of knowledge, to cope with a 'disequilibrium', and the latter that social interaction stimulates learning, as children instinctively copy and develop their own explanations, based on existing understanding. However, both are constructionists in that they believe that knowledge is constructed, initially through concrete examples and experimentation, and eventually through discussion, reading and explanation (Wadsworth, 1996).

The Zone of Proximal Development (ZPD) was developed by Vygotsky to add more detail to the acquisition of knowledge, and is acknowledged as a useful way of engaging with the learning process by many researchers in adult education, both for those with and without English as a first language (Safford-Ramus, 2008; Adler, 2001). The ZPD describes the process of learning, when the movement from what is known into what is unknown is likely to be challenging, and if the challenge is too great it will induce fear, which can block further learning. These ideas, and the model created, have informed

other educational researchers working in the field of mathematics, such as those who have worked on mathematical resilience (Lee & Johnston-Wilder, 2017).

Piaget and Vygotsky differ in the way they describe the move from concrete, practical knowledge to a theoretical understanding which can be applied in a variety of situations, as for Piaget this is formal operational reasoning, but for Vygotsky, this is higher order thinking, or functioning (Smidt, 2009; Wadsworth, 1996). Commenting on adult learning, Piaget believed that not all adults fully develop formal operating reasoning as they may be prevented by disability or a restriction in the learning environment (Wadsworth, 1996). This restriction can include issues with the affective domain, which may have caused a mental 'closing of the gate' that allows learners to make progress in their learning. Thus, affect can play a central role in learning as we learn through experience, and that experience can either motivate us to continue or, if negative, to reject the experience and close our minds to it.

Dweck (2017), who first published in 2006, built on earlier work into both the affective domain and the different attitudes that people can display to learning. She described the different approaches as those with a growth mindset (GMS), and those with a fixed mindset (FMS). Her study of undergraduates in the USA found that when those with a GMS got poor test results, they were upset by it, but still attended classes, did assignments and worked harder, whereas those with a fixed mindset (FMS) were inclined to give up and believed that they did not have the ability to make progress. This indicated a belief in innate ability, but Dweck argued that teachers could counteract the effects of these beliefs by encouraging students (Dweck, 2017).

The development of research concerned with cognition, of which Dweck's work forms a part, has been further developed in mathematics education by Boaler, among others, in her work on mathematical mindsets (Boaler, 2016).

Vygotsky's references to the importance of social interactions can also be seen to inform our appreciation of the importance of the teacher's contact with adult learners as they mediate and facilitate learning, and how the classroom, as the context for learning, can be seen as important as the place where the 'zone of actual development' is explored to enhance learning (Smidt, 2009). This supported the inclusion of a section on classroom dynamics in this study.

Learners' understanding of the relevant language and symbols is also critical to development, as it enables them to make sense of what they see or hear (Smidt, 2009). This will be even more important for those whose first language is not English and who may not have an alphabet but use ideograms to represent objects (Barwell, 2009; Stacey, 2018).

Higher mental functioning, according to Vygotsky, is also essential for the move from concrete examples to abstraction and adds tools to our learning repertoire. These higher powers include meta-cognition (knowing that we know) and reflection, in addition to the abilities to generalise, compare, order, analyse, and recall (Smidt, 2009). The latter is particularly important as memory allows for abstract thought, but as Piaget discusses, memory on its own is insufficient as it can preclude understanding, which can lead to a loss of faith and self-belief, especially in mathematics (Wadsworth, 1996).

On problem solving Piaget highlights the need to nurture "the disposition, desire and confidence to pursue problems" combined with "the belief that one can succeed", (Wadsworth, 1996, p. 159) in other words, the importance of self-efficacy (Bandura, 1997).

In conclusion, it seems clear that many theorists acknowledge the importance of the role of teachers, classrooms, and resources for success in learning, and the need for dialogue and discussion to develop meaning and enhance the understanding of mathematical content. Learning has also been seen as open ended in terms of time, dependant as it is on social situations, which implies that adults have just as much chance as young people to develop aspects of formal or higher order thinking skills, which can in turn enhance their understanding of, and success in, mathematics. However, there can be acknowledged differences in the approach to learning experienced by adults (Knowles, Holton, & Swanson, 2015; Rogers, 2003).

Potentially one of the barriers for adults which might influence their approach to learning is the limited time that they have before the first GCSE mathematics examination, which is approximately 28 teaching weeks. Whilst conceptual understanding and an ability to model answers are highly desirable (Skemp, 1987; Safford-Ramus, 2008), for some learners there may only be time to gain some

procedural competence, which they hope to retain for long enough to achieve the desired grade.

This concludes the section on learning theories. The next section of this literature review covers concepts of self-efficacy and anxiety, and the development and use of different scales.

2.3 SELF-EFFICACY AND ANXIETY IN MATHEMATICS

2.3.1 Introduction

In the section of the literature review, I first set out my definitions and understanding of the terms 'self-efficacy' and 'anxiety'. I then review the scales that have been developed by other researchers for each of these concepts. Finally, I review research that has used a combination of many different self-efficacy and anxiety scales to gather data from participants.

As discussed in the introduction in Section 1.5, 'Definition of terms', I have used Bandura's description of self-efficacy as a person's belief in their ability to organise, prepare for and complete certain courses of action. The implication of this definition is that if a person has confidence in their ability, they are more likely to reach the goal that they aspire to, because the feeling of competence has a positive effect on their performance and gives them a sense of control over outcomes (Bandura, 1997; Skemp, 1987). In contrast, by 'anxiety', I mean feelings of apprehension, fear, fright or agitation, which can be based on or exacerbated by feeling a lack of control over certain situations or events, and can have a negative effect on performance. I accept that, whilst some anxiety can have a positive effect on performance if it enhances thinking skills, too much can induce a state of panic or near-panic, which can have a negative effect (Bandura, 1997; Skemp, 1987; Evans J. , 2000).

Bandura's 1997 definition of self-efficacy has been used by many writers in the mathematics field, in addition to Skemp (1987). For instance, Holloway (2013) quoted from Bandura's work, who said that "Perceived self-efficacy is concerned with judgements of personal capability" (1997, p. 11), and that stereotypical threat, such as a belief that females are genetically less mathematically capable than males, can influence self-efficacy judgements. In addition, Holloway expounds on the findings of other research, which suggested that self-efficacy beliefs can be improved with

remedial mathematics courses, such as those found in HE provision (Klinger, 2005; Marshall, Staddon, Wilson, & Mann, 2017).

The identification of differences in the perceptions of learners in terms of their self-efficacy and anxiety in mathematics has led over many years to a proliferation of instruments designed to measure the strength and depth of these constructs. For instance, Tobias used two of the Fennema Sherman scales, 'Confidence in Learning Math' and 'Math Anxiety', to develop her composite 'Math Anxiety' scale (Fennema & Sherman, 1976 ; Tobias, 1993), which included two phrases which show that they relate to confidence in ability: "I don't think I could do advanced math" and "I think I could handle more difficult math". Once researchers have been able to measure aspects of the affective domain, the next steps have been strategies to mitigate the effects that they could have on learning because, as Buxton (1981) pointed out, measuring a perception does not necessarily treat it.

The work of Swan (2006) and Foster (2016), which measured confidence pre and post calculations for students in FE and secondary schools respectively, highlighted the differences between self-efficacy and confidence, as the pre-test request for confidence in their answers demonstrated self-efficacy, a belief in their ability, whereas the post-test assessment checked for confidence in their answers. These studies demonstrated the nuances between the two concepts, and that learners' self-efficacy and confidence were not necessarily accurate and challenged the linking of perceptions with performance.

Self-efficacy as confidence in the performance of a specified task is differentiated from self-confidence, self-image, self-respect and self-esteem (Boylan & Povey, 2021; Black P. , 1998), although it may have an impact on all of these and other facets of personalities.

In addition to research on self-efficacy, research on anxiety is relevant to my thesis. Anxiety can be a complex blend of fear, loathing, or panic, which can either be induced by past experiences based on teacher and/or parental pressure (Buxton, 1981; Skemp, 1987; Tobias, 1993; Holloway, 2013), or concerns about the perceptions of peers (Skemp, 1987; Davidson & Levitov, 2000). Memories of school may have left adults with the belief that mathematics is boring, repetitive, and irrelevant (Macrae, 2003),

but these perceptions are not the same as being anxious about mathematics. As Buxton (1981) said, fear and anxiety could lead to avoidance and panic in mathematical situations, whereas irritation will probably not have the same effect. High stakes tests were particularly identified as causes of anxiety (Holloway, 2013; Evans J. , 2000).

In addition, anxiety can be caused by insecurity generated by a lack of perceived control over specific situations, which can lead to apprehension or fear (Skemp, 1987; Bandura, 1997). A certain level of anxiety can have a positive effect on cognitive function which can enhance performance, but too much can interfere with functioning and performance then declines (Wang, et al., 2015; Yerkes & Dodson, 1908).

Previous research has demonstrated the importance of building self-efficacy and reducing anxiety for success in mathematics for many age ranges of students, including for adults, although this has usually been for adults in HE (Evans J. , 2000; Hunt & Sandhu, 2017). For instance, research based on interviews conducted with HE students on non-traditional pathways in education, who had presented at support sessions for mathematics at a university, was conducted by Dodd, who identified a need for more research in this area, as these learners lacked confidence in their abilities in mathematics, which was important in performance and for achievement (Dodd, 2016). These findings are supported by other writers and researchers who have expressed the importance of self-belief for success in test situations (Black P. , 1998), and the negative effect that can be experienced on motivation and self-image of low confidence in ability (Boylan & Povey, 2021). However, Hardy (2009) challenged the link between confidence in ability and performance, and highlighted the need for caution when making assumptions about mathematical ability if they are based on confidence in class.

These, and many other sources, for both self-efficacy and anxiety, will be referenced in the subsequent sections of this literature review, which now moves to an evaluation of self-efficacy scales.

2.3.2 Self-efficacy scales

Self-efficacy scales developed out of the work of Bandura (1997), as a way of evaluating an individual's potential by measuring their confidence in their ability. One of the first self-efficacy scales was a generalised one for use in recruitment and training contexts,

which includes questions on how people would cope or respond given certain challenges, and used a scale from 1 to 4, where 1 is 'not at all true', and 4 is 'exactly true'. It is known as the Generalised Self-Efficacy Scale (GSES) and was developed in 1993 in Germany (Schwarzer & Jerusalem, 2022).

However, earlier scales existed, prior to the work of Bandura, which can be interpreted as self-efficacy scales, such as the 'Confidence in Learning Math Scale', devised by Fennema and Sherman (F-S) as part of their 'Mathematics Attitude Scale'. This confidence scale consisted of 12 statements, six positively and six negatively framed, on each of which participants are asked to rank how they feel from 'strongly agree' to 'strongly disagree', thus a Likert scale. For instance, it asks students to comment on both "I don't think I could do advanced mathematics", and, in contrast, "I am sure I could do advanced work in mathematics" (Fennema & Sherman, 1976 ; Mulhern & Rae, 1998).

The Composite Math Anxiety Scale from Tobias (1993) contains the first of these statements, which can be interpreted as self-efficacy statements, with others drawn from the F-S Confidence scale, such as "I think I could handle more difficult mathematics" (1993, p. 258).

In Evan's work with undergraduate students in England, there is a scale that can be interpreted as a self-efficacy scale, which he calls an 'Experience Scale'; he uses a scale from A, which is 'very capable', to D 'not at all capable', through B 'fairly capable', and C 'not very capable', and asks questions about course content: 1) Basic operations (+, -, x, ÷), on whole numbers, 2) Fractions, 3) Percentages, 4) Decimals, 5) Basic Algebra and 6) Graphs (Evans J. , 2000, p. 247).

A survey in Australia with 14-year-olds in Secondary schools, which focused on self-efficacy and course content, resulted in the MSES (Mathematics Self-Efficacy Scale) (Nielsen & Moore, 2003), which has been used by other researchers whose work is discussed in this thesis. In the scale there are 9 questions on algebra, decimals, geometry, trigonometry, area and volume, fractions, and Pythagoras ('Find the length of a missing side'), designed to ascertain "students' perceived competence for the content" (Nielsen & Moore, 2003, p. 131), rather than actual working out of answers. The scale goes from 'not at all confident' which is given 1, to 'very confident', which is given 5, in a 5-point attitude scale, so the higher the score the more confident they are

about their ability. The researchers created two scenarios in the questionnaire, namely 'in a classroom' and 'in a mathematics test', so respondents had 18 questions in all to consider. This was a large-scale quantitative investigation (n= 302, split 54% females and 46% males).

Nielsen and Moore noted "A statistically significant difference between class and test scores supported Bandura's prescription for context specificity in efficacy research" (p. 128). The results showed that seven out of nine of the test questions were those that students felt least confident about, thus their perceived ability declined in test situations, especially for those that were least confident. Those who ranked their self-efficacy highly had less of a discrepancy between the 2 scores. This study's results are of particular interest, as when they compared self-efficacy levels with test outcomes there was a correlation between results and perceived competence for low self-efficacy students (Nielsen & Moore, 2003).

The Nielson and Moore research was a quantitative study, and one aspect mentioned but unexplored in the research paper relates the individuals' preferences with the mathematical content, for instance, if an individual has, say, high self-efficacy in algebra but low self-efficacy in geometry. In ESOL teaching and learning this display of preferences is called a 'spiky profile' (Colquhoun & Delaney, 2009), when, say, learners can be good speakers of English but have very little writing competency. My research aims to fill this gap by providing detail on specific topics and self-efficacy, which would increase our understanding of and knowledge about learners for teachers in mathematics classrooms.

A self-efficacy scale was used in research which examined 16–18-year-old participants' accuracy of perceptions of algebra in FE classes (Swan, 2006). Pupils were asked to look at questions prior to completion and gauge how confident they were in their ability to answer them correctly. Swan used a self-efficacy scale which consisted of 5 descriptors, so named the five points on the Nielson and Moore scale, with 'Very confident', 'quite confident', 'don't know' 'I don't think I can do this' and 'I definitely can't do this', and this is the scale content that I have adopted for the self-efficacy scale in this research.

The participants were rewarded with points if they had accurately gauged if their ability, whether the answer was correct or not, they were awarded 2 points (Swan, 2006).

Although the results of this research were, in most cases, not statistically significant, it does highlight the challenges faced by FE students with mathematical calculations containing algebraic notation. This study is also of relevance to this thesis because in 2006, GCSE mathematics was not compulsory in FE colleges, so the participants were motivated to attend for some reason, such as to ensure progression to the next level of their course or into HE, which are often the motivations of the adults in GCSE mathematics classes. GCSE mathematics became compulsory for 16- to 18-year-olds who had not achieved a grade 4 or better at school in 2014.

More recent research by Foster (2016), which follows the model used by Swan (2006), asked secondary school pupils in England to assess their self-efficacy by asking how confident they were about each of ten mathematics questions, after completing the answers, and at several points in the academic year. This research has supported the approach in Foster's research of asking participants for their responses more than once in the year, so that progress on self-efficacy on specific aspects of course content can be tracked.

O'Sullivan et al, working with Access to HE students in Ireland used a primer mathematics course for adults, which worked on exposing learners' perceptions of themselves as mathematicians, and provided opportunities to build self-efficacy with mathematics. Their research found an improvement in progression rates for those who had completed the primer course, compared to those who were not on the course, between 6% and 42% over a 4-year period (O'Sullivan, Robinson, Keogh, & O'Neill, 2018). In a similarly focussed study in Australia Robinson et al (2019) researched self-efficacy with 688 non-traditional pathway learners in a university noted that an additional 'catch-up' course for adults raised self-efficacy for those adults, and that 70% felt well prepared for the mathematics encountered in other courses. The course was designed to counteract the effects of a loss of mathematics skills due to the time that elapsed between school and university, in which it was successful, but the adults involved still had higher withdrawal rates and lower scores than those students on traditional pathways (Robinson, et al., 2019), which disagrees with the findings of O'Sullivan et al, which may be due to a number of factors, such as the courses that the adults were progressing onto.

In the research discussed in this section there was little or no mention of word problems, which as will be seen in the data analysis is a potential important omission, but it does support my research approach in terms of including and considering the importance of the assessment of self-efficacy in relation to performance.

Links between self-efficacy and anxiety in student populations are noted by several researchers (Dodd, 2016; Foster, 2016; O'Sullivan, Robinson, Keogh, & O'Neill, 2018), and it is anxiety scales that will be explored in the next section.

2.3.3 Anxiety scales

This section examines the development of anxiety scales, in response to substantial and continuing work on the effects of mathematical anxiety on the ability to perform in mathematical contexts.

Anxiety scales for students of mathematics have been in the public domain since the 1970s, for over 50 years. Quantitative and qualitative research that has used, adapted, or consulted these scales has revealed anxiety about mathematics that stretches from very young children (Petronzi, Staples, Sheffield, Hunt, & Fitton-Wilde, 2019), through secondary school-aged children (Szucs, McLellan, & Dowker, 2017; Boaler, 1997), to those in colleges (Hough, Solomon, Dickinson, & Gough, 2018; Swan, 2006; Lewis, 2013), and also those in universities or polytechnics (Evans J. , 2000; Hunt, Clark-Carter, & Sheffield, 2011).

It is not essential to use anxiety scales when conducting particularly qualitative research, as some, for instance, have used a narrative approach to acquire and analyse participants' experiences (Boylan & Povey, 2009; Cross, 2018), but my research has used an anxiety scale, in addition to collecting participants comments in this mixed methods study.

Anxiety scales, as explored in Evans (Adults' Mathematical Thinking and Emotions, 2000), have developed broadly along two lines, namely the Fennema-Sherman line of the Mathematics Attitudes Scale (MAS) (1976) and the Richardson and Suinn line of Mathematics Anxiety Rating Scale (MARS) (1972). There is a profusion of these scales, as many researchers have adapted existing scales to suit their preferences, and this researcher is no exception.

Hopko developed his 9-point scale after reviewing the MARS-R scale of Plake and Parker with its 24 statements (Hopko D. R., 2003; Plake & Parker, 1982). An initial revision realised a 12-point scale which matched well in terms of validity during the research, but this was subsequently reduced to a 9-point scale after further revision and trials. Regarding content, "Thinking about an upcoming test one day before", along with other statements, is present in all the scales, but "Taking a final examination in a math course" was last present in the work of Plake and Parker (1982).

As can be seen by the use of 'math' in the above, much of the work on anxiety scales has originated in the USA. A scale designed for use in the UK was created and tested at English universities and called MAS-UK (Mathematics Anxiety Scale-UK). An attitude scale numbered 1 to 5 is used with 23 statements, which are a mix of classroom scenarios, every day and class-based mathematics, and two questions on assessment, namely "Taking a maths exam", and "Being given a surprise maths test in a class". The mathematics questions range from the four number operations, mostly using money, but also include three mentions of algebra and equations, and one of changing a fraction to a percentage (Hunt, Clark-Carter, & Sheffield, 2011).

The MAS-UK, when tested, revealed that "as predicted, overall maths anxiety was significantly greater in women than in men" (Hunt, Clark-Carter, & Sheffield, 2011, p. 462).

The Mathematics Calculation Anxiety Scale (MCAS) also devised and tested by Hunt et al contains 26 statements drawn from the content of the GCSE curriculum, which is highly specific, such as "Identify the prime numbers in the list…" and "State Pythagoras' theorem" (Hunt, Bagdasar, Sheffield, & Schofield, 2019). The scale is, again, based on an attitude scale from 1 to 5, where 1 is 'Not at all' and 5 is 'Very much'. The research revealed differences between various aspects of mathematics, such as between anxiety about calculations, compared to anxiety about algebraically phrased questions.

The MCAS scale was tested on university undergraduates, and the researchers acknowledge that the "results cannot be generalised to a non-undergraduate population given that maths GCSE grade C or above (or equivalent) is typically a minimum entry requirement" (Hunt, Bagdasar, Sheffield, & Schofield, 2019, p. 4). This is very true, as the MCAS is unsuitable for most adults returning to study after a break, due

to the amount of knowledge it assumes to be present. However, it could be useful for evaluating skills towards the end of the course or used with those returning who have already achieved a grade 4 but need a higher grade to progress.

In addition to the above limitations of this scale for adults returning to GCSE mathematics classes, there is no mention of word problems in the MCAS. As shall be seen in future chapters, this is an important and notable omission.

Some researchers have employed a mix of self-efficacy and anxiety scales in their research, which has similarities with this study, so these will be discussed in the next section.

2.3.4 Research that combines self-efficacy and anxiety

This section is specifically concerned with research that has included adult learners and used scales that contain instruments for gathering learners' perceptions on their own self-efficacy or anxiety, or, in most cases, both. There have also been some examples of attempts to link self-efficacy, anxiety, or both to performance, although this has not often been in final examinations (Evans J. , 2000; Dodd, 2016).

Self-efficacy, as previously explained, was described by Bandura as a "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" (1997, p. 3) . Many researchers have employed Bandura's definition of self-efficacy, and linked that belief to performance (Dodd, 2016; Foster, 2016; Jameson & Fusco, 2014; Swan, 2006).

Maths anxiety is a subject that has engaged researchers for many years, although much of that work has been achieved in the USA, and often with students in schools, colleges, or universities on traditional pathways into education (Tobias, 1993; Evans J. , 2000). However there is some work which has been undertaken with non-traditional pathway learners in HE settings on self-efficacy and anxiety in mathematical settings (Dodd, 2016; Jameson & Fusco, 2014), and others which are concerned with ABE learners in the USA (Watts, 2011; Clarke, 2021). Finally, there has been some work in the UK with FE students, although this is predominantly concerned with 16–18-year-olds, rather than focussed on the adult provision (Swan, 2006; Dalby & Noyes, 2018).

The importance for self-belief in one's ability, its link to performance and relationship with mathematics anxiety has been investigated by Jameson and Fusco's (2014) work with 166 non-traditional adults (over 22 years old) in USA HE settings. This research discussed that "self-efficacy, the belief that a person can successfully execute a desired behaviour to result in a desired outcome, has consistently been shown to be low in highly math anxious individuals", and that "many adults dislike and avoid math", and this is likely to be due to "a combination of math anxiety and low confidence" (p. 309). This view is supported by work in Australia, which found that "students who experience mathematics and anxiety often lack self-belief and confidence in their ability to do mathematics" (Everingham, Gyuris, & Connolly, 2017, p. 1154).

Watts (2011) used the 9-part, 5-point self-efficacy scale (MSES) devised by Nielson and Moore (2003) with Adult Basic Education (ABE) learners, compared outcomes with the MARS scale (Richardson & Suinn, 1972), and performance on an initial assessment type of test, a 'placement' test, in the USA. Clarke, using the MSES for self-efficacy (Nielsen & Moore, 2003) and the 30 point MARS scale for anxiety (Suinn & Winston, 2003), applied these in a quantitative study which compared levels to grades on the High School Equivalency examinations, which are similar to the GCSEs in England, as they are marker examinations for university entrance (Clarke, 2021). Both Watts and Clarke researched with community college adults and found that self-efficacy scores in mathematics were the only predicter of scores on the tests, as those with higher levels of self-efficacy were more likely to achieve higher scores, and vice versa, thus mathematics anxiety was not a predictor for grades in assessments.

In addition to the link between self-efficacy and performance for adults, rather than anxiety and performance found in other research, neither found any differences in terms of age, or gender, or, in the case of Clarke's research ethnicity, among their groups of participants (Clarke, 2021; Watts, 2011). These findings did not conform to the view that generally females are more anxious about mathematics than males (Boaler, 1997). This may be because both males and females in mathematics classes have so far been unsuccessful in mathematics examinations. It seems unfortunate that neither Clarke nor Watts seem to have published these important findings, and that the only way to locate them is through the theses and dissertations sections in library searches.

Jameson and Fusco (2014), used the AMAS questionnaire of Hopko et al (2003) for anxiety and the same self-efficacy scale (MSES) devised by Nielson and Moore (2003), which offers choices from 'not at all confident' to 'very confident' on mathematical topics, such as working with decimals and calculating the number of degrees in an angle. They also noted that in the group of older students, compared to 60 traditional students (18- 22 years), there were lower levels of self-efficacy, so lower confidence in their abilities. However, Jameson and Fusco also noted higher levels of anxiety, especially in some mathematical content such as geometry. This supports the findings of Bandura, who found that adults differed from younger students as they displayed lower levels of self-efficacy than they had when they were last in an educational setting, due to attending to and recalling particularly good or poor performances that occurred at an earlier time, leading to a bias in self-efficacy (Bandura, 1997). Thus, negative interpretations of previous failures or non-successes were compounded in learners' minds, reducing self-efficacy beliefs, and increasing anxiety levels.

Research with 115 undergraduates in the USA (Palestro & Jameson, 2020) found that whilst there was a relationship between anxiety and performance, because performance declined as anxiety increased, as judged by responses to the AMAS scale (Hopko D. R., Mahadevan, Bare, & Hunt, 2003), this effect was moderated by high levels of mathematical self-efficacy, as judged by the MSES scale (Nielsen & Moore, 2003). However, there was no moderating effect when researchers looked at participants' emotional self-efficacy, as judged by a different scale (Palestro & Jameson, 2020). This may indicate that there is something specifically about mathematics which undermined confidence in their abilities for these individuals.

Dodd investigated the feelings towards mathematics of non- traditional Foundation Degree students at a university in the UK and advised changing any practice which reduced self-efficacy and increased anxiety. Comments collected from students included words and phrases such as lack of confidence, anxiety, and fear, which are echoed in the findings of the pilot study for this thesis. Additionally, using an asymmetric scale, she found that although there was overall "no clear correlation between anxiety and performance… but all students who identified themselves as 'not at all anxious' gained high marks" (Dodd, 2016, p. 153). Dodd's study will provide a useful comparison

for this study, whether I find that adults with no anxiety also uniformly gain high marks or not.

In contrast to the above research, in a large scale study of 439 community college adults in the USA, in which 25% of the participants identified failing a mathematics examination previously, there was little or no difference in the self-efficacy levels between them and the other 75%, probably because all had identified as needing a remedial mathematics course, indicating low self-efficacy in the subject (Zientek, Fong, & Phelps, 2019). Zientek et al found that a mastery system, which they defined as positive experiences that gave learners confidence, was more effective than other methods tested in raising self-efficacy levels and reducing anxiety. In addition, they saw self-efficacy and anxiety as linked, anxiety arising as a result of low self-efficacy. Furthermore, they identified the importance of the role of teachers in controlling the process of learning in mathematics, as they identified failure in mathematical tasks as confidence reducing and demotivating. The limitations of this study were identified as being that participants self-selected, and that the findings were not linked to results. The latter was identified as an important requirement of future studies.

Marshall et al in 2017 used the MAS-UK scale (Hunt, Clark-Carter, & Sheffield, 2011) with 57 university students participating in extra mathematics workshops on two occasions. From the findings the workshops had a more significant impact on anxiety than self-efficacy, as 78% said that they felt less anxious, but 59% felt more confident in their ability to do the required mathematics (Marshall, Staddon, Wilson, & Mann, 2017).

A more nuanced effect was found in the research of Perez-Fuentes et al (2020) in a study of 2,245 secondary aged pupils found that self-efficacy, which they described as perceived competence, was a relevant and strong predictor of achievement, as the higher the self-efficacy, the better was the performance in an abilities test given to all participants. Anxiety levels, as judged by responses on the Fennema-Sherman mathematics attitude scales, had a relatively small effect, compared to self-efficacy, but the effect was dependant on the anxiety levels: the more anxious participants became, the greater the negative impact on results (Perez-Fuentes, et al., 2020).

Malcolm Swan's research focussed on 785 GCSE Mathematics resit students in Further Education provision, which included 55 adult students, aged 19 to 21 (Swan, 2006). Swan

used the Fennema-Sherman scales for confidence and anxiety (Fennema & Sherman, 1976), but firmly located the confidence scales as self-efficacy, as the questionnaire was distributed before the work was undertaken, so was asking for students' levels of self-belief in their capabilities to answer the questions. He defined and used 'confidence' for post work surveys, as students were being asked to assess how confident they were about their answers.

This use of the terms 'self-efficacy' as pre-event and 'confidence' as post-event are important for clarity in academia, and I will be using these terms in my work. I also use a scale like Swan's self-efficacy scale with participants in the questionnaire.

Timed testing has been identified as a potential cause of maths anxiety (Skemp, 1987; Boaler, 2016), but a certain level of general anxiety may enhance performance, as demonstrated by a study where confident learners were out-performed by the less confident under certain conditions, namely when the less confident were given feedback on how to improve, but not told the score that they achieved (Mandler & Sarason, 1952). However, there may be a point for learners where the pressure becomes detrimental to functioning (Skemp, 1987; Yerkes & Dodson, 1908). The idea that learners' performances, if plotted, would resemble an inverted U shape is supported by several researchers (Evans J. , 2000; Wang, et al., 2015), and this makes sense from a psychological point of view, as too high a level of adrenalin in the body will impair thinking, but a certain level of adrenalin should enhance performance.

The work of Wang et al (2015), whose research encompassed young learners in schools and undergraduates on a psychology degree on a variety of mathematical tasks, concluded that student with high intrinsic motivations combined with moderate anxiety performed better than all other participants. They noted the importance of not over-facing students with the mathematical content of tests, and that younger males performed better than older females, with age more important than gender. The danger of over-facing learners has been recognised by other researchers working with non-traditional adults, who noted that a successful outcome raised self-efficacy and reduced anxious responses to mathematics (Jameson, 2020; Watts, 2011).

The next section covers learners' motivations, perceptions, and characteristics, such as age, gender and whether their first language is English or not.

2.4 LEARNER MOTIVATIONS AND CHARACTERISTICS

2.4.1 Learners' motivations

As explored in Chapter 1, the impetus for this research came from my professional practice, as I have taught adult learners' mathematics up to Level 2 in an FE college for almost 20 years. Since 2014 I have specialised in the delivery of GCSE mathematics to FE students of all ages and nationalities, mostly with adults (19+). The learners are generally highly motivated to re-engage with mathematics classes due to intrinsic or extrinsic motivations, defined by Bandura as "inborn drive verses anticipated benefits" (1997, p. 2).

Intrinsic motivations, or inborn drives, can include joining courses for interest, enjoyment, or health, as adults get an opportunity to meet new people and experience a new environment (BIS, 2011). Wang and colleagues (2015) in their research have shown that high intrinsic motivation combined with moderate levels of anxiety was the most successful combination in terms of good test performances, but for most adults it is not perhaps the intrinsic but the extrinsic drives that are the most important.

Extrinsic motivations, or anticipated benefits, include career changes, to help children with homework, or Access to Higher Education or Degree programmes, for which a grade 4 or better in GCSE Mathematics is requirement for course entry (Skemp, 1987; Black, Mendick, & Solomon, 2009; Young, Wu, & Menon, 2012). Thus a 'pass'/ grade 4 in GCSE mathematics can enable learners to improve their life chances and opportunities, so the teaching and learning of the skills required to complete this task becomes a question of equity (Boaler, 2016; Bélanger, 2015): of helping people to realise different aspects of their potential, within fast-changing economic and social environments (Bélanger, 2015).

Changing motivations, whether intrinsic or extrinsic, economic, or social, can be seen as part of a progression through the stages of adulthood, which in the 20th and 21st centuries have seen revision of career plans in mid-life (Tennant, 2006), because the length of peoples' lives in many countries has increased substantially over the same period, in addition to the increasing rates of change in society.

These societal changes, combined with the caring and career responsibilities adults may have, can cause a pressure on both their ability to attend, and their ability to concentrate

when they get to class. This may be especially true for those who are attending evening classes who have been working during the day, and allowances should be made for these learners (Spencer & Ingram, 1947).

Whatever motivations adult learners bring with them need to outweigh the aspects of their lives that work against regular attendance, concentration, and achievement during the course, for them to succeed overall with a pass grade. For some learners this can take more than one attempt, so persistence may also be a factor for success.

2.4.2 Learners' perceptions: the affective domain

The motivations of adult learners who join mathematics classes have overcome, to some extent, the doubts and anxieties that they may hold as a result of experiencing failure in mathematics examinations previously, and these can be significant. Researchers have recognised the importance of the affective perceptions of students on their cognitive state, and thus how an ability to think and reason can be undermined by emotional responses to certain situations (Skemp, 1987; Palestro & Jameson, 2020; Dodd, 2016), especially those involving timed testing.

Timed testing has been shown to deplete working memory, leading to a vicious cycle of deteriorating skills and performance (Hunt & Sandhu, 2017; Ashcraft & Kirk, 2001). Emotional responses to situations that are seen as threatening will result in 'flight or fight' responses, as adrenalin levels rising in response to the perceived threat. As a teacher in an FE college, I have experienced both responses in classes, when adults stop attending, become defensive in class, or do not attend in the week that I happen to have mentioned that we would be starting work on fractions.

Other research has shown that perceptions of fear and anxiety generated in childhood (Young, Wu, & Menon, 2012; Dweck, 2017) may persist into adulthood unless adults re-engage (Skemp, 1987). Adults returning to mathematics classes can present with a degree of fear and anxiety about either the mathematics, or examinations, or both (Tobias, 1993; Barton & Stone, 2013). Their confidence in their ability can also be low. It is important to keep in mind that most of the learners who engage with these courses have attempted examinations previously but do not have the desired grade, so often enter with a feeling of failure, and a belief in some cases that they are 'not maths people' or 'don't have a maths brain', in short that they lack innate ability in mathematics

(Buxton, 1981; Skemp, 1987; Boaler, 2016). The belief in a lack of innate ability has been shown in other research conducted with 16- to 19-year-olds in FE (Norris, 2023).

A belief in innate ability emerged from data collected in a qualitative study of eight adults in FE on a pre-GCSE mathematics course (Apostolidu & Johnston-Wilder, 2023). The belief in innate ability led the participants to conclude that they could not learn mathematics. The participants expressed low self-efficacy, and an avoidance of situations, including work and careers, which would have exposed them to shame about their mathematics skills. This research also confirmed previous research that found that a fast pace of delivery in class had a negative effect on learners (Boaler, 2016), and that teacher/student relationships were important in developing positive attitudes towards mathematics in FE (Dalby, 2021). The research tested a mathematics resilience toolkit, which included a number of approaches including the 'Growth Zone' model, which emulates Vygotsky's ZPD. It was found to be successful in developing independent learners that had a range of techniques to try if they got stuck on a task (Apostolidu & Johnston-Wilder, 2023).

In research which aimed to develop an effective mathematics resilience scale with students, Kooken et al found that beliefs in innate ability were quite common in their sample of 262 participants, 59 of whom were FE college students. They also noted that it was beneficial for participants' perceptions when they realised that everyone struggles with mathematics at some point, even those who appear on the surface to have no problems, and that this knowledge may encourage persistence and reduce anxiety. They advocated that this is in addition to teachers encouraging a growth mindset and sharing their own struggles (Kooken, Welsh, McCoach, Johnston-Wilder, & Lee, 2016). Mathematical resilience is defined as a combination of self-efficacy, optimism, motivation, and confidence that leads to engagement and successful outcomes for learners, which contrasts with the challenges of avoidance, and feelings of anxiety and helplessness (Lee & Johnston-Wilder, 2017).

The importance of a change in the environment between school and college for all learners in FE in England, both 16–18-year-olds and older adults, was identified in research which surveyed students on a number of occasions over an academic year (Dalby, 2021). Three aspects of mathematics delivery were seen as important by students: the curriculum content and it perceived relevance to individuals, the teachers

and their teaching approaches, and the setting in which learning took place. In addition, changes in the attitudes of students occurred in the first three months of college, and then became stable and retained, so the early experiences of mathematics classes in colleges were critical for establishing positive perceptions (Dalby, 2021).

The findings by Dalby (2021) were confirmed in the action research project by Preece (2023), who was testing the efficacy of PERMA (Positive emotion, Engagement, Relationships, Meaning and Accomplishment) with eight teachers and 136 new students in FE colleges. The findings confirmed the importance of the teacher and learner classroom interactions, such as teachers making eye contact with learners, and greeting them at the start of class, in addition to a 'think, pair, share' approach to encourage learner interactions. These approaches, although they were not specifically in mathematics classes, are of relevance to my research, as they supported the emotional well-being of learners in FE classrooms, by building confidence and a community (Preece, 2023).

The relevance of teaching styles that includes learners in the process, identifies their needs, builds trust and develops a persona in the classroom that enables adults to engage further illustrates the different approaches that are likely to be successful in the adult learners' classrooms and those which are different from a school setting are found in other publications on adult education (Jarvis, 2010; Dweck, 2017).

Success and confidence are closely linked, as are low attainment and disaffection, according to research in the post 16 education field (Brown, Brown, & Bibby, 2008; Dalby, 2012), as students acquire a view of themselves as 'good' or 'bad' at certain subjects, such as mathematics. Disaffection with mathematics can lead to dis-engagement from the subject, and attendance among young people in colleges, which have a more open, less monitored structure than schools, is often poor (Dalby, 2012). Again, this has an increasingly negative effect, as missed classes means missed work, so on re-entry students know less than their peers, which may lead to stress or confusion and to further disengagement (Boaler, 2009; Dalby, From failure to functionality: a study of the experience of vocational students with functional mathematics in Further Education, 2012).

Adult learners returning to education often may have to overcome an aversion to mathematics, and sometimes will acknowledge that they actively avoid situations where their mathematical understanding will be exposed. A learner's view of themselves, in terms of their self-efficacy and self-esteem, can be substantially impaired if they are called upon to answer a question when they have no confidence in their answer (Boylan & Povey, 2009; Lewis, 2013).

Evans, who said that maths anxiety can include feeling of resentment, embarrassment, intimidation and anger, which can be "transmuted into fear" (2000, p. 240), identified FE colleges as an important refuge for the maths anxious, as they can help people to rebuild their confidence and skills in a more trusting atmosphere, rather than at universities, where students may be intimidated by being with so many people that they perceive as proficient mathematicians. He also found that fear interfered with the levels of concentration necessary for success in mathematics, thus linking fear with poor performance.

Newmarch (2005) found that the benefits of studying mathematics as adult learners included "building self-esteem and confidence; reducing anxiety about numbers;" (2005, p. 9). A poor opinion of their skills can lead adults to "have a very negative self-image" (p. 10). A discussion on confidence in Newmarch is followed by a section on the anxiety that can be caused by mathematics, as she says that this anxiety could manifest itself in a fear of maths which induces "panic when faced with numbers and calculations" (p. 6). In addition, "Many adults may initially feel anxious at the prospect of stepping into a maths classroom. They are worried about repeating failure and feeling embarrassed and humiliated, and they associate maths with stress, frustration, and powerlessness." (p. 6). This fear can lead learners into a vicious circle, when anxiety interferes with working memory, so the prophecy that they are not good at mathematics becomes self-fulfilling and a downward spiral of inability (Ashcraft & Moore, 2009).

Recent research has continued to develop strategies which aim to challenge beliefs in innate ability and change the downward spiral of inability, through changing the focus onto a growth mindset, which aims to develop flexible and open-minded thinking about mathematics (Boaler, 2016; Boylan & Povey, 2021).

In a quantitative study (Liu, 2021) with 1201 13- to 17-year-old students in Singapore it was found that a growth mindset belief predicted intrinsic motivation and mathematics performance, whereas a closed view of mathematical ability and fixed intelligence, e.g. a belief in innate ability, led to lower motivation, an avoidance of mathematical tasks and lower performance, with a particularly strong link to motivation. The link to fear of failure in front of peers was also noted in the study, and the researcher found that asking students to think about their perceptions and the impact that they might have, thus asking them to consider their cognitive positioning, could allow those students to work on changing that approach to a more positive one. This was suggested as particularly important for lower-level students who often also had lower self-efficacy (Liu, 2021) a finding which was supported by research with a very different group of adults, which employed an autobiographical approach (Wilder & West, 2023).

A qualitative study (Sheffler, et al., 2023) conducted with two separate groups of older adult learners, one of 15 and the other of 27 participants, concluded that a growth mind-set was as important for older adult lifelong learners as it was for young students. The researchers generated a belief in a growth mindset with the adults by discussions around the malleability of intelligence, which led to an increase in motivation and learning, and subsequent cognitive gains in tests which were conducted after the three months of input. The improvements in cognition were more marked in those adults who previously held growth mind-set type beliefs, than those with fixed mindsets. This could indicate that an inclusion of growth mind-set work in the curriculum could help counteract innate ability beliefs.

It has also been noted that learners' perceptions of ability in the consideration of self-efficacy about maths can lead to an interpretation of what they can do efficiently, in terms of shopping and other daily activities requiring maths skills, for those skills to be labelled as 'common sense', and all that which they see they cannot do as 'maths' (Newmarch, 2005; Bynner & Parsons, 1997).

Qualitative research which gleaned the thoughts and opinions of Primary teacher trainees discussed the beliefs of one adult who described their pain with and alienation from mathematics, although they had achieved the grade C (4) required for access to their teacher training course. Specific topics were mentioned by this person, such as times tables knowledge, Pythagoras, and the existence of Pi (Boylan & Povey, 2009). This

and other research on teachers in the primary sector have identified a need to help teachers overcome some of their own fears about mathematics, to alleviate the potential impact of these on the thinking of their pupils.

In another study which looked at university teaching staff in the USA found that an autobiographical approach, thus a sharing of perceptions and beliefs, was helpful in encouraging the 61 adults who took part to confront their anxieties with mathematics, in research by Wilder and West (2023). The use of a meta-cognitive approach in the classroom with the teachers had a positive effect on their understanding of what their students could be experiencing. It helped teachers to ensure that they responded appropriately to students' prior experiences of mathematics. There was an issue, especially with the 42 females in the study, of performance avoidance due beliefs in innate ability, and a lack of control over outcomes, which led to a fear of getting a poor grade, which had determined what courses or modules they had chosen in the past, but which lacked relevance to their onward journeys (Wilder & West, 2023).

Concerns about the self-efficacy with mathematics of the university population, who may have the grade required for university, but may not have felt confident with the subject, or have studied it for two years through their 'A' level provision, was raised in the Smith Report of 2017. Sir Adrian Smith also expressed concern about negative attitudes to mathematics generally, especially among females (2017). This report, commissioned by the DfE, supported initiatives such as MiFEC and CfEM (Noyes & Dalby, 2022; Education and Training Foundation, 2022), although the focus of these initiatives have been on the 16-18 year olds in FE, rather than the adults who are the focus of this thesis.

To summarise this section, FE has been seen by researchers and learners as a refuge for those who are aware that their skills or qualifications are inadequate in some way, and who have chosen to try and remedy that situation (Evans J. , 2000). However, the learners who enrol on these courses are likely to bring memories of their previous experiences in classroom which affect their perceptions of learning (Newmarch, 2005). The comments made by learners participating in the pilot study, both on the questionnaire and in subsequent discussions about the questionnaire, supported these views with comments such as "the fear of failure is always there".

2.4.3 Learners' characteristics

In this section I explore the existing research around the general topic of learner characteristics, as there is a tendency, as previously discussed, to generalise from our experiences in order to make sense of a complex world, which can lead to stereotypical assumptions about many issues. These experiences are sometimes substantiated by research, and in general they may be true, but, as I will demonstrate in this research, this may lead to misconceptions about learners' identities, and lost opportunities in terms of understanding and meeting the needs of individual adult learners.

In 2019/20 academic year 30,650 adult learners were on GCSE Mathematics courses. Two thirds of these were female and one third male, and, analysed by age, 45% are aged 19 to 24 years, and 55% are 25 or over (Gov.UK (1), 2020; Gov.UK (3), 2020).

As around 300,000 students take the GCSE mathematics examination each year, adult learners represent approximately 10% of the total number of those who take GCSE mathematics examinations annually. The majority of these are most likely to be re-take students, who have not achieved a grade 4 (equivalent to the 'C' grade) in previous examination attempts, or learners who have never taken the examination, such as those who have migrated into England and need UK qualifications.

As can be seen in the first table in Appendix 8.7, the characteristics of learners are only some of the themes commonly found in publications that aspire to relieve the symptoms of maths anxiety in adults. The influence of learners' characteristics includes theories that females are likely to be more anxious than males, and that as learners age they become more anxious (Evans J. , 2000; Boaler, 2016). There is also a view that learners working in a language that is not their first language in a mathematics classroom will be disadvantaged compared to other students (Bernard, 2016; Boaler, 2016). Whilst all these assumptions may be true for certain learners, stereotyping learners in this way could lead to a deficit view of groups of adults which may not be accurate, as this research will show.

In addition to beliefs about characteristics, it is acknowledged by many researchers that past experiences will inform learners' current views about mathematics (Skemp, 1987; Buxton, 1981; Evans J. , 2000), whether that derives from experiences in schools, such

as issues with ability grouping (Boaler, 2016), or as a result of pressure from parents (Bernard, 2016; Tobias, 1993).

Research with teacher trainees for the Primary sector examined the trainees' beliefs about confident pupils, which was that if a child was confident about their answers in mathematics they would be prepared to speak out. This is an example of a prevalent stereotypical view, which may be unhelpful when considering adults in GCSE mathematics classes, and there will be other examples of these in this section. Only one trainee interviewed suggested that it was possible for a child to be confident about their answer and not prepared to speak out (Hardy, 2009).

2.4.3.1 Age

As previously stated, in 2019/20 academic year 30,650 adult learners were on GCSE Mathematics courses and, analysed by age, 45% were aged 19 to 24 years, and 55% were 25 or over (Gov.UK (1), 2020; Gov.UK (3), 2020). These two groups could be very different in terms of the stage of life that they are at, as the 19-24 year olds are perhaps more likely to be continuing their first career and life trajectory, whereas those who are older may be revising career plans and making changes in their lives, or in their perspectives of life, education and future goals (Tennant, 2006).

These developmental differences, whilst they cannot be pinned down to any particular age or group, could have an effect on perceptions, but as can be seen in Appendix 8.7, of those offering advice around the subject of maths anxiety, only two mention that age can be a factor worth considering (Boaler, 2016; Evans J. , 2000). This lack of attention to the age of participants may be because the focus of researchers has largely been concerned with either younger school aged students (Boaler, 1997), or those individuals who are mostly on traditional pathways into higher education (Evans J. , 2000) but, as has been shown in more than one study in the USA, older females on non-traditional pathways into HE were more anxious than their younger peers (Betz, 1978; Jameson & Fusco, 2014).

Age was also a factor in the findings of Watts, studying ABE students in the USA, as the older learners regardless of gender had lower self-efficacy and performed less well that younger students on the placement tests that were used to correlate performance with

self-efficacy and anxiety. However, in that research, anxiety was a factor for all learners, regardless of age (Watts, 2011).

Jameson and Fusco (2014) agreed with the finding on age and self-efficacy in their research on 226 undergraduates in the USA, three-quarters of whom were non-traditional adult students, but found that their older cohort of participants also declared higher anxiety levels. They found that the older the adult was, the more anxious they became, and that their self-efficacy also declined, which they felt might be due to being in a new environment, comparing themselves with younger learners also in the classroom, and a disassociation between what they perceived as classroom mathematics, compared to everyday mathematics that they used in their lives.

There are a substantial number of older, non-traditional pathway learners each year who take the GCSE Mathematics examination in England, many of whom hope to enter higher education establishments, but little research in England on these learners. It is this under-researched group that is the focus of this thesis.

2.4.3.2 Gender

As previously discussed, in 2019/20 academic year 30,650 adult learners were on GCSE Mathematics courses. Two thirds of these were female and one third male, so approximately 20,000 females and 10,000 males (Gov.UK (1), 2020; Gov.UK (3), 2020). Gender is an issue which is addressed by many publications in the field, both those that are reporting on research, and those concerned with helping learners to overcome negative feelings about mathematics. However, in a review of 63 publications of research findings which investigated links between gender and mathematics, which covered the years from 2020 and 2022 inclusive, the reviewers noted the lack of research concerned with further education, or with lifelong or adult learners who were not in university or teaching roles, in addition to a paucity of longitudinal studies (Becker & Hall, 2024).

Research with younger students has revealed that boys outperformed girls in final examinations, that girls were more likely to dislike the fast pace of lessons and less likely to ask questions in front of peers (Boaler, 1997). Hunt et al, who developed the MAS-UK, and Szucs et al in their Nuffield funded project, both confirmed that their findings, although they were with very different age groups, indicated higher anxiety levels

among the females than the males in their studies (Hunt, Clark-Carter, & Sheffield, 2011; Szucs, McLellan, & Dowker, 2017). However, in an earlier study by Devine et al, although higher levels of anxiety were found in female students, the performance of students was found to be similar. In this study data on test anxiety was also collected from the 433, 11- to 15-year-olds, and when this was considered, it was just the females that emerged as negatively affected by mathematics anxiety in test situations (Devine, Fawcett, Szucs, & Dowker, 2012).

Research from the USA looking at non-traditional pathway learners has also recorded higher levels of anxiety in mathematics for females than for males (Betz, 1978; Jameson & Fusco, 2014). Betz (1978), researching in the USA with 655 university undergraduates in the 1970s, found that in one group of psychology students (n=81) "men's math-anxiety scores did not correlate with their final course grades nearly as much as the women's anxiety scores correlated with theirs" (Tobias, 1993, p. 102), which suggests a closer correlation between anxiety and success for females than males. However, other work from the USA and UK respectively has contradicted this, and no significant differences were found between the genders (Watts, 2011; Evans J. , 2000).

As some research confirms the existence of gender differences in terms of anxiety, but other research findings did not, this could highlight a danger of making assumptions about adults in GCSE mathematics classrooms. Stereotyping beliefs can lead students and/or teachers to have certain expectations, which become self-fulfilling prophecies (Boaler, 2016; Holloway, 2013), so an approach which does not draw attention to gender differences is preferable for the learners, especially for females (Ashcraft & Moore, 2009). Research work on gender which challenged the stereotypical view that females perform less well than males by Good et al (2008) were shown to have a positive effect on performance (Holloway, 2013). However, if there has been a pervasive perception among the population generally that males should perform better than females in mathematics, then the psychological impact of failure on males may be greater.

2.4.3.3 First language: English, or not?

The inclusion of adults whose first language is not English into mathematics classes is prevalent in FE, as those without a Level 2 qualification in mathematics in the UK are fully funded by the DfE. This contrasts with the ESOL provision, which must be paid for unless learners meet certain criteria, such as living in low-income households. However,

neither the ethnicity, nor the first languages, of GCSE mathematics learners is collected by government sources, so numbers are uncertain, but from personal experience, in adult GCSE classes, LX learners (Dewaele, 2018) are around 10% to 15% of the total.

This government funded mathematics provision gives an opportunity for ESOL and other 'non-native' learners to access additional classes free of charge, where they can fulfil their objectives, whether those are to gain a qualification in mathematics or simply to gain more time and contact with 'native' English speakers, to improve their English.

There has been much debate about how those whose first language is not English should be referred to, as 'native vs non-native' contains an implicit hierarchical feel to some researchers, as does L1 and L2 user, where the L2 refers to English as a second language. There is an additional complication as qualifications themselves are also referred to as L1 (Level 1) and L2 (Level 2); in fact, GCSE mathematics is a Level 2 qualification.

Due to these inherent biases and complications, I have gone with an alternative description, namely, to describe learners as L1 when their first language is English, or LX, when it is not (Dewaele, 2018). This approach has an additional advantage as it protects the identity of the non-L1 participants, as their nationality, ethnicity and first languages are unmentioned in this thesis.

The teaching of mathematics to students whose first language is not the language spoken in the classroom is widespread in the world due to colonialisation of many countries, largely by European nations, such as the English, French, Belgian, Dutch, Spanish and Portuguese. In this thesis I will mainly consider the literature that is concerned with the delivery of mathematics in English to LX learners (Dewaele, 2018). This literature is drawn from many nations, such as South Africa (Adler, 2001), Canada (Barwell, 2009), the UK (Woolley R. , 2013), and the USA (Kersaint, Thompson, & Petkova, 2013).

The delivery of mathematics in a non-first language has produced much useful material, such as the work in South Africa, which showed that English speakers benefitted from the resources produced for LX learners (Adler, 2001). In addition, there are variations in vocabulary which can be confusing for learners of all languages, such as the use of 'product' for multiply, or on words that have a unique mathematical meaning which must be understood, such as median, mode, mean and range (Woolley R. , 2013).

In a small study in England which used a selection of word problems including those from the PISA framework, the performance of twenty Arabic EAL adults was compared with that of twenty L1 English speaking adults, age ranges from 19 to 61 years. This research highlighted a dilemma for the assessment of word problems, as the English speakers whose mathematics skills were lower than the Arabic speakers, outperformed the Arabic speakers in tests, and it was found that the English speakers computational skills predicted their performance in word problems. This contrasted with the Arabic speakers, whose reading comprehension and mathematics computational skills were both factors (Saad, 2021). Whilst this was a small study, it does draw attention to the additional challenges to cognitive load that some learners may face.

However, the differences between languages can affect LX learners present in GCSE mathematics classes both positively and negatively. Whilst exposure to different vocabulary and teachers might have a positive impact on English language learning (Stacey, 2016), the differences between definitions of words and even mathematical symbols could have a negative effect. For instance, LX learners may be unfamiliar with the notation used in England, such as the division and ratio signs, or confused by different methods, such as the way to write a division calculation (Stacey, 2018).

In addition, there is some work developed for LX learners which has been less applied in the English mathematics arena, such as improving the understanding of word problems by asking learners in pairs to generate their own word problems, to improve their understanding of the structure and content of these kinds of questions (Barwell, 2009; Swan, 2006). In addition, working in pairs or small groups, reading questions out loud, paying attention to the cultural context and showing pictures to illustrate this, identifying the key information that is important for a successful answer, and even role play can help learners to make sense of mathematics in a different language from one's own (Adler, 2001; Barwell, Mathematical Word Problems and Bilingual Learners in England, 2009).

There is also an understanding that learners in the ESOL provision in the UK will have 'spiky profiles', by which it is meant that whilst learners might be able to speak quite well, and read some English words, their written language is likely to be behind their proficiency in other areas (Colquhoun & Delaney, 2009). Equally, if they have had no opportunity to speak English, but have read it, their reading comprehension skills may

be much better than their spoken English. These spiky profiles can also be evident in the mathematics classroom, but whilst they are mentioned in at least one previous research paper (Coben, Swain, & Tomlin, 2004), this aspect seems to be lost in terms of adults' mathematics classrooms currently.

English language learners have generally been identified as underperforming compared to their English-speaking peers (Adler, 2001), but this is not always the case, as I will show, and this type of generalisation can be detrimental to performance (Holloway, 2013). In addition, the complexity of the experiences of migrants into the UK is explored in research by Maphosa and Oughton (2021), who share the experiences of those from previous UK colonies, who have been taught in English and completed English qualifications, but who still have to re-sit English and Mathematics GCSEs for entry into HE, as their qualifications from their country of origin, in their case Zimbabwe, are not recognised. Thus, whilst English could be seen as these learners' second language, it perhaps should be seen as equivalent to a first language and highlights a need to be aware of the dangers of generalisations and stereotypical assumptions about adult learners, although there may still be issues about the cultural content of word problems (Ginsburg, 2022).

The awareness of mathematical stereotypes based on ethnicity by learners, i.e., that different groups have different levels of ability compared to others, has also been shown to have a negative effect upon performance, according to the work of Aronson et al (1999), as discussed by Holloway (2013), and in other research from the USA on teachers' negative impact on the performance of pupils (Beilock, Gunderson, Ramirez, & Levine, 2010). This research again emphasises the danger associated with any overt or covert assumptions based on stereotypes in adults' mathematics classrooms, the advantage for teachers of keeping an open mind, and the importance of counteracting stereotypical views when necessary.

In conclusion, learners whose first language is not English may or may not be disadvantaged when they engage with mathematics in an English-speaking FE college, but if they are this could have a negative impact on their examination grades.

The next section will discuss publications that include interventions for adult learners.

2.5 INTERVENTIONS FOR ADULT LEARNERS

2.5.1 Introduction

In terms of self-efficacy and anxiety, many researchers have recognised the connection between them, and devised and tested interventions which have been designed to benefit adults. In Australia Tout (2000) explored the benefits for learners of using objects in the classroom and group problem solving as ways to "build confidence and overcome any maths anxiety they may have" (p. 220).

In the USA, Safford Ramus (2004), reported from a doctoral students' dissertation which focussed on an assessment of a 'Mind Over Mathematics' (MOM) intervention, in which eight non-traditional age students over 25 in a community college were encouraged to talk about their issues with the mathematics course. These learners "found that (discussion) decreased their anxiety and increased their confidence", and "With confidence boosted and anxiety decreased, the participants felt ready to move on to the next level of their mathematics education" (Safford-Ramus, 2004, p. 212), which highlights the link between the affective and cognitive domains.

Group work and the keeping of journals by learners have also been found to be effective (Lanigan, 2007; McDonnell, 2004). Holloway recognised that carefully chosen activities used a classroom can both improve self-efficacy and reduce anxiety, and both he and Rogers have identified the importance of teacher/learner and learner/learner relationships in classes of non-traditional students (Holloway, 2013; Rogers, 2003).

Evans, in a postscript in 2018 to his article 'Adult Maths and Everyday Life: Building bridges, facilitating transfer' describes "Affect and emotion as energisers of what happens in the classroom, including the process of learning and learning transfer. This is an example of the idea that transfer is an emotional, as well as a cognitive, process." (Evans, 2018, p. 143). This view, that the affective domain has relevance and importance in mathematics classrooms, is supported by many other researchers (Benn, 1997; Dodd, 2016; Foster, 2016).

Whilst some research has taken place with 19+ adults in FE type institutions such as community colleges in the USA (Khazanov & Peskoff, 2011) and TAFE colleges in Australia (Lisciandro, Jones, & Geerlings, 2018; Tout, 2000), there has been little

research focussed on adults in FE in the UK. In terms of establishing a niche for this investigation, previous research has generally focussed on traditional students, such as primary and secondary school children (Carey, Hill, Devine, & Szucs, 2017; Petronzi, Staples, Sheffield, Hunt, & Fitton-Wilde, 2019), 16-18 year olds in FE (Dalby, 2012; Dalby & Noyes, 2018; Swan, 2006), and undergraduate populations (Hunt, Clark-Carter, & Sheffield, 2011; O'Sullivan, Robinson, Keogh, & O'Neill, 2018).

Whilst English speaking adults in FE have formed a small part of the research in England, the same cannot be said of LX learners, as many publications for ESOL learners recognise the diversity of adult learners' knowledge and experience, and recommend exploiting that in the classroom in order to improve and enhance their engagement with English, both in language and in mathematics classrooms (Pitt, 2005; Sutter, 2009; Barwell, 2009).

In terms of government funding in England, adults continue to benefit from free English and mathematics courses, regardless of age or country of origin, until they achieve a grade 4 in GCSEs in the subjects. In addition, the government continues to fund initiatives to engage adults in learning with such projects as the recently launched 'Multiply' scheme (Gov.UK (4), 2022). These initiatives are targeted at 'hard to reach' learners and are designed to encourage adults back into more formal learning environments, such as those in general FE colleges, or local authority provision. Initiatives are often designed to raise basic skills in the population and are in response to what are perceived as poor positions in international scales, such as PISA, TIMSS and PIAAC (OECD, 2022; PISA Facts Maps, 2018; TES, 2016).

The identification of themes in the data collected and the literature review led to a review of publications designed to address anxiety about mathematics, published both in the UK and USA. The books range from those designed for a more academic audience (Evans J. , 2000; Skemp, 1987), through those intended more for the teachers of mathematics (Boaler, 2009; Bernard, 2016; Boaler, 2016) , to those primarily for use by students as self-help guides (Buxton, 1981; Davidson & Levitov, 2000; Tobias, 1993). An analysis of these and other publications support the relevance of the themes selected in this thesis, both from GCSE Mathematics courses and characteristics of learners' perspectives (Griffiths & Stone, 2013), and additional information is contained in Appendix 8.7.

This section will continue with a resume of relevant research that is applicable to the three main themes of course content, classroom dynamics and assessment, and includes research around the sub-themes identified from the questions in the questionnaire, and the emergent themes that arose from the comments.

2.5.2 Curriculum content and pedagogy

In this section research and other publications have been reviewed to see which individual topics in the content of the GCSE mathematics course have emerged as a possible cause for anxiety and worry among learners. Publications recognised that learners could experience difficulties with word problems, although not as many as those who mentioned the potential for anxiety caused by algebra problems, and fractions, decimals and percentages, however, word problems are rarely present in self-efficacy or anxiety scales.

The ability of students to engage with calculations if they are affected by an emotional response is present in research that explored teaching GCSE mathematics in secondary, rather than FE, classrooms. This emotional response about certain topics or tasks has resulted in students that disengage from the work, become increasingly stressed, with a subsequent decline in performance (Foster, 2013).

Research has taken place on many topics in terms of the strategies that students might apply to be successful in answering questions. One example is work which assessed the different strategies that adults employed to compare the sizes of fractions, and whilst successful students drew on a number of alternative methods, and often chose the optimal one, mathematics anxiety seemed to impede students' progress in the implementation of the strategy, rather than the choice of strategy (Sidney, Thalluri, Buerke, & Thompson, 2019).

The challenges of algebra, with its introduction of letters in place of numbers, can cause significant issues for learners, and generate an extremely negative response. One solution to help learners engage with these is to ensure that mathematical terms applied in algebra, such as 'simplify' or 'solve', are defined in a way that learners can understand them, whether they are L1 or LX English speakers (Adler, 2001). For instance, simplify can be defined as 'tidy up', or 'group like terms', and 'solve' can be explained as find a number for the letter.

The PISA study (OECD, 2023) tested mathematical problem-solving skills of 15-year-olds in 239 countries in 2022 and noted the challenge of data collection on mathematical content, as contexts and cultures can be very different. This recognition of the challenges of context and culture was supported by other research with 101 participants in England, which found many word problems to be a form of cultural imperialism, as they were so strongly situated in circumstance which might be outside of the experiences of migrant learners (Maphosa & Oughton, 2021). However, the OECD report highlighted the importance in the modern world of being able to devise mathematical formulae from descriptions of situations, to employ mathematical concepts, procedures, and facts appropriately, and to be able to evaluate answers to ensure that the interpretation and application are reasonable (OECD, 2023).

The OECD (2023) description is echoed in other reports which focussed on the needs of adult education, which saw the challenges of interpretation of word problems for adults, with its linking of numeracy and literacy levels, but suggested that adults may more easily engage with a meta-cognitive approach to evaluation of their answers, due to the greater amount of life experiences they bring to the classroom, compared to school aged students (Gal, Grotluschen, Tout, & Kaiser, 2020). These findings may be true, but in my research, they emerged as important to learners from both self-efficacy and anxiety perspectives, hence their inclusion here.

In an overview of research into word problems over the last 50 years, Vershaffel et al note that "Word problems are among the most difficult of kinds of problems that mathematics learners encounter" (Vershaffel, Schukajlow, Star, & Van Dooren, 2020, p. 1), and consequently learners often need to inhibit their first reaction and read the question carefully to ensure comprehension. This summary paper noted the importance of a range of interventions, such as teachers, textbooks and software, and techniques, such as scaffolding, investigation and discussion, thus both pedagogical and resource solutions, to improve outcomes on these types of questions. It also noted that word problems in mathematics classrooms differ from those in real life, and can include 'trick' questions, such as 'if it takes 3 hours for one line of washing to dry, how long will it take two lines of washing to dry?'; in this case proportional reasoning skills which have worked in other questions cannot be applied. The focus of the publication is on children on traditional pathways through education from many countries and cultures, thus

supporting the view that problem solving is an international challenge for mathematics. Finally, the article acknowledged the need for more research (Vershaffel, Schukajlow, Star, & Van Dooren, 2020). The omission of those on non-traditional pathways in education is of interest, but perhaps issues are not age specific.

Ginsburg (2022) in a summary of research about word problems which focuses on adults, identifies four steps necessary to tackle word problems, namely " read/decipher the problem; create a mathematical model of the situation (often called mathematizing); solve the problem using mathematics; and reflect on the solution for its reasonableness" (2022, pp. 67-68). The review again highlights the lack of research with basic education learners, as it also draws on research with university students, but it highlights the need to include this topic more effectively and consistently in teaching episodes by using situations that are meaningful for learners. Ginsburg also advocates encouraging paired or group work, as discussion with peers can aid the reasoning process, and could improve learners' ability to choose the correct options for calculations; these techniques could thus reduce the cognitive load on individual learners and alleviate the impact of the cognitive load on working memory, an important aspect identified in other research (Shibli & West, 2018).

In a small-scale study with 30 adult participants, Kontogianni and Tatsis (2019) tested 13 'open ended' tasks, seven of which involved word-based problem solving, in proportional reasoning settings. Their main focus was on fractional calculations, but the study highlighted two points of interest in this research, namely the importance of multiplicative reasoning, rather than additive, for relatively complex word problems, and the relevance of real-life skills for problem solving which many adults possess due to life experiences. This was especially advantageous when the word problem was based in a familiar context.

However, issues identified by these and other researchers with word problems is that they can be seen by students as being false, in terms of real life. An example given in one publication is a comparison of the price of boxes of cereal, where student are expected to know that, say, the large box is better value, but in real life it might be that the larger box cannot be afforded, or will not be easy to store, so there can be other issues that affect a real life decision that do not appear in the mathematics classroom (Foster, 2013). Whilst this could well be true, relating word problems initially to learners'

personal experiences so that they are in a known context could be important for developing reasoning skills and confidence in ability, as the latter has been known to increase with the acquisition of knowledge and understanding in an FE setting (Dalby, 2021; Preece, 2023).

Dalby (2021) recognises the need to attend to the affective domain for FE learners of all ages, in addition to improving knowledge and understanding through the use of relevant contextualised resources perceived as relevant to learners' vocational provision. In contrast, Hough et al (2017) investigating the usefulness of Realistic Mathematics Education (RME) resources, generally unrelated to the vocational provision, which used context and model building to make sense of the mathematics with 75 GCSE re-sit students, found that whilst they had a positive effect on the learners' number work, there was no effect on performance in algebra, compared to the control group of 72 students. There was also little or no change in attitudes from the participants who generally had low confidence in their ability combined with their low achievements. Other research has queried the content of RME resources, and whether they were a good match with GCSE type questions, in addition to that the approach required more time to develop effectively with learners, which could be a problem for those on short courses (Majewska, 2019), such as those that adults experience in FE.

Other research on word problems includes concerns about reading and comprehension skills, in terms of their general vocabulary, their knowledge of the mathematics register, sentence processing skills and ability to comprehend passages of information, all of which can affect a student's ability to interpret word problems. Successful interventions can be a picture to illustrate the context of the word problem, or a table with a display of information to reduce the word count (Neri, Wagner, & Retelsdorf, 2021). To add to these pertinent points, is the learner able to sift out the critical pieces of knowledge to work out the required answer, and can they choose which calculation will be correct (Safford-Ramus, 2008)? In addition, if the path they have chosen turns out to be incorrect, do they have sufficient confidence in their ability (self-efficacy) to try an alternative?

Word problems have also been considered earlier in this literature review, as they are a recognised challenge for those learners whose first language is not English (LX learners (Dewaele, 2018)), in the section on first language (2.3.3.3). However, the language of

mathematics for all learners, regardless of whether they are studying it in their first language or not, is a recognised issue for many (Adler, 2001), and the importance of using 'normal' language with adults, prior to teaching the mathematical register and symbolic representations, should improve comprehension and reduce anxious responses (Safford-Ramus, Misra, & Maguire, 2016).

Some have argued for the importance of adult learners enjoying their courses, including the content, and feeling some control over their learning, which should contrast with school experiences, contribute to a greater sense of agency and a change of long held beliefs (Skemp, 1987; Tennant, 2006). This change in learners' perceptions, if it occurs, will happen after their motivations, whether intrinsic or extrinsic, have caused them to re-engage with mathematics.

Extrinsic factors encompass the idea that the course is not seen as an end in itself (although there are learners like this, usually the older 60+ ones), but as a means to another course, such as Nursing, Teacher Training, or other HE degrees (Skemp, 1987; Black, Mendick, & Solomon, 2009; Young, Wu, & Menon, 2012). Career changes are often after having children, and the learners' aspirations and expectations have changed since they left compulsory education.

This approach, where GCSE Maths is seen as a means to an end, rather than of value for itself, may affect the attitudes of the participants in the class if they become frustrated by the emphasis on conceptual understanding, rather than rote learning, as the latter can be quicker (Skemp, 1987). This approach can have been supported in school subconsciously, as students strive to gain the approval of teachers and "relief from anxiety" (p 96) of incurring the teacher's displeasure. However, in contrast, conceptual understanding may be perceived as higher value by adults, if they recognise the need to understand to improve retention of how and why different formulae or methods are applied in different questions or situations.

Thus, the links between anxiety, participation, and performance is recognised by many. This will be explored further in the section on assessment, (2.7.4).

2.5.3 Classroom relationships

This section covers classroom relationships, by which I mean many aspects of relationships, interactions and the dynamics that naturally occur within a classroom.

Hence in this section there is a further focus on pedagogy or andragogy, as it is acknowledged that interactions within a classroom will be very different for adults than it is for children, due to a transformation in the way that knowledge is perceived by adults, as a way to initiate change, and the changes in their self-identity which have occurred over time (Rogers, 2003; Sutter, 2009; Knowles, Holton, & Swanson, 2015). A definition of classroom dynamics would normally cover face to face interactions between learners, with their teacher, and with each other, but these interactions did not occur during the pandemic in the same way, as learning went online. Colleges used various online tools to run lessons with learners, but access to IT varied across individuals, and time was also a factor, especially for those with children at home for schooling.

Many publications relevant to this field consider teacher/learner interactions to be important (Dweck, 2017), and some also mention learner/learner (peer) interactions (Boaler, 2016; Swan, 2006), and the concern students feel about what their peers think of them, especially if they are unable to understand a certain aspect of the mathematics (Skemp, 1987; Buxton, 1981). This concern about what their peers think of them, and potential loss of face in front of peers, can lead to younger students responding negatively in the classroom (Foster, 2013; Boaler, Experiencing School Mathematics: Teaching styles, sex and setting, 1997), and this could also be a response for adult learners, but perhaps adults would be more likely to disengage from the course altogether, as for them mathematics is not compulsory.

Mathematics could be seen to have challenges for learners, as it is perceived that students will benefit if they can develop conceptual understanding to a level where the knowledge can be applied in a range of different scenarios. This, combined with the belief that understanding is better than rote learning, both for retention of concepts and to further the knowledge base, means that a climate of discussion and debate is effective for many students in class (McDonnell, 2004; Sfard, 2008). This may contrast with some students' memories of maths classes as silent places where they worked alone on pages of sums (Skemp, 1987; Boaler, 2016), which highlights a conflict present for many teachers in classrooms, if the need to manage behaviour can supress the need for discussion and debate.

The relationship between the teachers and students was identified as different for FE students, compared to their relationships with schoolteachers of mathematics, and a factor of importance to FE students in the work of Dalby (2012). The importance of differences between school and subsequent educational experiences is echoed in the work of Knowles et al (2015), who explored and highlighted the need for a different approach to learning for adults. For instance, in research conducted in several FE colleges staff and students were on first name terms, the mathematics work was often focussed on vocational provision, and the classes had a more relaxed feel to them (Dalby, 2012). These were seen as key factors in establishing a more positive relationship with mathematics in colleges, compared to schools, which could also be applied to the adult provision.

The negative relationship with mathematics that FE students may bring with them to classrooms is equally prevalent in adults' perceptions according to other qualitative research on 21 adults, which described this perception as damaged mathematical identities, but it also found that adults were prepared to re-negotiate that identity in order to achieve the goals they had set themselves. This thesis found that supportive teachers, and a learning-centred environment that encouraged collaboration contributed to the participants change in perceptions (Syyeda, 2021).

The anxiety and fear felt by some learners about mathematics has been identified by some as amounting to a disability, due to its impact on neurological pathways in the brain (Young, Wu, & Menon, 2012). This fear can be experienced in classroom situations, when teachers ask learners to speak out with an answer to a question (Skemp, 1987). Students need to be able to ask questions without the fear of humiliation, according to the research of Johnston-Wilder and Marshall (2017), in order to make progress in their mathematics learning. The fear of failure in front of peers is further discussed by Marshall et al (Marshall, Staddon, Wilson, & Mann, 2017) in research on workshops at an English university, which evaluated the perceptions of 57 students undertaking remedial mathematics work using the MAS-UK (Hunt, Clark-Carter, & Sheffield, 2011).

Sharing test outcomes with whole groups, rather than keeping individual performances private, can cause those who have not got 'good' results to feel ashamed and humiliated in class (Skemp, 1987). This emotional response reduces learners' confidence and self-

esteem in mathematics, which will inhibit their ability to cope, as a fear of failure can impact on performance (Black P. , 1998; Skemp, 1987; Buxton, 1981).

Research on adult learners in mathematics classes has highlighted the importance of establishing a community within the classroom, to encourage participation, a sense of belonging and engagement (Jaworski, 2009; Knowles, Holton, & Swanson, 2015). Recognition of the real-life skills that learners bring to the classroom, and that building on these can enhance the sense of belonging to a community can counteract a deficit view of adult learners. This sense of belonging can lead to enjoyable lessons, where adults can have fun whilst they learn new ideas and skills (Oughton, 2013).

2.5.4 Assessment

Timed testing has long been identified as a potential cause of maths anxiety (Tobias, 1993; Ashcraft M. H., 2002; Boaler, 2016; Safford-Ramus, 2008), and this section encompasses performance anxiety in many forms, which is covered by the over-arching theme of assessment. As can be seen in Appendix 8.7 a number of the initial publications reviewed when establishing an informed base for this literature review, few mentioned mathematics examinations or tests (Davidson & Levitov, 2000; Evans J. , 2000), although almost all covered the issue with time pressures in making calculations (Skemp, 1987; Tobias, 1993; Boaler, 2016). Several researchers, in addition to those displayed in Appendix 8.7, have discussed the impact of time pressures on implementing calculations successfully (Sidney, Thalluri, Buerke, & Thompson, 2019; Ashcraft & Moore, 2009; Foster, 2013).

This may be an issue for STEM subjects generally, and it needs to be discussed in GCSE mathematics classes, as marks are awarded for working out and methods in addition to the final answer. This allocation of marks for method and calculation means that learners need to be persuaded to attempt questions, even if they have little confidence in their ability to succeed.

The allocation of marks for method and calculations means that there is a conflict between what I as a teacher, judged on the results of my students in public examinations, expect of my students, and what is seen by some as best practice. For instance, students will be encouraged to attempt questions that they may have a procedural competence with, but little or no understanding of the underlying concepts,

such as using acronyms like BODMAS to help with recall, or guessing answers (Skemp, 1987; Foster, 2013), but these issues are not new, and whilst the system is this way, are unlikely to change.

There is a long-standing appreciation of the issues of time pressures on students, as shown in various experiments, such as when Buxton (1981) explained to adults on an ITE course that they would have a mathematics test which would be timed. He got his watch out and waited a few moments, then asked the twenty trainee Primary school teachers to record their feelings. There was no sign of the test at all, this was simply the expectation of the test. Only two of the 20 responded positively, the rest recorded negative emotions, such as fear, anxiety, panic, and in one case, terror. The negative impact of timed testing of mathematics anxious learners on their performance is proven in both quantitative and qualitative research, along with a spiralling effect of anxiety impacting on the availability of working memory, which drives anxiety higher, which decreases performance, in a vicious circle (Beilock & Willingham, 2014; Jameson, 2020).

As a result of their research Johnston-Wilder and Marshall identified a need to separate mathematics anxiety from examination anxiety, as they recognised that adult learners could display both conditions, and this has also been found by research with younger pupils (Szucs, McLellan, & Dowker, 2017). The former advocated exploring prior experiences within the context of showing learners how the brain responds to perceived threats, and how the growth zone model, similar to the ZPD of Vygotsky, can facilitate improvements in mathematical performance. In addition, they recognised the advantages to be gained by immediate feedback on work, the benefits of scaffolding learning that is carefully paced, and the importance of teaching calming techniques to learners, such as regulation of breathing (Johnston-Wilder & Marshall, 2017). Zientek et al (2019) also identified the importance of timely feedback, and limiting time pressure and competition in the classroom, in addition to creating a community for adult learners and addressing issues around anxiety.

In an examination, eyes are often drawn to the clock, as there is an appreciation by students who want to perform well that they must get as much down as they can in the time available. Time pressures have a negative effect on thinking, as adrenalin levels rise and the 'fight or flight' response kicks in. Thus, when we impose a time limit in an

examination, which in most cases we do, it makes it harder for students to answer questions quickly, as “the urgency results in slower progress” (Buxton, 1981, p. 96).

Other research has identified the negative impact of previous failure in GCSE mathematics examinations, as, using the MAS-UK scale by Hunt et al (2011), it identified a substantial difference in anxiety scores for undergraduates who did pass the GCSE mathematics first time in a school setting, compared to those who did not, which indicates that the perceived failure of mathematics GCSE in itself has an impact (Marshall, Staddon, Wilson, & Mann, 2017).

The consideration of performance under test conditions is a complex one, with two differing strands of thought. The first strand is that the more anxious people become, the less likely they are to perform well (Suinn R. M., 1972), and the second strand is that there is an optimal level of anxiety which enhances performance, whilst too little or too much anxiety will result in reduced performance (Yerkes & Dodson, 1908; Evans J. , 2000). It seems true that some emotion in examinations will be important for success, as under these circumstances’ adrenalin levels will rise, enhancing thinking and potentially the speed at which questions can be attempted, as perceptions are heightened. Negative effects of this heightened state could result in panic and an inability to think.

Research on that mix of mathematics and examination anxiety was conducted in Ireland, where work was carried out evaluating the effectiveness of asking students to write about their mathematics anxiety for ten minutes before the start of courses, and before the start of a university mathematics examination. A significant improvement in results was seen, with a subsequent improved engagement and progression rates (O'Sullivan, Robinson, Keogh, & O'Neill, 2018). Beilock and Willingham (2014), whose research concurs with this finding, have speculated that writing about the emotions prior to an examination encourage a sense of perspective, which reduces anxiety.

Sharing of anxiety, even if it is just with a piece of paper, could be an effective way of enabling adults on FE programmes to help overcome their fears, enabling them to avoid the barrier this could place on their performance in examinations, although there is other research which concludes that anxiety does not necessarily depress exam results,

if the students have had time to become familiar with the material (Mandler & Sarason, 1952). This suggests that self-efficacy is an important factor in examination success.

According to Boaler, failure is a necessary part of the learning process, and we must fail in order to build the skills to succeed (Boaler, 2009; Boaler, 2016), but students do not like to fail in my experience, they like to understand and succeed. Other authors have also identified this tension, as "positive self-esteem and high attainment are closely correlated" (Black P. , 1998, p. 134). In a classroom the support of teachers and peers may resolve misunderstandings or errors, but in an exam situation there is no permitted interaction, and, if progress depends on success, adults may feel a great deal of pressure.

It seems likely that adults, whether or not there is a need for examination success for progress academically, may feel additional pressure compared to younger students because, being adults, they are used to exerting some control over their lives (Knowles, Holton, & Swanson, 2015), and examinations are one experience where there is no possibility of control, either of the time allowed or the content of the paper. This complete lack of control could be very challenging for adults and enhance their feelings of anxiety.

Of most interest to this thesis is that almost none of the publications or research work explored mention other, non-mathematics examinations. The only slight reference found to this is that Evans (2000) asks about English diagnostic tests in his questionnaires, which gives him a comparison to the mathematics version.

2.5.5 Conclusion for interventions for adult learners

It is clear from this section on the interventions for adult learners that there is a large body of work in the public domain designed to help both the learners and their teachers appreciate the complexity of the range of perceptions that adults can carry with them to the classroom. In addition, the research and publications demonstrate a belief in the possibility of an improvement in learners' perceptions, and the positive effects this could have. The work completed in this thesis aspires to add to that body of work.

2.6 CONCLUSION OF LITERATURE REVIEW

This literature review has covered a number of important and relevant areas for this thesis, such as the learning theories that apply to adult learners, and useful research on their motivations, characteristics, and perceptions.

It has also covered the development of self-efficacy and anxiety scales, and the research that has employed them both individually and together.

Finally, it has summarised a large body of work from both researchers and practitioners around the importance of interventions for all age groups, including adults, designed to challenge the negative perceptions of mathematics displayed by so many people.

In the next chapter the chosen methodology and research design will be introduced and discussed.

3 CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

In this chapter I will cover the methodological approaches that have been pertinent for this research, which aims to add to our understanding the under researched group of adult learners studying GCSE mathematics in England.

The development of the design of the research and the research implements is also covered in some depth, as there were a number of factors which influenced this that were outside of my control: macro factors such as the Covid 19 pandemic, and micro factors such as that participants self-selected.

This chapter includes a justification for the use of thematic analysis as a way of analysing the data that facilitates answers to the research questions, based on the perceptions and beliefs of the 21 participants.

To recap, the research questions are:

1.What are the learners' perceptions of mathematics and examinations when they engage with GCSE classes in colleges?

2.Do courses in FE colleges change adult learners' perceptions of mathematics and examinations and, if so, how?

3. Do these perceptions differ by age, gender or whether the learner is a first language English speaker, or not?

4. Is a positive level of self-efficacy necessary for, or related to, examination success? Is there a point at which too high a level of self-efficacy is detrimental to examination performance?

5. What levels of anxiety are present in the adult mathematics learners participating in the study, and are anxiety levels also related to examination success?

6. What other findings emerged from the data?

Finally, this chapter discusses the ethical issues that arose during the research process.

3.2 METHODOLOGY

3.2.1 Introduction

In this methodology section I have included sections on mixed methods and insider research because the first was the appropriate methodology for data collection based on a questionnaire with comments sections and interviews, and the second because of the potential impact of being an insider had on the research process.

Data collection for the main research phase took place over two academic years, namely 2020/21, and 2021/22.

'Mixed methods' was chosen as data can be checked and triangulated to add depth to the understanding of the perceptions of participants. The pilot study revealed that a questionnaire designed with both attitude scales and comments sections worked well for the adult participants of this research, as many used the comments sections to expand on their views, whether negative or positive, about the aspect that they were ranking. The themes that emerged from the comments also led to a reassessment of the content of the questionnaire which, combined with personal knowledge and subsequent reflection, meant that additional statements were included in course content, such as the statement on word problems.

The questionnaire was further developed to include two attitude scales, one for self-efficacy and one for anxiety, rather than the single attitude scale used in the pilot study, as this would yield more depth and nuance to the data (see Appendix 8.4). Interviews were offered to participants to check understanding and opinions, and to enable participants to express their views more fully. This added to the qualitative data collected and helped to triangulate the data, which added validity to the study.

I have worked for almost 20 years teaching mathematics in the FE sector, so the interpretation that I have placed on the data collected, and even on the methodology chosen, may be biased, influenced as I have been by my experiences as a teacher.

The overarching ontology of this methodological approach broadly fall within Pragmatism, with its elements of Post-Positivism and Interpretivism, which is compatible with the Critical Realism perspective used in this research (Bhaskar, 2020; Tashakkori & Teddlie, 1998). This combination of perspectives works well for me on a personal level: as an insider researcher I have deeply help beliefs in the possibility of

change and improvement in the area that I have chosen to research, which I acknowledge as a potentially significant source of bias, which I have counteracted with continual evaluation and reflection.

3.2.2 Mixed Methods Research

3.2.2.1 Theoretical perspective of Mixed Methods Research

Mixed methods research (MMR) emerged from the paradigm wars of the 1970s, which arose out of two contrasting views: those of the purists argued that quantitative and qualitative research should be separately considered, as they were so different, and those of pragmatists who disagreed. The argument of the pragmatists, and other researchers working from post-positivist, constructivist, and critical realist perspectives, was that the use of the two sets of data was complementary and would in add to the knowledge and understanding of social phenomena (Creswell & Plano Clark, 2018; Morgan, 2007).

Researchers supporting the development of MMR as a viable alternative to separate consideration of quantitative and qualitative data have argued that it is particularly applicable in applied settings, and can reflect the complexity of both the research problems and the social environments in which research is set (Creswell & Plano Clark, 2018; Greene & Hall, 2010).

Mixed methods investigations gather both quantitative and qualitative data (Pole & Lampard, 2002; Biesta, 2017), and blend the data gathered so that it converges to produce a fuller and more explanatory picture of a social situation. When data collection involves both quantitative and qualitative data, this can be described as an embedded (Bazeley, 2018) or convergent design. The use of a convergent design in mixed methodology aims to merge the two forms of data analysis to use the advantages that both quantitative and qualitative data have, whilst using each to mitigate the deficiencies of the other (Creswell J. W., 2015; Creswell & Plano Clark, 2018).

In addition to convergent MMR designs, researchers have identified two other forms of MMR, namely explanatory and exploratory sequential designs (Bryman, 2016; Creswell & Plano Clark, 2018; Bazeley, 2018). These describe designs where the qualitative data follows on from the quantitative data, either to explain the quantitative findings or to develop a deeper understanding of the quantitative results (Buchholtz, 2019). If the

findings of small scale studies such as this one are followed up with larger studies that confirm the results, then warranted assertions can be made, and used to evoke change to situations or circumstances that are beneficial for life chances or conditions (Greene & Hall, 2010; Bazeley, 2018).

The development of MMR as a viable alternative to the segregation of quantitative and qualitative data, either in the collection, analysis, or discussion phases of a research study has gained academic credibility since 2007 with the introduction of a journal, which has provided a platform for its development (Morgan, 2007). One change that has been seen in the field is the rejection of 'triangulation' as a descriptor of data collection that is integrated or merged, rather than sequential, in design, although some researchers have argued that this also applies if data is merged at the analysis or discussion phases (Guetterman, Plano Clark, & Molina-Azorin, 2024; Buchholtz, 2019).

Mixed methods research, while having strengths in terms of merging (Bazeley, 2018), integration (Guetterman, Plano Clark, & Molina-Azorin, 2024; Buchholtz, 2019) or triangulation of data, and adding depth and understanding to quantitative research, can be seen as pseudo-scientific, blurring the demarcation line between positivist and interpretivist approaches, and making the research sound more scientific than may be justified (Cohen, Manion, & Morrison, 2018; Mason, 2018). Hence, the onus is on the researcher to be clear about what data has been gathered, how that data has been analysed and interpreted, and to not over claim from the findings (Bazeley, 2018).

Finally, it is acknowledged by those who have worked in the field that MMR does blur the boundaries if it interprets qualitative data in a quantitative way, but it is argued that this is a strength, as it can inform social understanding (Morgan, 2018; Guetterman, Plano Clark, & Molina-Azorin, 2024), particularly valuable in understanding educational settings (Bazeley, 2018). As Buchholtz (2019) says, the combination of quantitative and qualitative data can be greater than the sum of its parts in an MMR study, and generalisations from the findings are not possible due to the qualitative input, but these studies can generate hypotheses that can be tested in quantitative research.

3.2.2.2 Application of MMR to the Research Design

This research was designed to gather both quantitative and qualitative data in a broadly convergent design (Bryman, 2016), by using two attitude scales on a 15-statement

questionnaire, which has given participants the opportunity to express their feelings using pre-selected wording, such as 'no anxiety', to comment on each statement within each scale, and to comment in an open section at the end. However, this process can also be described as an embedded research design, as the quantitative component is embedded in and applied to a qualitative form of data collection (Bazeley, 2018).

In addition to comments collected on the questionnaires, interviews were offered to all participants to facilitate clarification from both the researcher and participants' points of view. In terms of MMR, this was an explanatory sequential part of the research design, as it occurred after the data collection by questionnaire and was designed to draw out additional insights from those displayed in questionnaire responses (Creswell & Plano Clark, 2018; Bazeley, 2018). This design has enabled the data gathering to encompass, as fully as possible, the thoughts and opinions of the participants.

Qualitative data adds to our understanding of the social world, of which mathematics education forms a part, and enables or deepens our understanding of what is evidenced by quantitative data (Creswell & Plano Clark, 2018; Buchholtz, 2019). However, it also enables a drawing out of significant issues from a social or moral view that may not be seen by a purely quantitative analysis (Collier, 1994). The inclusion of comment sections for each statement has encouraged participants to expand on their views, facilitating a better comparison between those views, which would not be seen as effectively by an analysis of responses on the scales due to the nuances in individuals' perceptions, e.g., the anxiety levels of two participants who respond with 'some anxiety' on a scale may be very different in terms of the strength and depth of feeling.

Thus, there are both quantitative (deductive) and qualitative (inductive) aspects to the investigation, which supports the choice of a mixed methods study (Tashakkori & Teddlie, 1998; Biesta, 2017; Creswell, 2015). The research also draws on both objective and subjective material, for instance, the grade a student achieves is objective, as it is awarded independently by an examining body, but the ranking that participants give on the attitude scales are subjective opinions ranked objectively, and their comments about mathematics and examinations are purely subjective.

The quantitative content includes:

1) Secondary data from government sources (Gov.UK (1), 2020; Gov.UK (2), 2020)

2) Two attitude scales on the questionnaire
3) Calculations for median averages within the themes
4) Analysis by gender, age, and first language
5) Comparison of examination grades

The qualitative aspects are:

1) Comments made on the questionnaire.
2) Interview transcription.
3) The analysis of the affective domain of the participants.

The choice of a mixed methods approach has been included as it enables 'triangulation' of data, an important aspect of this study's design as it enables cross referencing of the data to show the reliability of the findings (Cohen, Manion, & Morrison, 2018; Maguire, 2019). Cross referencing refers to using more than one method to collect data (Mason, 2018; McNiff, 2016), or by using more than one set of people (McNiff, 2016), and both have occurred in this study.

In addition to the use of cross-referencing, the data have been merged and integrated both during and post analysis. The analysis was completed using descriptive statistical analysis and case study analysis, before merging the data through thematic analysis (Creswell & Plano Clark, 2018; Bryman, 2016). Statistical analysis only allowed for limited inferences given the size of the data set, but it enabled me to engage with the data in depth and to interrogate it for similarities and differences (Buchholtz, 2019), even though generalisations to the wider population are impossible (Bryman, 2016; Greene & Hall, 2010; Bazeley, 2018).

To counteract a potential objection that this research is pseudo-scientific, I have interpreted the results from many viewpoints to check for validity (Cohen, Manion, & Morrison, 2018), and reported on the learners' views by quoting from their comments, rather than paraphrasing them (Sfard, 2013). In addition to using quotations from the participants, the comments have been checked against the attitude declared on the questionnaire to check for consistency in the responses. These are then further compared with their final grades in the examinations to see if any patterns emerge.

The data analysis has also looked for patterns in the data around age, gender, and whether participants are first language English speakers or not, to see if this type of

analysis yields useful insights and adds to our understanding, if only to the complexity of educational research.

I intended that this research would benefit teachers and learners involved in the life-long learning sector, as it has included voices from those who have rarely been heard before (Scheiner, 2019), but it is possible that the findings, if substantiated by further research, could also enable teachers in other sectors, such as secondary or primary schools, to "fathom hidden mechanisms of success and failure in school mathematics" (Sfard, 2013, p. 148), if the participants' perceptions add to the understanding of those working in other mathematics classrooms.

3.2.3 Insider Research

3.2.3.1 Theoretical perspective

As a researcher who has taught in the sector I have investigated since 2005, I am an insider researcher, which brings several advantages, in terms of personal knowledge of both the FE sector, and of the adults who return to education after some years (Burgess, Sieminski, & Arthur, 2006). An interest in understanding the attitudes, hopes, and fears of those learners has developed over this period, and I have an empathetic response to adult learners, which is influenced by my own experiences in mathematics lessons as a school pupil (Creswell, 2012; Bell, 1993). However, insider researchers are vulnerable to accusations of bias as they may be circumspect, knowingly, or unknowingly, about the participants they recruit, or the way they interpret the data, or both (Burgess, Sieminski, & Arthur, 2006).

The challenges of being an outsider to potential participants, rather than an insider, was highlighted by one researcher in FE, who achieved a 64% response rate from a questionnaire sent to those who knew her, but a 4% response rate from those who did not (Chow, 2005). However, as highlighted in Potter (2006), these findings could just expose the severity of the power imbalance between researcher and participants, and the existence of coercion, whether overt or covert, of learners by teachers.

The challenges associated with insider research for the researcher, which exposes issues around social justice within organisations, have been discussed in the work of Sykes (2006), who fears that research which can be seen as damaging to these organisations could affect researchers' onward journeys in both their organisations and/or academia.

In this thesis, I believe that I have avoided the concerns of Sykes (2006) by maintaining a positive approach to the findings, and have worked to improve mathematics education for learners, rather than criticising either the FE sector, or colleges, or what has been done previously. Bias and power imbalances may well exist, and I have counteracted these with an open and honest interpretation of the data.

3.2.3.2 Application to the research

As a researcher who works within the education community being investigated, I can be seen to be in conflict, almost by definition, with the methodological prescriptive to be as objective and analytical as possible, so that the work may be seen as valid. This conflict cannot be resolved, but it can be ameliorated by closely recording both my positionality and journey, and by critically reviewing and challenging the findings at each stage (Clough & Nutbrown, 2007; Maguire, 2019), in order to try to achieve an objective and disinterested outcome (Burgess, Sieminski, & Arthur, 2006; Clough & Nutbrown, 2007; Munn-Giddings, 2017).

At each stage of the data collection, I have tried to ensure that the participants are able to respond positively, neutrally, or negatively to the questions posed, to reduce bias in the data collection, and so identify emergent patterns that have some validity (Taber, 2017; Cohen, Manion, & Morrison, 2018). However, the sample for the pilot study was drawn from my own learners in a college classroom, so could be seen to be biased, as my learners may have modified their answers knowing that I was going to see them (Oates, 2006; Burgess, Sieminski, & Arthur, 2006).

In the main study participants have been recruited from more than one college, and more than one teacher's learners within colleges, to add validity to the findings and reduce the potential effects of insider bias, but I acknowledge that I am a product of a range of influences in terms of social and political beliefs, which influences the findings and their interpretation (Scheiner, 2019). The participants have self-selected which has brought issues concerning the validity of the sample (Spiegelhalter, 2019). Recruitment and sampling are discussed more fully in Section 3.3.3.2. Participants will be described using features such as age, gender, and first language, and it will be left to other researchers and practitioners to determine for themselves if the findings could have application in their own or other educational environments (Le Voir, 2006; McNiff, 2016).

This concludes the section on methodologies. The next section, 3.3, details the research design and includes discussions on the influences of both the pilot study and the Covid 19 pandemic.

3.3 THE RESEARCH DESIGN: DATA COLLECTION BY QUESTIONNAIRE

3.3.1 The Pilot Study

The pilot study was conducted in the summer of 2018, after ethical approval. The methodology employed for the pilot study was Action Research, due to the interactive nature of the investigation into the efficacy of the questionnaire between myself and the participants, because I was in the role of teacher/researcher (McNiff, 2016; Munn-Giddings, 2017). In addition, the pilot study was informed by participatory principles, as the participants were involved in evaluating the research instruments, namely the questionnaire (Cohen, Manion, & Morrison, 2018; Munn-Giddings, 2017). The timeline for the pilot study is contained in the figure below (Figure 1).

The questionnaire used in the pilot study was based on the AMAS scale (Hopko D. R., Mahadevan, Bare, & Hunt, 2003), with the addition of a question on non-mathematics examinations. The use of an existing survey adds academic weight to the pilot study, as it is tried and tested by other researchers, and avoids the major challenge of constructing, testing, and validating a survey from scratch (Wilson, 2017; McNiff, 2016). However, the inclusion of an additional question, which was on non-mathematics examinations, could be seen to distort the validity as it is untested in a large-scale investigation. However, for the purposes of this research, it was important to determine if the participants recorded a difference in their perceptions of mathematics and other, non-mathematics, examinations, as it would validate the inclusion of that question in the main study.

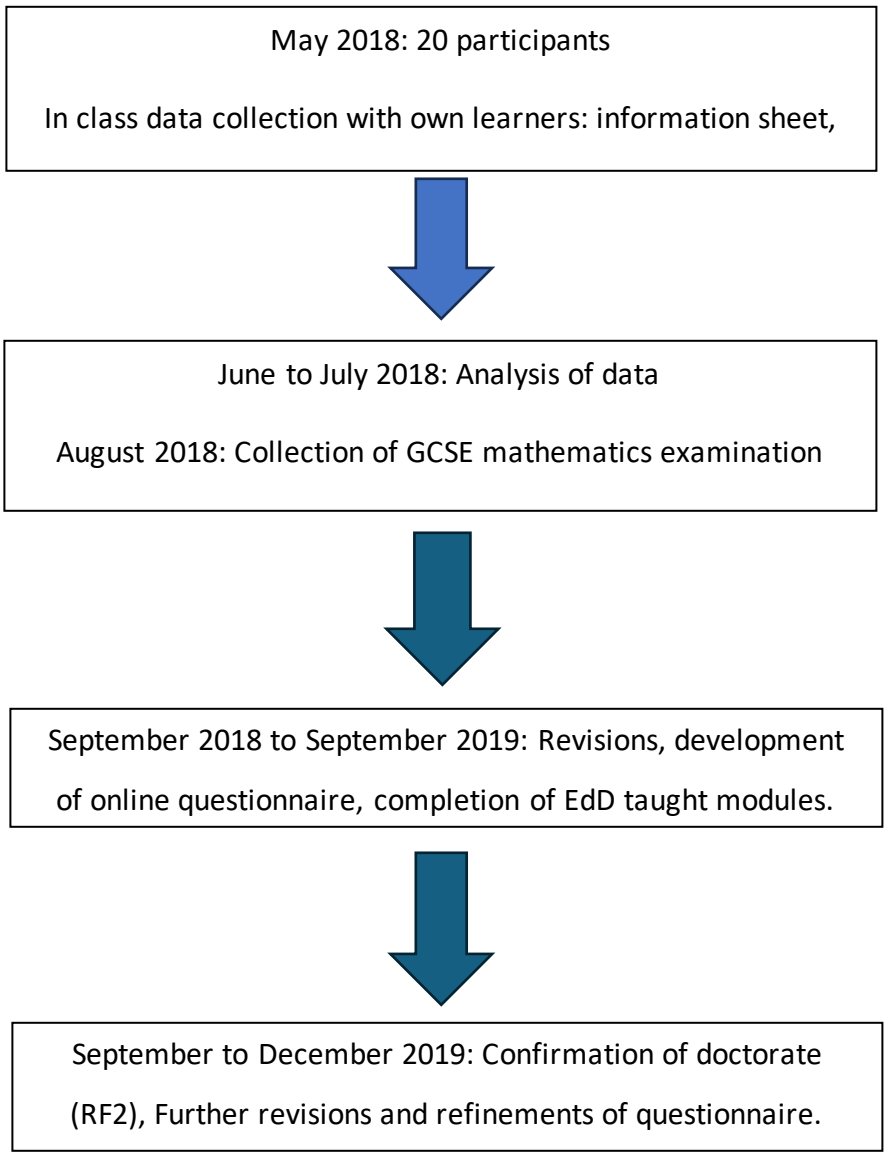


Figure 1: Timeline for the pilot study: action research

The questions used in the pilot study are contained in Table 1. They included using a times table grid, anticipating a mathematics test the next day, watching a teacher work an algebra example on the board, and so on. The origins of the structure and content of the 'GCSE Mathematics and Examinations Questionnaire' will be explained in more depth in Section 3.3.4, as the final questionnaire used in the main study differs from the pilot study questionnaire in several ways.

Question number and main topic	Range on the attitude scale	Number of comments per question	Positive comments	Negative comments
1 Having to use a times table grid	1 to 4	8	6	2
2 Thinking about an upcoming maths test one day before	2 to 5	11	5	6
3 Watching a teacher work an algebraic equation on the board	1 to 5	12	7	5
4 Taking the Maths GCSE exams at the end of your course	2 to 5	12	2	10
5 Taking any GCSE or other exams	1 to 5	8	3	5
6 Being given a homework assignment of difficult problems which is due in next class	2 to 4	8	4	4
7 Listening to the teacher talking at the front of the class	1 to 2	9	9	0
8 Listening to another student explain a maths formula	1 to 4	8	2	6
9 Being given a quiz in a maths class	1 to 5	11	5	6
10 Starting a new topic in class or in a maths book	1 to 5	8	3	5
11 If you have any other comments…		10	6	4

Table 1: Pilot study results: range of scores and number of comments

The pilot study was useful and informative in terms of developing the content and structure of the questionnaire, the consideration of a sampling strategy, and for decisions concerning methodological perspectives, due to the volume of both quantitative and qualitative data that could be collected from participants. In addition

to informing the main research project in many ways, it led to a presentation and paper for the CERME conference in 2022 (Stacey, 2022).

Twenty learners participated in the pilot, found the questionnaire easy to use, and appreciated that confidence was to be considered in opposition to anxiety. However, further reading and deliberation made me re-consider that aspect, so self-efficacy and anxiety have been separated for the main study (Bandura, 1997; Swan, 2006). This adds to the usefulness of the data, as it allows participants to be able to express, say, anxiety about a particular aspect, but to have a different level of self-efficacy, e.g., to be quite anxious about examinations, but have some confidence in their ability to perform well in those examinations. This is an example of a response that was not possible in the pilot study because participants chose a single position on one attitude scale.

Examination grades and scores were collected during the pilot study for each participant and plotted onto scatter graphs. There was little difference between the angles of the trend lines when these were compared, so I decided to collect exam grades rather than scores in the main study. This had several practical benefits, as learners' grades were easier to collect, and variations in grade boundaries and examination profiles between examination boards were negated.

In the pilot study the learner characteristics of age and gender were both explored in scatter graphs that compared examination grades with scores from the questionnaires. Although there were insufficient numbers of participants to justify the use of graphs, it was useful to display the data in this way to look for interactive relationships within the data. Whilst trend lines mostly followed the hypothesis of the study, that more confident learners were more likely to pass, the graph by age contradicted that, as it revealed that some learners were high performing but also highly anxious. These learners could have been viewed as outliers in the data, but in fact, this knowledge led to improvements in the questionnaire for the main research phase, as it supported the separation of self-efficacy and anxiety into two scales.

There was no attempt in the pilot study to gain a representative sample from the classes, such as a mix of those I believe to be confident or anxious, or a mix of gender, ages, or nationalities (Oates, 2006). The participants in the pilot study (n=20) tended to be older than the mean average age of the cohort, and no learners participated whose first

language was not English. This has not been the case in the main study, but this has been entirely coincidental, as there was no attempt on my part to influence individuals' participation.

The data collected during the pilot study has not been used in the main analysis, as there was an issue with the potential levels of insider bias in the sample of participants (Spiegelhalter, 2019), as they were all drawn from my own students, who were all aware that I would be investigating their responses (Burgess, Sieminski, & Arthur, 2006; Oates, 2006). This is described as the halo effect by Cohen et al (2018), but as in the pilot I was testing the format and content of the questionnaire, this was less relevant.

In addition to the bias that this knowledge might have had on the data, there is another form of bias present, as those participants who left the course or who did not attend the examinations for various reasons were not present in the final grades analysis. The loss of participants during the process of a research phase could lead to some distortion of the data (Munn-Giddings, 2017; Oates, 2006; Vignoles, 2017).

As can be seen in Table 1 the full range of the attitude scale was used by participants, which was contrary to some theorists' expectations (Cohen, Manion, & Morrison, 2018). In the pilot study in four out of the ten questions, the full range of 1 to 5 was used, and three-quarters (15) of the participants used either 1, or 5, or both. From this, it seems likely that most participants had no issue with deciding how strongly or otherwise they felt about the content, which may reflect the strength of feeling there is about mathematics generally, either positively or negatively. Whether the 25% who did not use the extremes were reticent about using extremes on any questionnaire, or whether they felt less strongly is unknown. A comparison of individuals' strength of feelings can only be inferred from the data, rather than known.

From the study's point of view, the inclusion of a comments section gave an opportunity for triangulation of the data by collecting responses in more than one way (Cohen, Manion, & Morrison, 2018; Maguire, 2019; McNiff, 2016; Biesta, 2017). In addition, the inclusion of a comments section worked well, as a total of 105 were made, an average of five per participant. Its inclusion allowed participants to more fully express their attitudes and feelings (Creswell, 2012). It also provided information on what additional statements could be beneficial.

When a small group of participants in the pilot study was asked to compare the AMAS and MECS questionnaires, they confirmed that they saw the MECS version as more balanced and less likely to encourage anxiety by having a range of responses that went from 'very confident' to 'very anxious', rather than a range which always included the word anxious. Consequently, in the final version, the 'GCSE Mathematics and Examinations Questionnaire' (Appendix 8.4), the self-efficacy scale is placed before the anxiety scale.

Another section in the research design includes a detailed resume on how and why the questionnaire was extended (3.3.4), but prior to that it is necessary to cover some of the details of the impact of the Covid 19 pandemic on mathematics education in FE, and subsequently on the participants (3.3.2).

3.3.2 Impact of the Pandemic

This section contains a brief resume of the Covid 19 worldwide pandemic in terms of some of its impact on mathematics education within FE because the data for the main research phase was collected during the 2020/21 and 2021/22 academic years.

The Covid 19 pandemic, which started in the UK in March 2020, caused significant disruption to the 2019/20 academic year, as a lockdown was enforced in FE colleges, which were closed for learners except those who were the children of 'key workers', such as those who worked in the National Health Service. In addition to providing classes online, colleges in England were required to produce a list of grades for GCSEs, based on students' performances in tests and practice papers that had been completed before the lockdown. This process was known as CAGS (College Assessed Grades).

The whole of the 2020/21 academic year, when the first round of data collection commenced, was significantly different from pre-pandemic years in terms of students' and teachers' experiences, as most classes and all examinations continued to be online. The examination results were based on a process known as TAGS (Teacher Assessed Grades). Grades were decided after little or no face-to-face learning in classes, and several online assessments. There was evidence that some learners had been called in to colleges to sit practice papers if their access to online materials was limited.

Mathematics education, like the rest of the school, college, and university curricula, moved online in England, as in many other countries, resulting in disruption and fear

(Albano, Antonini, Coppola, & Pierri, 2021; Chan, Sabena, & Wagner, 2021). Face to face learning has some significant differences from online learning, including less chance of developing a community within the class by students building relationships with each other, and a more structured lesson format which can inhibit student feedback (Tennant, 2006). Many adult learners may have recognised these issues, as they experienced learning online potentially for the first time, with issues around access to hardware and/or Wi-Fi, and use of software with which they were unfamiliar, much of which proved a challenge, as noted in the questionnaire responses.

Additional challenges resulted from the disruption to life generally, especially perhaps for those who were parents or carers. However, it was noticeable that some learners preferred the online experience, as it enabled them to isolate, reducing the chances of infection and of necessary cover for absence in the home for children and other dependants.

In the main research phase, I intended to visit classrooms to recruit participants early in the academic year of 2020/21. The target for visits was weeks 2 to 4 when learners would have begun to understand the structure of the new class and environment, but not yet experienced much mathematics input. This proved impossible due to the pandemic as no colleges permitted a personal visit, so I produced a PowerPoint presentation to introduce myself and the project, for distribution through class tutors to recruit potential participants (Appendix 8.3). The PowerPoint, along with copies of the information sheet, consent form, questionnaires, and a link to the online questionnaire, were circulated by email throughout the East Midlands and South Yorkshire areas, via contacts I had established with colleges, and the South Yorkshire Maths Hub, which is NCETM funded.

Adult learners self-selected to take part in the research and were drawn from several different colleges and classes, but due to the relatively low numbers of participants (n= 5), all of whom were female, and that the data collected, although it revealed interesting and informative rankings and comments, was not as comprehensive as I wanted, I requested an extension to the data collection from the 2020/21 academic year into the next academic year, namely 2021/22. Ethical approval was granted.

The impact of collecting data over two academic years with a more diverse group of participants has been highly beneficial both for this research and my research journey, as will be seen in subsequent chapters.

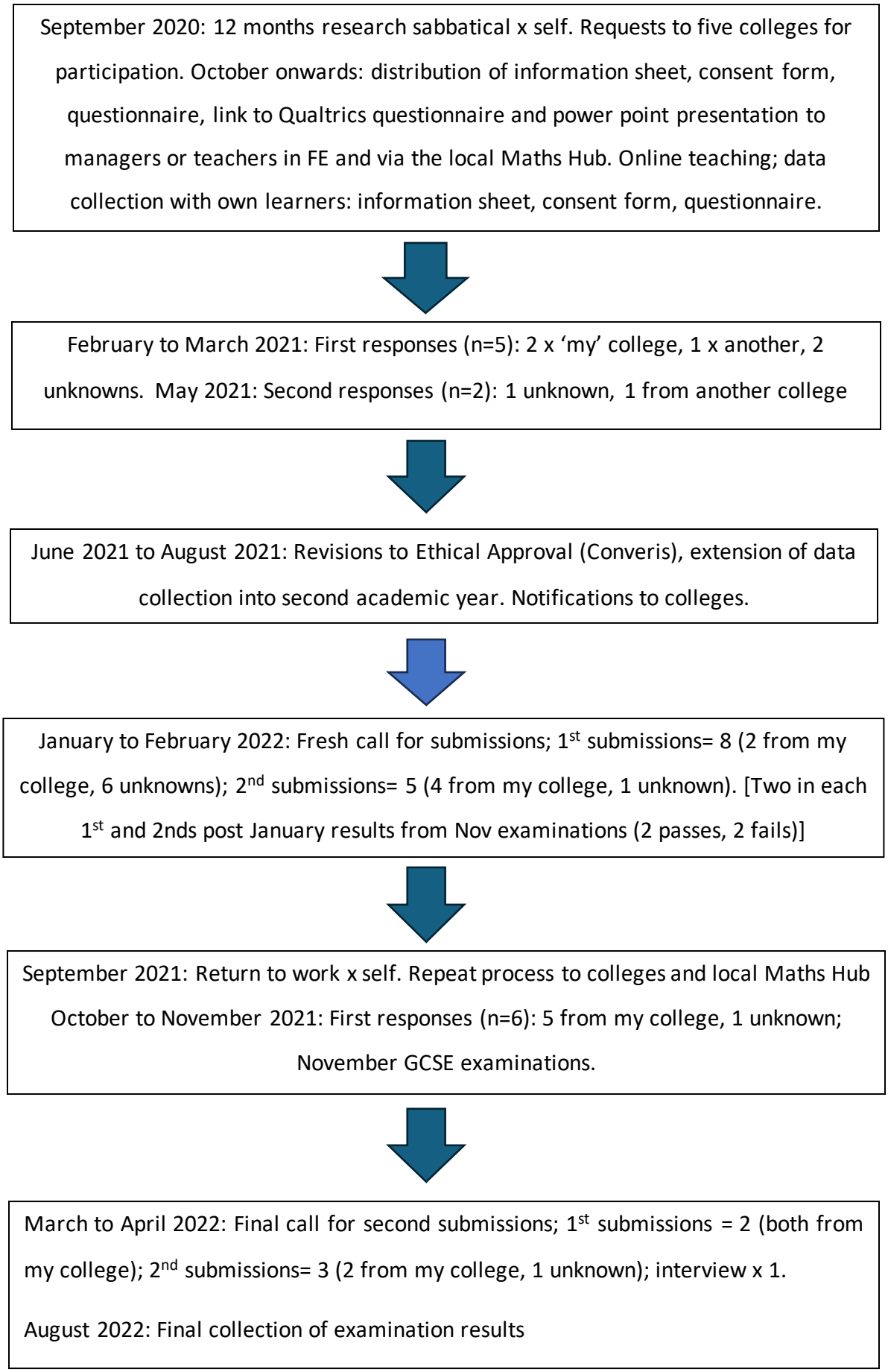
3.3.3 The Main Study

3.3.3.1 Introduction

In this section, I will describe and justify the choices made, in terms of the sampling, the bias that might be present in the sample, and the blending of the two cohorts from the two academic years, and of those learners that I was teaching with those that I was not.

The timeline for the whole study is provided in Figure 2 and gives an overview of the process of data collection. It can be seen in the timeline that the number of colleges represented in the data is unknown because nine out of the 21 participants used their private email addresses, rather than college emails. However, whilst eleven out of the 21 participants used email addresses from the college where I have worked, one did use another college's email address. Consequently, the number of colleges attended by the research participants is two or more.

Figure 2: Timeline for the main study: mixed methods research



3.3.3.2 Recruitment and Sampling

Information on the research was circulated in two academic years, namely 2020/21 and 2021/22, to several colleges in the South Yorkshire, North Nottinghamshire, and North Derbyshire areas, using contacts built up through the local NCETM practitioners' mathematics hubs, in addition to personal contacts, such as work colleagues who had moved teaching posts into other colleges. It was also circulated to teachers within my own college. All the above were fully informed that that potential participants must all be drawn from GCSE mathematics classes, rather than other classes such as Functional Skills, and must all be 19 years or older.

Participation was encouraged by sharing the advantages in terms of the potentially beneficial effect of elucidating perceptions on performance, which was outlined in the information letter (Appendix 8.1), thus encouraging learners by showing that participation could have a personal benefit (Pole & Lampard, 2002), but no other incentives were offered.

Participants self-selected after sight of the information letter, consent form (Appendix 8.2), and either a personal approach or access to a PowerPoint presentation (Appendix 8.3). The latter was particularly useful in 2020/21 when personal visits to classes were banned due to Covid 19, as it contained a voice-over and a picture of me to encourage trust and engagement.

Potential participants also had access to the questionnaire by opening up either the Word version attached to the email request or the online version, so that they could see what participation involved, and were told that completion was likely to take approximately 15 to 20 minutes.

In the first academic year, five learners came forward to participate, and in the second a further sixteen participated, so the final number of participants was twenty-one (n=21). Participants were asked to complete a second questionnaire to evaluate if and how opinions had altered over the course, and in the run-up to the examinations. Ten participants completed a second questionnaire, so the final number of questionnaires is thirty-one (n=31).

In the pilot study older learners were more likely to volunteer, as the mean average age of 38.5 years showed, but this could be construed as an advantage as there is generally

less research available about older participants. The reason for this could be that research for 19+ learners is often conducted in universities (Evans J. , 2000; O'Sullivan, Robinson, Keogh, & O'Neill, 2018), so most data gathered relates to the 19 to 24 age group. This age group is present in this study but has not dominated the data, as four of the 21 participants were 19 to 24 years, nine were 25 to 34 years, and eight were 35 years or older, as can be seen in the summary table (2) below.

Data collection	First questionnaire submissions	Second questionnaire submissions	Examination results collection	Age range. Gender. L1 vs LX.
First Cohort	Five responses: Feb/March 2021	Two responses May 2021	Five responses August 2021	All five 25+. All 5 females. Four L1s, 1 x LX.
Second Cohort	Sixteen responses October/April 2022	Eight responses January/April 2022	Three responses November 2021 Two withdrawn Eleven responses August 2022	Four 19 to 24 years, twelve 25+. Three males, 13 females. Thirteen L1s, three LX.

Table 2: Summary of data collection by age, gender and first language

In terms of gender, there were three males and eighteen females who participated in this research. Participants whose first language was not English numbered four out of the 21 participants, thus 17 are first language English speakers. The analysis of data gathered from questionnaire responses includes two individuals who left prior to the examinations; thus, they are included in the data but have no examination grade.

In addition to the completion of a questionnaire with two attitude scales, one for anxiety and one for self-efficacy, all participants were offered the opportunity to engage in semi-structured interviews (Section 3.5), which would draw more qualitative data to add to the comments made on the questionnaires and triangulate the quantitative analysis of the ranked responses on the attitude scales. One participant came forward for an online interview (n=1).

Finally, in the last phase of data collection in both years, I asked learners to email their examination results at the end of August, or to give me permission to collect the data from the examination results' lists, which all did (n = 19).

There is evidence that learners may benefit from completing a questionnaire on their feelings about mathematics, as writing about their concerns may improve results

(O'Sullivan, Robinson, Keogh, & O'Neill, 2018). This means that the participants' results may have been improved by participation in the research.

3.3.3.3 Limitations and Bias in the sample

This section will discuss various forms of limitations and bias that may be present within the research sample, e.g., that some participants were from my own classes, that independent researchers were not employed for the data collection, and that participants self-selected, which implies the presence of volunteer, sampling, and other biases in the data. It is impossible to determine the levels of volunteer or sampling bias in the data (Tymms, 2017), as this study drew participants from two different year groups, several colleges' cohorts, and different teachers' classes, and the overall characteristics of these varying groups are unknown.

Opinions on an adequate sample size are divided, with some sources saying that a few respondents in qualitative research can be enough (Burgess, Sieminski, & Arthur, 2006), but other sources specify a minimum of 30 (Cohen, Manion, & Morrison, 2018). As this research has been based on a sample of 21 participants, who self-selected to participate, it may not be representative of the wider population. In addition, this was a convenience sample from colleges within a restricted geographical location, which may have further influenced the data (Lawson, 1998).

In 2020/21, I was on a research sabbatical, but in the second year I returned to teaching, and some of those that I taught are included in the data. However, the sample is drawn from several different colleges, and teachers within colleges, including my own. This has enabled a reduction in the insider implications and bias in the sample for the main data collection (Cohen, Manion, & Morrison, 2018), although this is unlikely to have been completely mitigated as participants were approached through mathematics teachers rather than by independent researchers. However, because participants were responding directly to me as a researcher, either on email questionnaires or online via a Qualtrics survey, their own teachers would not have seen any responses.

Due to the self-selection of the participants, this study may be affected by volunteer bias, where certain sections of the population are more likely to volunteer than others (Spiegelhalter, 2019). This has implications for the research because to get a representative sample it would be better if whole classes or cohorts of students

participated. In contrast with this largely qualitative research, large cohort responses are visible in much of the research involving HE students, as it seems to be often conducted with undergraduate psychology students on traditional pathways in education, sometimes incentivised by module credits (Mandler & Sarason, 1952; Hunt & Sandhu, 2017), although some include those on non-traditional pathways (Dodd, 2016; Evans J. , 2000). Thus, findings from this research indicate that further quantitative research is required to establish if the issues raised are present in the wider population of adults on GCSE mathematics courses.

To conclude, whilst bias is potentially present in the sample in several forms, which does not detract from the qualitative findings of this thesis, which indicates the need for further study of this under-researched group. However, it does mean that there are a number of limitations on the data, in terms of its relevance and reliability.

Justifications for blending the two cohorts in the data analysis, both from different year groups, and for including participants taught by me in addition to others, are next.

3.3.3.4 Blending the two cohorts

The justification for blending the two cohorts from two consecutive year groups is based on a review of the data, which indicated that there were no real differences between questionnaire submissions from the two cohorts in either the main themes of classroom dynamics, assessment, and course content, or in the totals for self-efficacy and anxiety.

One aspect where the two cohorts did differ was in the grades achieved; the number of participants who passed under the TAGS, compared to the pass rate for those who had been examined was different, as only one out of the five from Cohort 1 was awarded a grade 3 or lower, whereas six out of the 16 from Cohort 2 were awarded a grade 3 or lower. For some of Cohort 1 assessments anxiety was slightly lower than for those taking examinations, but this group was subject to other assessments that would contribute to their final grade.

An additional benefit of mixing the two groups is the protection of individual identity. In the next section I will discuss blending my own learners in with those from other colleges and teachers' classes.

3.3.3.5 Blending my learners with others

In this section, I will justify mixing my students with those not taught by me, some of whom came from colleges other than the one in which I teach. Participants P1 through to P5, and P16 were not taught by me; they were drawn from other teachers' classes, and in some cases from other colleges.

The responses gathered from my learners when compared with those taught by other teachers were very similar, and it was possible to match up individuals from each group with, in some cases, identical self-efficacy and anxiety scores.

In addition, the respondents in the first phase of data collection, the 2020/21 academic year, did not differ sufficiently in their responses from the pilot study to indicate that the identity of the teacher would have an effect, as all respondents from both were uniformly positive about, for instance, their perceptions of their teacher. The positive view of their teacher found in all the responses could be showing a level of bonding which might surprise those used to more traditional, or formal mathematics education settings, or it could mean that those who were negatively disposed to their teachers had either left the course or declined the offer of participation in this research.

For these reasons the inclusion of a mix of my own and other teachers' students as a single body of participants was justified.

The next section will discuss the development of the questionnaire, which was the main data gathering tool.

3.3.4 Development of the Questionnaire

3.3.4.1 Introduction

The questionnaire, which can be seen in Appendix 8.4, consists of two attitude scales attached to statements that have been constructed to provoke a response in participants, in order to measure perceptions or attitudes which may not be measurable in any other way, such as by observation (Tymms, 2017).

The format and content of the questions were carefully developed using previous questionnaires and a review of what both other publications and research indicated as either contributory factors to anxiety or lack of self-efficacy in mathematics, or as

potential solutions to challenge those factors. Further information is contained in Appendix 8.7.

The questionnaire was tested and amended due to feedback from the pilot study, and further consideration of existing scales. The final questionnaire had 15 statements, split into three main themes, and each statement had two attitude scales, one for self-efficacy and one for anxiety. Individual questions are justified in Section 3.3.4 and summarised in Table 3. The questionnaire was made available to learners in two forms, paper-based and online through the Qualtrics system.

With each part of each statement there was an opportunity for participants to make comments. The advantages of questionnaires with comments sections for each question are that they allow participants to both express an attitude about each statement, in terms of how confident or anxious they feel, and to amplify on that expression using a comment with more nuanced information. Questionnaires conducted outside of classrooms are private from the participant's point of view. Follow-up interviews allowed the researcher to further investigate or clarify comments.

The development of the two attitude scales will be discussed in the next section, followed by the sources of the questions and more details on the format and content of the questionnaire.

3.3.4.2 Two attitude scales

There was a change from the pilot study in terms of the structure of the questionnaire, as I moved away from using a symmetric scale, with 'Very confident' at one end and 'Very anxious' at the other, to two asymmetric ordinal scales, one for self-efficacy and one for anxiety, which had precedents both academically and practically (Fennema & Sherman, 1976 ; Richardson & Suinn, 1972; Bandura, 1997).

The separation into two scales for each question was prompted by the work of Bandura, who argued that if those with low levels of self-efficacy are placed in situations that are perceived as beyond their control, they are likely to experience low levels of self-efficacy combined with high levels of anxiety (Bandura, 1997). GCSE examinations with their high stakes for adults in terms of the need for a specific performance to enable a desired outcome, such as entrance to university or promotion at work, combined with no control over the contents of the exam papers, could fall into this category.

The self-efficacy scale was drawn from Swan's work, with a range from 'Very confident' to 'I definitely can't do this' (Swan, 2006), and participants rated their self-efficacy when faced with several tasks and situations. Swan allocated scores to his scale, which ranged from 5 for 'very confident' to 1 for 'I definitely can't do this', so a high score reflects high self-efficacy. In this study I have used 1 for very confident, to 5 for 'I definitely can't do this', as this seemed to enable a better comparison between self-efficacy and anxiety scores, thus in my data analysis a high score indicates low self-efficacy.

Participants were also asked to rate their anxiety for each question from 'No anxiety' to 'High anxiety', which follows the AMAS scale (Hopko, Mahadevan, Bare, & Hunt, 2003), apart from one aspect as 'Low anxiety' has been changed to 'No anxiety', to allow those learners who are not anxious to say so (Dodd, 2016). This reflects the MARS and MAS-UK questionnaires that used "Not at all anxious" as the first choice (Richardson & Suinn, 1972; Hunt, Clark-Carter, & Sheffield, 2011). The use of 'no anxiety' is also in response to an issue identified by learners in the pilot study, which was that the AMAS format assumes some level of anxiety by using 'low' at one end of the scale.

This alteration of the anxiety scale was to give participants the opportunity to show the strength of their feelings about a topic or theme, as those who have chosen, say, 'some anxiety' should recognise the degree of difference between that and 'moderate anxiety'. However, it is impossible to accurately gauge the strength of feeling between individuals, e.g., one participant's perception of their feelings about, say, word problems, might be similar to another's, but they may have chosen different options on the scale. This highlights the implicitly qualitative nature of the quantitative data collected.

The inclusion of both scales has allowed for a variation in the responses of participants and has added significantly to the value of the research, as it has allowed participants' whose self-efficacy differed from their anxiety to express that clearly. The pilot study questionnaire included an implicit assumption made by me, that those who were confident would not be anxious, or vice versa, and this may not have been the case.

3.3.4.3 Sources of statements

This section consists of a justification for the inclusion of each statement in the questionnaire, in addition to a summary of which scales have been evaluated to inform

the overall format, which is of three sections, one on course content, one on classroom dynamics, and one on assessment. The questionnaire can be viewed in Appendix 8.4, and a summary of the statements is contained in Table 3.

Questions from the GCSE mathematics and examinations scale (GCSE-MES)
Using a times tables grid
Drawing graphs and charts
Working out 12% of £42
Finding two thirds of £42
Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take 2 people?
Doing a quiz in a maths class
Being given a homework assignment of difficult maths problems which is due in next class
Thinking about an upcoming maths test one day before
Taking the Maths (GCSE) exam at the end of your course
Taking any GCSE or other exams
Starting a new maths topic in class
Listening to the teacher talking at the front of the maths class
Watching a teacher work an algebraic equation on the board
Listening to another student explain a maths formula
Asking a question in a maths class about something you have not understood
15 questions with an option for comments on each and additional comments: 'If you have any other comments relating to confidence or anxiety…' 1/3 (5) questions on each course content, classroom dynamics and assessment

Table 3: List of questions in the GCSE-MES questionnaire

The three sections each consist of five statements drawn from several sources, thus the number of statements in this research is fifteen. The AMAS questionnaire of nine statements (Hopko, Mahadevan, Bare, & Hunt, 2003), which has been included in its entirety (see Table 3), was developed out of existing longer questionnaires, such as the MARS version with 98 questions (Richardson & Suinn, 1972), and tested for its accuracy and efficacy. I added to this in the pilot study list by including a question on 'other examinations', as it was important for this research to evaluate whether participants had a different level of anxiety or confidence compared to mathematics examinations (Szucs, McLellan, & Dowker, 2017).

I have also investigated other researchers' work to identify additional topics that have generated a strong response in adult and GCSE resit students, using the work of Evans (2000), among others, feedback from the pilot study, and my own personal experience.

I will now show the source or sources of each of the questions shown in Table 3, where these exist. Where a source does not exist, the statements are unique to this research and will be discussed in the following section, (section 3.3.4.4).

1. Using a times table grid: Research that followed on from the 98-item MARS scale has included statements on using tables at the back of a mathematics book (Suinn R. M., 1972; Plake & Parker, 1982; Hopko D. , Mahadevan, Bare, & Hunt, 2003). The MAS-UK includes a statement on being asked to memorise a times table (Hunt, Clark-Carter, & Sheffield, 2011).
2. Drawing charts and graphs: This is an original statement; please see next section.
3. Working out 12% of £42: Statements on percentages appear in some scales, referencing sales tax on a purchase in the USA (Suinn R. M., 1972; Suinn & Winston, 2003), and VAT calculations in the UK, which Evans includes in his SAS scale, in addition to a self-efficacy ranking on percentages generally, and specific questions in his performance scale (Evans J. , 2000). Hunt et al (2011) include a statement on being asked to change a fraction to a percentage.
4. Finding two thirds of £42: Fractions as a topic are included in the self-efficacy section of Evans' Experience Scale (2000). Hunt et al (2011) include a statement on being asked to change a fraction to a percentage.
5. Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take 2 people? This is an original question; please see next section.
6. Doing a quiz in a maths class: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982), although it is called a 'pop' quiz, and the word 'pop' has been dropped to avoid confusion. It is present in Evans (2000) as a 'surprise quiz', which may contrast with how quizzes are used in FE classes if they are used in a different way, such as a starter to check retention or encourage revision of last week's learning, as is the case in my own classes.
7. Being given a homework assignment of difficult maths problems which is due in next class: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982).

8. Thinking about an upcoming maths test one day before: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982).
9. Taking the maths GCSE exams at the end of your course: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982), although it is worded as a (final) examination, without reference to GCSE, as is also the case in Hunt et al (2011) and Evans (2000).
10. Taking any GCSE or other exam: This is an original statement; please see next section.
11. Starting a new maths topic in class: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982).
12. Listening to the teacher talking at the front of the maths class: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982), although in all cases it is framed as listening to a lecture on mathematics. Evans also asks about feelings in a mathematics lecture, which is more relevant for undergraduates.
13. Watching a teacher work an algebraic equation on the board: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982). In Evans' work (2000) algebra is included in his self-efficacy list on the Experience scale, and in Hunt et al (2011) three statements that mention algebra include reading the word 'algebra' and watching someone work out an algebra problem.
14. Listening to another student explain a maths formula: This statement is present in the AMAS scale by Hopko et al (2003), which was derived from the MARS and MAS-R scales (Suinn R. M., 1972; Plake & Parker, 1982), and is also present in Evans' SAS questionnaires (2000). It is re-phrased in Hunt et al (2011) as listening to 'someone talk about maths'.
15. Asking a question in a maths class about something you have not understood: Evans includes similar statements to this, when he asks about raising your hand in a maths class and being asked a maths question by a teacher in his SAS section (Evans, 2000), both of which are present in the MARS questionnaire (Suinn R. M., 1972). These

questions provoked strong responses among his participants, as did a similar statement in Swan's questionnaire (Swan, 2006).

This section has shown the sources of the statements on the questionnaire, but some of the statements are original to this research, and these will be discussed next.

3.3.4.4 Original statements

The statement on drawing graphs and charts is original to this research, as other scales refer to reading and interpreting charts and graphs (Plake & Parker, 1982; Suinn R. M., 1972), which is clearly a different skill than producing a drawing from a set of data. Evans refers to graphs only in his Experience Scale in terms of self-efficacy, as he asks "How would you rate yourself now in each of the following areas?", with choices that range from 'very capable' to 'not at all capable' (Evans J. , 2000, p. 247). These are inadequate references to charts and graphs, as they do not explore learners' perceptions of the physical drawing activity, which forms an important part of the GCSE mathematics examinations and is therefore significant to both the learners and teachers of these courses.

The statement on word problems is also original to this research. The statement has been phrased as "Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take 2 people?" and was included because of my classroom observation of the difficulties that learners face when trying to engage with this type of question, whether their first language is English or not, as they try to interpret the question and decide which of the four basic number operations is applicable.

The wording of this statement is also original as many scales do not include this kind of statement, either those for self-efficacy or anxiety, which may be because the content of the GCSE mathematics papers has changed over time to include more 'real life' or contextualised problems, with a reduction in more 'pure' mathematical problems, such as those based on geometry or algebra (Brown T. , 2001). The 'real-life' problems that have been included in existing scales have been phrased as working out a monthly budget, or have included algebraic notation (Richardson & Suinn, 1972; Evans J. , 2000; Plake & Parker, 1982), rather than the types of questions that arise in current GCSE papers.

Another difference between the wordier statements in Evans' Performance Scale and this word problem is that his have been tested with undergraduate students (Evans J. , 2000), rather than many learners who have not yet attended a university, although they may aspire to do so. As such, this research has made an original contribution as it gathered participants from non or pre-university experiences in England, which has contributed to its importance.

Research has taken place on wordier questions (Neri, Wagner, & Retelsdorf, 2021; Ginsburg, 2022; Vershaffel, Schukajlow, Star, & Van Dooren, 2020), but an analysis of the potential challenges of word problems seems to be missing from many teaching guidance publications (Boaler, 2016), unless those are concerned with EAL learning (Barwell, Mathematical Word Problems and Bilingual Learners in England, 2009; Kersaint, Thompson, & Petkova, 2013). By contrast, in the EAL publications close attention is paid to the challenges faced by the LX learners (Dewaele, 2018) when attempting to interpret questions, and suggestions are included to help overcome these difficulties, such as developing their own questions to help them engage with the structure and format (Barwell, 2009). As will be seen later, I will argue that this approach needs to be included for first language English (L1) speakers too.

Another original aspect of my questionnaire is the inclusion of a statement on other examinations, in addition to the statement on GCSE Mathematics or 'final mathematics examinations', as they are often referred to in other scales. This was highlighted as a need in the research by Szucs et al (2017), and was included to enable me to compare the responses to ascertain whether, for this group of participants, their perceptions apply to all examinations, or whether there are specific issues about mathematics examinations that cause issues for them. The only mention of other subject areas that have been located in the source texts is in Evans (2000), who asks about feelings on getting the results of an English diagnostic test on his Situational Anxiety Scale, which is ranked from 'very relaxed' to 'very anxious', but a diagnostic assessment, whilst potentially stressful for students, is unlikely to have the emotional impact of an examination on which learners' future prospects depend.

3.3.4.5 Inclusion of opportunities for comments

The inclusion of comments spaces throughout the document, including an open-ended comments section at the end, is also a unique aspect of the research tool employed for

data gathering for this thesis. It can be viewed as a form of interviewing (Tymms, 2017), as it gathers participants' feelings raised by the statements, and encourages them to expand on the views expressed in the attitude scales.

This method of gathering qualitative responses can also be used for checking the attitudes expressed in the scales for consistency, and for mapping changes in perceptions, a requirement for research question 2.

3.3.4.6 The question on gender

One of the considerations for the questionnaire was how learners' sex or gender should be collected. The Oxford English Dictionary (OED, 2021) defines sex as either male or female and based on biological differences. This is supported by the Gay and Lesbian Alliance Against Defamation (GLAAD), who add that sex is defined at birth by external anatomy.

Gender, by contrast, can be viewed as more of a cultural or social view of sex. GLAAD goes further when they specify that a person's gender is defined by how they identify themselves, which can be based on deeply held internalised beliefs (GLAAD, 2021).

In the paper-based and online questionnaires, I chose to ask learners to identify their gender, rather than their sex, and provided spaces for them to do so, on both the paper-based questionnaire and in the Qualtrics online version. This approach enabled learners to self-identify, which seemed pragmatic and suitable for the purposes of the research.

3.3.4.7 The question on age

I asked the participants to declare their age in years only on the questionnaire, but to protect their identities I have not included exact ages in years in the data analysis. When presenting the outcomes of the research, I have clustered the participants' ages as follows: 19 to 24 years; 25 to 29 years; under 30 years old; 30 years and over.

Dividing the ages up in this way broadly aligns with the government statistics, which work on 19 to 24 years, 25 to 49 years, and 50+ years (Gov.UK (1), 2020), although I have not separated out the over 50-year-olds as there was only one participant in this category. I have introduced an additional split around 30 years to enable a more nuanced view of whether, for these participants, views changed among older learners.

The current theory is that learners become more anxious as they get older (Betz, 1978; Jameson & Fusco, 2014).

3.3.4.8 The question on first language

Participants have been asked for their first language on the questionnaires. This is to enable the research to evaluate whether there are significant differences between responses from those whose first language is English, known as L1 learners, compared to those who have another first language. This latter group are designated LX participants to protect their identities (Dewaele, 2018), as participants spoke several different first languages.

3.3.4.9 Conclusion to development of the questionnaire

The questionnaire was developed using a wide range of existing resources, contributions from academics within the university, knowledge drawn from the pilot study, and my experiences of teaching for over 20 years. It contains several original statements and two attitude scales, one for self-efficacy and one for anxiety, an approach which in itself is original.

In addition, it gave the participants the opportunity to make a comment after each statement, and at the end of the questionnaire. This is also an original and unique feature of this data collection.

This concludes the section on the development of the questionnaire. In the next section, I will describe how I have treated the data collected on the attitude scales.

3.4 TREATMENT OF THE RESPONSES TO THE ATTITUDE SCALES

The two attitude scales included in the questionnaire are one for self-efficacy and one for anxiety. This enabled participants to express how confident they felt about their ability in certain situations or with specific topics, and how anxious they felt, which might be very different.

To facilitate comparisons between individual participants, and between this data collection and others, the two attitude scales have been numbered from 1 to 5, so that 'no anxiety' and 'very confident', on the anxiety and self-efficacy scales respectively, are rated at one. Thus 'high anxiety' and 'I definitely can't do this' are rated at 5. More detail on this is contained in Section 4.2. There has been some concern raised by the literature

(Cohen, Manion, & Morrison, 2018) that participants may shy away from using the full extent of attitude scales, but this was not a feature in this research, as every participant (n=21) used either 1 or 5, or both, in their questionnaire responses.

3.5 INTERVIEWS

The inclusion of interviews in the data gathering process was designed to increase the bank of qualitative data available to this study, and to enable a check to be made on the data collected by the attitude scales and comments sections attached to each statement. The interviews were designed to be semi structured, and to follow up on the comments made on the questionnaire. The analysis was thematic (see Section 3.7).

In this mixed methods investigation, interviews with a selection of participants can add to the depth of our understanding of the issues and opinions that learners bring to GCSE mathematics classes. A separate ethical approval application was required for this part of the study (ER 32452066), and an interview schedule and information letter were also necessary. The information letter for participants and the interview schedule are contained in Appendices 8.5 and 8.6. The consent forms originally returned for the questionnaires were seen as sufficient for the semi-structured interviews.

The number of interviewees for the semi-structured interviews was intended to be four or five, all of whom would have previously completed a questionnaire. In fact, despite several requests, only one participant consented to an interview, and she remarked that her consent was a result of an awareness of the challenges of getting adults to be interviewed, which she had experienced in her own undergraduate studies. The interview took place online whilst we were both at home, as this was most convenient for the participant, and ensured a degree of privacy that would not necessarily have been available at a college.

As we were using an online vehicle, I asked the participant's permission to record the session, which was granted. In the interview process I adopted the stance of a pollster, to gather information from the interviewee, and probed for information to follow up on aspects of the interviewee's comments, or their written comments from the questionnaire (Brinkmann, 2016; Maddox, 2020). Thus, the initial questions were open, and based on the themes identified from the questionnaire, namely course content, classroom dynamics, and performance issues, such as examinations and tests. These

were followed up with less open prompt questions, and finally, closed questions were included if necessary.

Whilst conducting the interview, I employed a neutral stance, adopted a listening pose, and showed awareness of the change in the power relationship between myself and the interviewee (Barbour & Schostak, 2005), by treating her as the expert. This contrasts with our usual relationship of me as teacher, and her as learner, as she was a student in one of my classes. I also gave my participant plenty of time to think and respond, and noted any intonation or emotion in her speech which could add to my understanding (Coffey & Atkinson, 1996; Farnsworth & Solomon, 2013; Maddox, 2020).

Whilst the inclusion of intonation and emotion is clearly ideal and has been considered by comparing the comments with the intonation to confirm consistency in those comments, for the purposes of this study the comments obtained through the interview have been blended with those made on the questionnaires to protect the identity of that participant. This is particularly important as a presentation of the findings will be offered at the participating colleges, where these are known, to both students and staff. The treatment of the interview content as comments is partially supported by Tymms (2017), although his approach was to treat comments as a form of interview.

The transcription of the interview and subsequent blending with the comments made on the questionnaires has all been done by myself, rather than using the online transcription and coding services that were available, as I felt that imparted the most in-depth knowledge about the data collected. The proximity to the data was an important factor for this study, though this is an opinion, and I appreciate that in larger studies, those with significantly more data, or those required within a tighter time frame, this approach may not be possible.

3.6 COLLECTION OF EXAMINATION GRADES

Examination grades have been collected, either from participants self-reporting their grades, or from data from the college if participants had given permission for this. Participants' responses on the attitude scales have been compared to their examination grades.

There are some mixed messages from existing research on whether and how much performance in examinations is affected by anxiety, as Suinn said that he and Richardson

have assumed that it is, “since high mathematics anxiety should be associated with lower performance on mathematics tests…” (Suinn R. M., 1972, p. 2), which implies that the more anxious a learner is the poorer their performance will be, but some researchers, following the work of Yerkes and Dodson, have found that the relationship was an inverted U, where a certain amount of anxiety is beneficial to performance, but very low or very high anxiety is detrimental (Yerkes & Dodson, 1908; Evans J. , 2000; Wang, et al., 2015).

To conclude this section, each research question will be answered by close interrogation of the data collected by questionnaire, interview and reported results. To protect the identity of participants it has been decided that the most effective technique for evaluating the data will be by themes, which is the subject of the following section.

3.7 THEMATIC DATA ANALYSIS

3.7.1 Theoretical perspective

Thematic analysis is a method for analysing data that works by codifying issues, or points raised, in the data, and that then clusters those codes into themes. The themes can be further split into minor and major themes, when considered in relation to the research questions. It can also be helpful to have overarching themes, which cluster certain subthemes together. The researcher is advised to scrutinise the data carefully on more than one occasion, to spot patterns and identify common themes (Bryman, 2016; Braun & Clarke, 2013; Creswell, 2012).

Examining and coding data which progresses to looking for common themes has been present in the research community since the 1970s, according to Braun and Clarke (2013), as it has been a common method of analysing data to feed into further theoretical frameworks, particularly in psychology. Investigation of the work of other social scientists has revealed that coding has been used to organise large amounts of data, to give it structure, to enable it to be manipulated to highlight and support themes, or common issues, and to enable explanations of social phenomena (Coffey & Atkinson, 1996; Pole & Lampard, 2002; Silverman, 2006).

Braun and Clarke (2006) argued for a wider application of thematic analysis as an analytical method, and for its consideration as a theoretical framework, especially with application to qualitative research in areas outside of psychology. These proposals were

developed further in subsequent papers and promoted as a way of organising data to improve its accessibility to researchers, and to encompass both quantitative and qualitative data (Nowell, Norris, White, & Moules, 2017; Braun & Clarke, 2013), so supporting the mixed methods approach used in this research.

Thematic analysis can be used to subsequently inform narrative, grounded theory, or ethnographic approaches (Bryman, 2016; Nowell, Norris, White, & Moules, 2017; Pole & Lampard, 2002). The use of computer assisted analysis is now acknowledged to have a wider application, as it can be manipulated easily to reveal additional themes (Gibbs, 2017; Evans M. , 2017). However, computer applications have not been employed in this research, as the amount of data collected was manageable without recourse to these.

Disadvantages of thematic analysis include concerns that it may be too flexible as a theoretical framework, leading to a proliferation of themes that lack coherence and consistency (Nowell, Norris, White, & Moules, 2017), but this has not been the case in this research, as the structure of the questionnaire was designed to facilitate collecting data for the three main themes of course content, classroom dynamics, and assessment. This is supported by other research, such as a USA study with 244 pupils with an average age of 12 years, which found that anxiety about mathematics was found in three areas, namely calculations, classroom situations, and anxiety about tests in mathematics (Lukowski, et al., 2019).

Another disadvantage of thematic analysis can occur if the researcher ignores data that does not fit (Braun & Clarke, 2013), or reduces the richness of the data, so that the depth is lost (Pole & Lampard, 2002; Silverman, 2006). These concerns have been addressed by a flexible approach to the main themes, by developing sub-themes that were unconsidered in the original plan, mainly drawn from the individual statements that contribute to each main theme, and by quoting comments exactly, rather than paraphrasing them (Sfard, 2013).

3.7.2 Application to this research

Broadly, there are six steps or phases in the development of a thematic analysis approach, developed by Braun and Clarke and modified slightly in the later work by Nowell et al (Braun & Clarke, 2013; Nowell, Norris, White, & Moules, 2017). The 6 steps, with details of the process for this research, are:

i. Transcribe the data- in this study the data was organised onto Excel spreadsheets, and the interview data transcribed into a Word document. In addition, a case study was developed for each participant.
ii. Commence identification of codes and potential themes by reading and familiarisation with the data
iii. Code the data, either with a computer programme, or by hand- in this study all this was done by hand, to improve familiarity with the data. Comments were colour coded and clustered to support main, sub and developing themes.
iv. Develop themes: search for examples ensuring participants' voices are heard- in this study almost all of the comments made by participants have been used.
v. Define and name themes- in this study sub themes and overarching themes emerged from the quantitative data, and additional themes were developed from the comments.
vi. Write up the report.

In terms of the application of thematic analysis to this research, the mix of quantitative and qualitative data collected in this mixed methods study has meant that thematic analysis has worked effectively as a suitable theoretical framework for data analysis and interpretation (Bryman, 2016; Greene & Hall, 2010). The three main themes, developed over a lengthy period of reading, the pilot study, and reflection, are course content, classroom dynamics and assessment. Within each of these main themes, each question as it appears in the questionnaire has been treated as a sub-theme. Additional themes have emerged from the comments as important in the analysis, and highly relevant for the participants (Layder, 2013), such as time pressures, innate ability, and a sense of community in the classroom.

As stated above, the initial approach to establish patterns in the data was to complete a case study for each participant, and then merge this data into larger data sets. This can be seen as a group or multiple case study approach (Creswell J. W., 2015; Layder, 2018). Individual case studies are not included in the thesis due to the volume of information collected, and to protect the identity of participants.

As recommended in the literature, I have scrutinised the data personally and carefully on more than one occasion, to spot patterns and identify common themes (Bryman, 2016; Braun & Clarke, 2013; Creswell, 2012). The responses on the attitude scales were compared carefully to the comments made to ensure that any nuances or contrasts in the data were captured, or, if no contrasts exist, to triangulate the data. Triangulation is supported by this mixed methods data collection and analysis (Creswell J. W., 2015).

Learners' responses to the attitude scales on the questionnaires have been analysed in several ways, both as a whole and thematically, and compared using median average calculations. Interrogation of the data in many ways to test it (Cohen, Manion, & Morrison, 2018) was shown in the pilot study to be necessary, as one scatter graph contradicted the others, and this interrogation and challenging of the data has been central to the data analysis.

Participants' comments have been analysed and their views clustered into categories to enhance our understanding. Quotations have been employed in the thesis to illustrate the strength and depth of feeling about issues which were identified as important to the participants (Sfard, 2013).

A comparative analysis of the two sets of data obtained from the ten participants who repeated the questionnaire, to ascertain if, how, and why participants' perceptions have changed during the course has been completed. This review will be quantitative, as it will summarise movement, and qualitative, as it will use the comments made on the questionnaires. Changes in perceptions may be positive or negative, as learners may enjoy the experience of returning to a maths classroom or may be overwhelmed by the pace and content of the course.

Finally, all questionnaire responses were matched to examination results, issued in January or August each year, to evaluate for correlations between self-efficacy and anxiety levels of both mathematics and examinations against grades achieved. The analyses are presented in a number of ways, and expanded into gender, those whose first language is or is not English, and age comparisons, to evaluate for patterns that would confirm or challenge existing understanding, as outlined in the literature review, such as that females are more likely to present with maths anxiety than males (Tobias, 1993; Griffiths & Stone, 2013; Boaler, 2016).

3.8 ETHICAL ISSUES AND IMPLICATIONS

This research was subject to two applications for ethical consideration and approval through the university's recommended software, which is part of the Converis system. The application numbers for the two submissions are ER24593031, for the questionnaires, and ER 32452066 for the semi-structured interviews. The first application was revised in 2021 due to the covid 19 pandemic, to extend the deadlines

for data collection across two academic years, rather than one as initially envisaged. This extension was required to engage additional participation in the data collection, to support the original concept of the project.

One of the suggestions for improving the protection of identity is to collect a larger sample size than is required, so that not every participant is included in the final data analysis (Le Voir, 2006), but I felt that this would raise issues for integrity of the research. I feel that it is an ethical requirement that I present all the views of the participants as accurately and fully as possible, rather than interpreting or rephrasing them in the light of my biases (Cohen, Manion, & Morrison, 2018; Burgess, Sieminski, & Arthur, 2006) and to preserve the voices of the participants (Clough & Nutbrown, 2007).

The self-selection of participants continued through the main data collection process. Evidence exists which shows that participation in projects which allow learners to express their fears can be beneficial, cathartic and, if used prior to examinations, can improve results (Mandler & Sarason, 1952; O'Sullivan, Robinson, Keogh, & O'Neill, 2018), but this may not be the case. Self-selection allows those learners who had concerns that completion could raise their anxiety levels, or who felt that the study was irrelevant to them (Cohen, Manion, & Morrison, 2018), or who were too busy with other commitments to not participate.

One of the ethical considerations that I felt was most important was to check that I had no vulnerable participants before proceeding (Oates, 2006). While the participants in the investigation are not considered to be vulnerable in terms of the criteria specified in the ethical approval system used by the university, and those with a medical diagnosis of anxiety were asked not to participate in the information letters (Appendix 8.1 and 8.5), there are several ethical considerations which are important when considering the potential impact of participation, driven by the requirement that the research should do no harm (Bryman, 2016). For instance, participants may have undeclared or medically undiagnosed issues with anxiety, or be adversely affected by uncertainty, perhaps due to the Covid 19 pandemic.

In addition to undeclared issues with anxiety, an adverse effect could be experienced by participation, as learners were asked to reflect on their feelings about mathematics and examinations and to record their fears, which could prompt participants to feel the fear

or anxiety more strongly. This visiting of their anxiety or fear in an overt way could have a negative effect psychologically (Oates, 2006; Maguire, 2019). Guidance for the learners who experienced negative effects was included in the information sheet, which included advice to stop proceeding, and who to contact in the event of an adverse reaction, such as a member of staff, support at their college, or the Maths Anxiety Trust website at www.mathsanxietytrust.com.

Thematic analysis was used as a tool to analyse the data collected to protect the identity of participants, by grouping both their rankings on the attitude scales and their comments. In addition, each participant has been referred to by a randomly assigned reference, such as P1, P2, P3 etc, and the comments collected are rarely attributed to the individual participants (Pole & Lampard, 2002). The comments made during the interview have been blended with the comments collected from the questionnaire to protect the identity of the interviewee.

3.9 CONCLUSION OF METHODOLGY

In this chapter I have described the research methodology and design and traced the development of the project through the pilot study into the main study. The methodology has included action research, mixed methods, and insider research as crucial aspects of the data collection. I have also reflected on the limitations which have been kept in mind as the project has progressed.

The design includes the development of the questionnaire as a research instrument for the thesis, the inclusion of interviews and collection of examination grades.

This chapter has also justified the use of thematic analysis as a method of organising and analysing the data. Finally, it has covered the ethical issues that have arisen during the research phases.

In the next chapter I present the data analysis, using the research questions as structure. In the introduction I revisit these questions and show which part of the data collections have been applied to each question.

4 CHAPTER 4: DATA ANALYSIS

4.1 INTRODUCTION

In this introduction to the data analysis chapter, I show which part of the collected data is applied to each research question, to enhance our knowledge and understanding of the perceptions of the 21 adult participants studying GCSE mathematics who participated in the data collection:

1.What were the learners' perceptions of mathematics and examinations when they engaged with GCSE classes in colleges? Method: This question is addressed by the first round of data collected (n=21). It includes the participants' perceptions and comments, as recorded on the two scales of the questionnaire (self-efficacy and anxiety), with reference to their examination grades.

2.Did courses in FE colleges change the adult learners' perceptions of mathematics and examinations and, if so, how? Method: This question is addressed by a comparison of perceptions on the two attitude scales in the questionnaire, and on the change in their comments, on two occasions for ten participants (n=10), with reference to their examination grades. The first collection was relatively early in the academic years for most participants, and the second was later, when participants were closer to their TAGS or examinations.

3. Did these perceptions differ by age, gender or whether the learner was a first language English speaker, or not? Method: These questions are addressed by a review of the data collected on the questionnaires and in the interview, to interrogate it for emergent patterns based on participants' characteristics. The questionnaire collected data on age, gender and first language. Examination grades will also be included in this review.

4. Was a positive level of self-efficacy necessary for, or related to, examination success? Was there a point at which too high a level of self-efficacy was detrimental to examination performance? Method: The first question is addressed by comparing individuals' grades achieved against self-efficacy levels and comments. The second is addressed by examining the grades of those with the highest levels of self-efficacy.

5. What levels of anxiety were present in the adult mathematics learners participating in the study, and were anxiety levels also related to examination success? Method: This question is addressed by comparing the anxiety levels and comments made by participants on the questionnaire and in the interview with the grades they achieved.

6. What other findings emerged from the data? Method: An interrogation of all the data collected by comments and interview for additional themes.

A numbering system was applied to the responses recorded on the scales of self-efficacy and anxiety, which is from one (which is used for very confident and no anxiety) to five (I definitely can't do this and high anxiety). This presented the opportunity to determine median values that are used for comparative purposes in this thesis.

In addition to two attitude scales on each question, the comments of participants helped to evaluate what this group of learners found to be of most concern in terms of the content, the way the classes are run, and responses to assessment opportunities. These responses are compared with the findings of other research in Chapter 5.

The data collected from participants (n = 21) covered more than one academic year, participants have been drawn from more than one college, and from more than one teacher in the colleges. The first group were studying GCSE mathematics in the academic year 20/21, and the second group in 21/22. There were some of my own students in the second group, and the justification for blending my learners with others is contained in section 3.3.3.5. This was in contrast with the pilot study when all participants were my students.

From the total number of 21 participants, ten responded to the request for completion of a second questionnaire (n=10), which enables a review of the data to answer the second research question. Across the 31 questionnaires, with 30 questions on each, 930 quantitative responses were collected, half for self-efficacy and half for anxiety.

In addition to the quantitative data, nine participants contributed to the qualitative data with comments, both under the statements and in the additional comments sections, and one gave me an online interview. This generated over 120 comments for the qualitative data, which have been checked for consistency with the ranked responses by participants, and usually blended into one data set in the analysis to protect participants'

identity. There were no discrepancies. i.e., those who ranked a statement as, say, 'high anxiety', did not qualify or contradict that in their comments. Approximately half of the comments on the questionnaires were under self-efficacy, and half under anxiety.

Most participants completed the online questionnaire in approximately 10 minutes using digital devices, but one LX participant took up to an hour to complete the online questionnaire, which might demonstrate the time it took to understand the language of quite a wordy document, or to migrate some of the content into online translation applications. Some participants used a paper version of the questionnaire.

In addition to the main themes and participants' characteristics, a comparison of the attitude scales used in the data collection, namely self-efficacy, and anxiety, has been included. This is to contribute to our understanding of how and when these scales might be useful in other research, if the data is confirmed by a larger study.

A brief summary of the results is shown next, to give an overview of the data collected.

4.2 SUMMARY OF RESULTS

A summary of the results from the data collection is shown in Table 4, which includes a breakdown of each section of the questionnaire by attitude scale and for each individual participant, e.g., it shows that for P1, their course content score for self-efficacy was 14, which was calculated by attributing 1 to 'very confident', 2 to 'quite confident', 3 to 'don't know', 4 to 'I don't think I can do this', and 5 to 'I definitely can't do this'. Equally, for the course content anxiety total for P1, 1 was allocated to 'no anxiety' through to 5 for 'high anxiety'. The same system was applied to assessment and classroom dynamics questions from the questionnaire (Appendix 8.4). Self-efficacy scores and anxiety scores across the 3 parts of the questionnaire have been added, to give a total self-efficacy and a total anxiety score for each participant. Treatment of the data in this way has enabled comparisons to be made that might otherwise be obscured, e.g., for most participants their self-efficacy scores were lower for the assessment part of the questionnaire, and their anxiety scores were higher, compared to the course content or classroom dynamics sections. It has also enabled a comparison both between the participants and between the individual questions within each section of the questionnaire.

For those participants who completed two questionnaires, the second response is given in brackets. Examination grades are shown in the end column, and if learners attempted

the examination more than once, if this is known, both grades are shown. To help preserve identity for the relatively small group of participants, all results of grade 5 or more are shown as 5+, and grade 3s or lower are shown as 3-.

The first cohort (n=5) in academic year 2020/21 had teacher assessed grades, which are shown in Table 4 as (TAGS), and the second cohort (n=16) in 2021/22 experienced formally run examinations, either in November 2021, or May/June 2022.

Comments were made by nine out of the 21 participants: three out of the five participants from the first cohort, and six out of 16 in the second cohort. All of the males made comments (n=3), and one third of the 18 females (n=6). Three out of the four LX participants made comments, compared to six out of 17 L1 English speakers.

When analysed by age, none of the four 19- to 24-year-olds made comments: comments all came from the 25+ age group. In addition, only one of those in the younger age group passed.

In this data analysis section, relevant comments are quoted verbatim or summarised if that was more appropriate, but some corrections to grammar and spelling have been made. Most of the comments were made on the questionnaires, and all participants were offered an interview. The inclusion of interviews into the data collection enabled participants who wished to expand on or change their written responses the opportunity to do so, and one learner came forward to be interviewed (n=1). As anonymity is a consideration in all data discussion and distribution, the comments from the questionnaire have been blended with the comments from the interview within each section, as detailed in Section 3.5.

A review of the distribution of comments by grade achieved showed that they were made by a range of participants (n=9), e.g., three participants who made comments achieved a grade 3-, three achieved a grade 4, and two were awarded a grade 5 or better. One participant who commented withdrew from the course.

In the next section I address the first research question, on the perceptions of the participants on aspects of the GCSE mathematics courses and assessments.

Participants	Course Content-Self Efficacy	Course Content-Anxiety	Assessment - Self-Efficacy	Assessment - Anxiety	Classroom Dynamics-Self-Efficacy	Classroom Dynamics-Anxiety	Total Self-efficacy	Total Anxiety	Grade
1	14	12	19	19	14	11	47	42	TAGS 3-; 4
2	11	9	15	13	7	5	33	27	TAGS 4
3	7	5	13	10	8	5	28	20	TAGS 4
4	9 (10)	9 (8)	13 (12)	16 (12)	13 (16)	10 (9)	35 (38)	35 (29)	TAGS 4
5	8 (7)	5 (6)	7 (6)	5 (6)	5 (5)	5 (5)	20 (18)	15 (17)	TAGS 5 +
6	9 (8)	7 (7)	13 (18)	13 (20)	7 (15)	7 (11)	29 (41)	27 (38)	3-; 3-
7	14 (13)	14 (11)	15 (14)	18 (14)	13 (11)	11 (8)	42 (38)	43 (33)	3-
8	10 (10)	11 (9)	10 (10)	10 (15)	10 (10)	10 (9)	30 (30)	31 (33)	4
9	14 (10)	15 (9)	19 (12)	24 (15)	14 (12)	16 (10)	47 (34)	55 (34)	3-
10	10 (8)	11 (6)	11 (10)	15 (14)	12 (9)	11 (9)	33 (27)	37 (29)	5+
11	6 (5)	5 (5)	10 (9)	9 (8)	8 (5)	5 (5)	24 (19)	19 (18)	5+
12	9	7	16	17	13	10	38	34	4
13	15	12	13	13	12	12	40	37	Withdrawn
14	14	20	16	22	13	15	43	57	3-; 3-
15	13	19	14	17	17	15	44	51	Withdrawn
16	8	6	15	14	13	10	36	30	3-
17	15 (10)	13 (12)	17 (14)	17 (13)	14 (10)	12 (10)	46 (34)	42 (35)	4
18	8	10	11	10	12	11	31	31	3-
19	7 (7)	8 (6)	13 (11)	14 (15)	7 (7)	7 (6)	27 (25)	29 (27)	5+
20	9	11	14	21	11	6	34	38	4
21	9	10	13	11	8	8	31	29	5+

Table 4: Results from attitude scales on self-efficacy and anxiety 1st submission (2nd submission)

4.3 PERCEPTIONS OF PARTICIPANTS IN GCSE MATHEMATICS CLASSES ABOUT MATHEMATICS AND EXAMINATIONS

4.3.1 Introduction

This section addresses the first research question, which aims to understand the perceptions of this group of adult learners in GCSE mathematics classes, in terms of their self-efficacy and anxiety about mathematics and examinations, and whether perceptions can be linked to their final grades. To address this question the data collected from the first questionnaire completed has been analysed. As previously discussed, the questionnaire contained two attitude scales attached to 15 specific statements, one for self-efficacy and one for anxiety, and opportunities for comments after each (Appendix 8.4). Responses to each of the main categories of course content, classroom dynamics and assessment are evaluated in that order.

Responses to the questionnaire were evaluated to reveal the perceptions of the participants about the main categories, and about individual themes that emerged as most and least important for the participants. The statements from the questionnaire are used as headings. This was to enhance our understanding of the responses to the questionnaire which may support or challenge previous research findings. A review of grades compared to self-efficacy and anxiety levels to establish an overview on the data precedes examining the details of participants' responses.

4.3.2 Attitude responses compared to grades.

The table below (Table 5) shows the distribution of overall responses, based on the median values recorded in first submission overview contained in Table 4. Table 5 shows that whilst there is a relationship for many participants between self-efficacy, anxiety and grades achieved, for others the relationship is not shown by this analysis, e.g., for those with relatively high self-efficacy and low anxiety (top left box), as judged by the median values, of the nine responses, seven passed with a grade 4 or better, but two people did not. In addition, those with comparatively low self-efficacy and high anxiety (bottom right box), where there were also nine responses, four people got a grade of 3-, two people withdrew from the course, but three of the 9 passed with a grade 4. Thus, whilst the expected relationships between the three variables can be seen, there are commonly a number of exceptions for this group of 21 participants.

High self-efficacy/Low anxiety: Nine respondents. 2 x grade 3-; 3 x grade 4; 4 x grade 5+	High self-efficacy/High anxiety: One respondent. 1 x grade 5+
Low self-efficacy/Low anxiety: Two respondents. 1 x grade 3-; 1 x grade 4	Low self-efficacy/High anxiety: Nine respondents. 2 withdrawn; 4 x grade 3-; 3 x grade 4

Table 5: Comparison of grades achieved with self-efficacy and anxiety levels based on median values.

This has led to two key findings for these adult learners:

Key finding 1: High self-efficacy was a marker for grade 5s or better, the top grades that this group could achieve.

Key finding 2: Those with low self-efficacy and high anxiety were a high-risk group in terms of low pass rates and withdrawals.

Participants' individual responses to the scales with comments made will be covered in the next section to add to our understanding of these participants.

4.3.3 Course Content

4.3.3.1 Introduction

This section of the questionnaire was designed to obtain a nuanced impression from each individual of their self-efficacy and anxiety about a range of topics drawn from the GCSE curriculum. As seen in previous chapters, the questionnaire utilised statements identified by previous research as significant for students, and those identified by me, as an insider researcher with over 20 years' experience of teaching mathematics in a range of educational settings, in addition to feedback from the pilot study. This section of the questionnaire was comprised of five statements, each with an opportunity for participants to declare their self-efficacy and anxiety on individual scales, with opportunities to comment on each.

The responses to the scales will be covered initially, then developed through the comments collected, where appropriate. Key findings are identified at each stage of the process.

4.3.3.2 Responses to the scales for course content

To recap, there were five topic areas covered in this section of the questionnaire, namely 'using a times table grid', 'drawing charts and graphs', performing a percentage calculation ('working out 12% of £42'), performing a fraction calculation ('finding two thirds of £42'), and 'working on a word problem, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take 2 people?'. As previously discussed, each participant was asked to rank each statement on a 5-point self-efficacy scale, which ranged from 'very confident' to 'I definitely can't do this'. They then ranked their anxiety on a 5-point scale from 'no anxiety' to 'high anxiety'. Results are collated in the bar chart below and discussed here. In the next parts of this section, they will be explored more fully in combination with the comments to identify key findings.

As can be seen in the bar chart below (Figure 3), there was a variation in responses across the five statements. Whilst the majority of participants expressed high confidence in their ability, and little or no anxiety about times table grids, for instance, two were 'don't know' about confidence in their ability, and four participants expressed moderate anxiety.

In addition, most participants (n=18) expressed confidence in their ability to draw graphs and charts, but six showed moderate or greater anxiety with this type of task. The distribution of responses for percentages and fractions was similar, as participants demonstrated higher levels of anxiety, compared to their perceived ability to make the calculations. However, it is in the area of word problems where the greatest levels of concern were shown by the participants, both in terms of their ability to make the calculation and in terms of their anxiety, as only three people have expressed 'no anxiety' and ten have shown moderate or greater anxiety. Thus, the patterns vary across the five topic areas.

In the next part of this section these findings will be combined with the comments and examination grades and considered for indications of key findings for this mixed methods research.

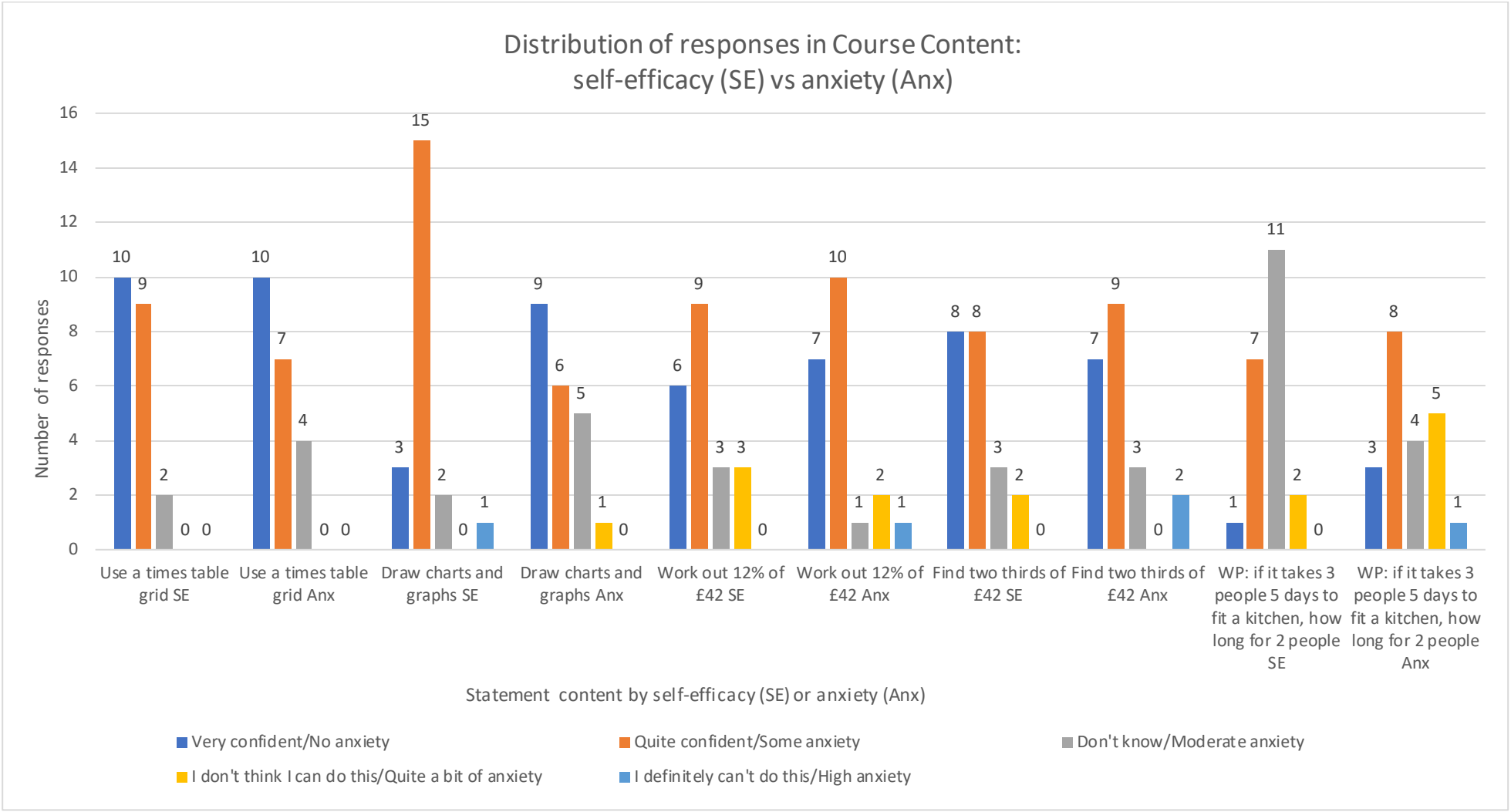


Figure 3: Distribution of responses in course content; (WP is 'word problem')

4.3.3.3 Using a times table grid

Participants were asked how they would feel 'using a times table grid', and most responded with relatively high levels of self-efficacy and low levels of anxiety. Comments made by learners on this statement made important and revealing contributions to the data, as a diverse range of responses were given.

Some participants mistook the question, which was revealed by the comments made. Mistaken responses made by one participant who achieved a grade 4, and another who achieved a grade 3-, included "I feel more comfortable doing times tables the column method rather than the grid method." and "I've never really had to use one before. If I had practice, then maybe I'd be more confident." The first of these illustrates the confusion between a times table grid and the grid method of multiplication, which the second comment might support. This highlights the importance for this research of the inclusion of comments in addition to the use of scales: without these comments the reasons behind the choices made on the scales for these two participants would have been unknown and could have only been surmised, which is the case for the other two participants who expressed moderate anxiety, one of whom achieved a grade 4 and the other who withdrew from the course.

The highlighting of this issue of misinterpretation of questions has revealed a flaw that could be avoided in future research if examples are included.

Key finding 3: The inclusion of comments in addition to scales in this research made an important contribution to understanding the perceptions of these participants, regardless of grades achieved.

4.3.3.4 Drawing charts and graphs

The question on charts and graphs asked participants how they would feel 'drawing charts and graphs', and most (n=15) responded with 'quite confident' levels of self-efficacy and low levels of anxiety, and the comments, again from one grade 3- and one grade 4 learner, showed relative confidence with this topic. However, anxiety responses were raised by this statement on drawing, as six participants ranked it as 'moderate' to 'quite a bit' of anxiety. The examination grades of those who responded with relatively high levels of anxiety ranged from a grade 3- to a grade 5+, which may have shown an

issue with drawing activities for these learners regardless of final grade and indicated that it was not immediately obvious what the relationship was between this task and either self-efficacy or anxiety.

Relatively positive comments included "I think I'm ok with graphing up to a point", and "I quite enjoy drawing graphs and charts". However, a less positive remark was "I'd be anxious if I wasn't certain I'd done it right", which may be evidence of an 'all or nothing' approach to mathematics in terms of right and wrong, and a lack of appreciation of the importance of method marks awarded by examiners for aspects of answers, in the event of an incorrect final answer.

The question on drawing graphs and charts was important for these findings in a second way, as two participants who withdrew from the course gave the most extreme responses to this statement, one with 'I definitely can't do this' on self-efficacy, and the other with 'quite a bit of anxiety' on the anxiety scale. This may indicate that, for these learners at least, the issue of producing graphs and charts may have been important to them in their perceptions of whether they could succeed in their mathematical aspirations, or perhaps to have influenced their decisions to continue with the course. These extreme responses, combined with the other data explored earlier, led to the next key finding.

Key finding 4: Drawing charts and graphs emerged as important to some of these learners, in terms of showing a relationship with a lack of self-efficacy and high anxiety, which justified its inclusion in this data collection.

4.3.3.5 Working out 12% of £42/ Finding two thirds of £42

The responses to these statements, although they cover different topics, are grouped together because both required a mathematical calculation to be done, and the responses on the scales, both between participants and overall, as can be seen in Figure 3, above, and the comments made were similar for the two statements.

For this group of participants, the responses showed a clear link between self-efficacy and anxiety, as participants were mostly concerned with their ability to perform these calculations, and they linked rising doubts about their ability with increasing anxiety levels. In terms of self-efficacy, some participants displayed less confidence in their ability to be successful with these calculations, and four/ five respectively declared

'moderate' to 'high' anxiety. With one exception these responses correlated with grade 3-s in the examinations and a withdrawal.

This view of self-efficacy and anxiety as linked for these participants was supported by the comments made on both the percentages and fractions statements, as they were mostly related to learners' self-efficacy, rather than their anxiety, but showed that the two are linked. For instance, one participant said, "I'm not confident with the process of working something like this out, I'd definitely get a bit of the fear in me when posed this question", and "I am not good with metal arithmetic. I panic when I see the % sign, I think".

One unexpected outcome, which demonstrated the diverse ways in which participants can perceive the content of questionnaires, and which could be helpful in a classroom setting, arose as some participants took the opportunity to use the comments section to perform the calculations, or mention strategies for completion. These included "I would work out 10% first. This would be £4.20 but would struggle to do 12% without a calculator", "42 divided by 3 is 14 so therefore two thirds would be 28", "2/3 x42" and "28". These participants may have felt the need to explore or demonstrate their skills to justify their choices, or to reassure themselves of their competence.

Correct or incorrect answers generated in the questionnaire could be useful in classroom settings, as demonstrated by the workings above, and by the participant, a grade 4 achiever, who declared 'very confident' and 'no anxiety' on the percentages statement and had performed the calculation correctly: "12 x 42 divided by 100" = "5.04".

These analyses have led to a reaffirmation of key finding 3, that the inclusion of comments in addition to scales in this research has made an important contribution to understanding the perceptions of these participants, regardless of their final grades.

4.3.3.6 Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take two people?

There was an important shift in responses to this statement compared to the others for this group of learners, as can be seen in Figure 3, above. For instance, in self-efficacy responses to the other four statements between 15 and 19 people expressed 'very' or 'quite confident', but on word problems this has dropped to eight, and 13 participants

'don't know' or did not think they could find an answer. For anxiety, the pattern was similar, as ten expressed moderate to high anxiety, which was more than the statement on charts and graphs. This showed the relevance of this question for these participants, and hence for the research.

The comments made by participants supported the proposition that word problems caused the most issues for learners in terms of the course content, and some gave insights into why this topic caused concerns for them. The learners, who were a mix of grade 3-, grade 4, and a withdrawn learner, said: "I have always struggled with numbers and being able to solve a maths problem has always presented a challenge." "I'd be panicking with something like this in exam conditions." "I don't know how to work it out." "I always struggle more with wordy questions. The more sentences there are, I seem to struggle. I find it hard extracting the maths I need to work out the answer." "I'm ok but I find I read too much into it and panic so takes me a while to get the answers", and "I don't struggle with the wording, it's more the sum attached to it that makes me nervous."

From these comments the issue for some of these learners with word problems seemed to be how to extract the sum from the information. The word problem I presented was a fairly simple example drawn from my experience of GCSE teaching, and yet it was seen as a challenge. Even the person who answered the question correctly in the comments area queried whether it was correct: "7.5 days?" and expressed both lower self-efficacy and more anxiety than given on other course content. This was highly informative for understanding the perceptions of these adult participants and correlated with recommendations made for ESOL or EAL learners, who are expected to find word problems challenging (Barwell, Mathematical Word Problems and Bilingual Learners in England, 2009), but in my experience it has been an approach less seen with first language English speakers. It led to key finding 5:

Key finding 5: Learners' perceptions of their ability of mathematical content need not reflect their actual ability, which may be reflected in their self-efficacy and anxiety levels.

In addition, two participants made their first comments on this word problem, which supported the importance of this aspect of mathematics for these participants. In contrast, none of those who achieved a grade 5+ commented on the word problem.

These facts added further evidence about the importance of this topic for success in the final examinations and led to the next key finding.

Key finding 6: Word problems in mathematics involve interpreting the language to decide on which of the mathematical operations would be appropriate to solve the problem, thus a two-step process, but this group of participants, especially those whose results were grade 4 or below, identified as uncertain or unable to manage this kind of task.

4.3.3.7 Additional themes: the language of mathematics and innate ability

Additional comments made by participants highlighted two other areas of concern, which led to the development of two additional themes. These have contributed to answers for research question 6 and are in addition to those in Section 4.6.

The areas of concern for some of the individuals in the group were all expressed in the comments sections and included one participant with relatively low levels of anxiety and high levels of self-efficacy, who achieved a grade 5+, who recognised that the language in examination papers had changed over the years. He said that it was a "Long time since 'O' level maths (note: 'O' levels were the fore runner of the GCSEs)- worried how much the language has changed- not so worried about the maths" and "As before is more the language than the maths". These comments highlighted concerns with the mathematical language rather than the computations and supported key finding 6 (above). They may have shown a need for some learners to be made aware of definitions of key terms, and how the terminology may have altered, adding an additional layer of complexity to their studies.

There was one positive comment made about the mathematical content, which came from an LX learner who got a grade 5+ in teacher assessed grades (TAGS): "I am comfortable with math". This was interesting, because this learner took over an hour to complete the questionnaire, which could indicate a lower level of English than mathematics and may indicate a need for further research around levels of mathematical ability compared to English language ability, and the language levels of different examination papers.

An additional key finding for this research was that for at least three of these participants there was an underpinning belief that some people can do mathematics, whilst others

cannot. This was shown in an additional comment made by one participant who said: "I'm very worried. Maths has always been a failing point for me over the years … as I just can't do it. I (do not have) a mind that can learn maths easily". It was supported by other comments, such as "…maths has always been a trauma for me", and "I have always struggled with numbers and being able to solve a maths problem has always presented a challenge". Again, these comments were made by one person with a grade 4, and two with grade 3-s, which showed that it was not only those who failed to pass who expressed a belief in innate ability. However, all three expressed the lowest levels of self-efficacy overall, which illustrated their lack of self-belief, and they were all among the most anxious, as shown in Table 5.

These comments, once again, supported the advantage of collecting comments from participants (key finding 3), and yielded further insights into underlying concerns.

Key finding 7: Underpinning beliefs about innate ability were present in those participants (n=3), with the most doubt about their ability, e.g., the lowest levels of self-efficacy, and who described the most anxiety.

4.3.3.8 Conclusion for course content

It is clear from the data collected in this section that many of this group of learners had concerns about the course content, especially word problems. Drawing charts and graphs was also an issue for some participants. Self-efficacy and anxiety for most learners were closely linked. A possible explanation for this could be that self-efficacy and anxiety were closely linked for these adults because they were more aware of the implications of failure for their onward journeys, e.g., into Higher Education.

These findings indicate a need for further research to establish whether they are applicable to the wider community of adult GCSE mathematics learners.

4.3.4 Classroom dynamics

4.3.4.1 Introduction

This section contained 5 statements which were quantitatively rated according to self-efficacy and anxiety responses, with opportunities for qualitative comments. As previously discussed, the statements in this section were adapted from the AMAS questionnaire (Hopko, Mahadevan, Bare, & Hunt, 2019), with the exception of 'asking a question in a maths class about something you have not understood', which was

included because the pilot study, other research and reflection provided new insights, which justified its inclusion in this main study.

The responses to the scales are covered initially, and then developed through the comments collected, where appropriate. Key findings are identified when appropriate.

4.3.4.2 Responses to the scales for classroom dynamics

The five topics covered in this section of the questionnaire were 'starting a new maths topic in class', 'listening to a teacher talking at the front of the class', 'watching a teacher work an algebraic equation on the board', 'listening to another student explain a maths formula', and 'asking a question in a maths class about something you have not understood'. Participants were asked to rank each statement on the 5-point self-efficacy scale, which ranged from 'very confident' to 'I definitely can't do this'. They then ranked their anxiety on the 5-point scale from 'no anxiety' to 'high anxiety'. Results were collated in the chart below (Figure 4) and reported on here. In the next parts of this section, they are explored more fully in combination with the comments to identify key findings.

The bar chart (Figure 4) showed that there was a variation in responses across the five statements. All of the participants said that they were either very or quite confident about listening to a teacher talking and expressed little or no anxiety about this, with one exception, who declared 'moderate anxiety'. This contrasted with the responses to 'asking a question in a maths class about something you have not understood' when four participants responded with 'I don't think I can do this' or 'I definitely can't do this', and the same four expressed 'quite a bit' to 'high anxiety'. This statement on asking about something that you have not understood was the one in this section that drew the lowest self-efficacy and the highest anxiety responses.

Overall, whilst participants doubted their ability to cope with starting a new topic in class, as only two learners expressed 'very confident' with a further 7 who were quite confident, and twelve responded with 'don't know' or 'I don't think I can', less anxiety was displayed, as 16 had little or no anxiety about new topics.

The two statements which could be interpreted as algebraic drew similar responses in terms of anxiety. These statements were 'watching a teacher work an algebra equation on the board' and 'listening to a student explain a maths formula'.

However, participants showed more self-efficacy in listening to their teacher than to other students.

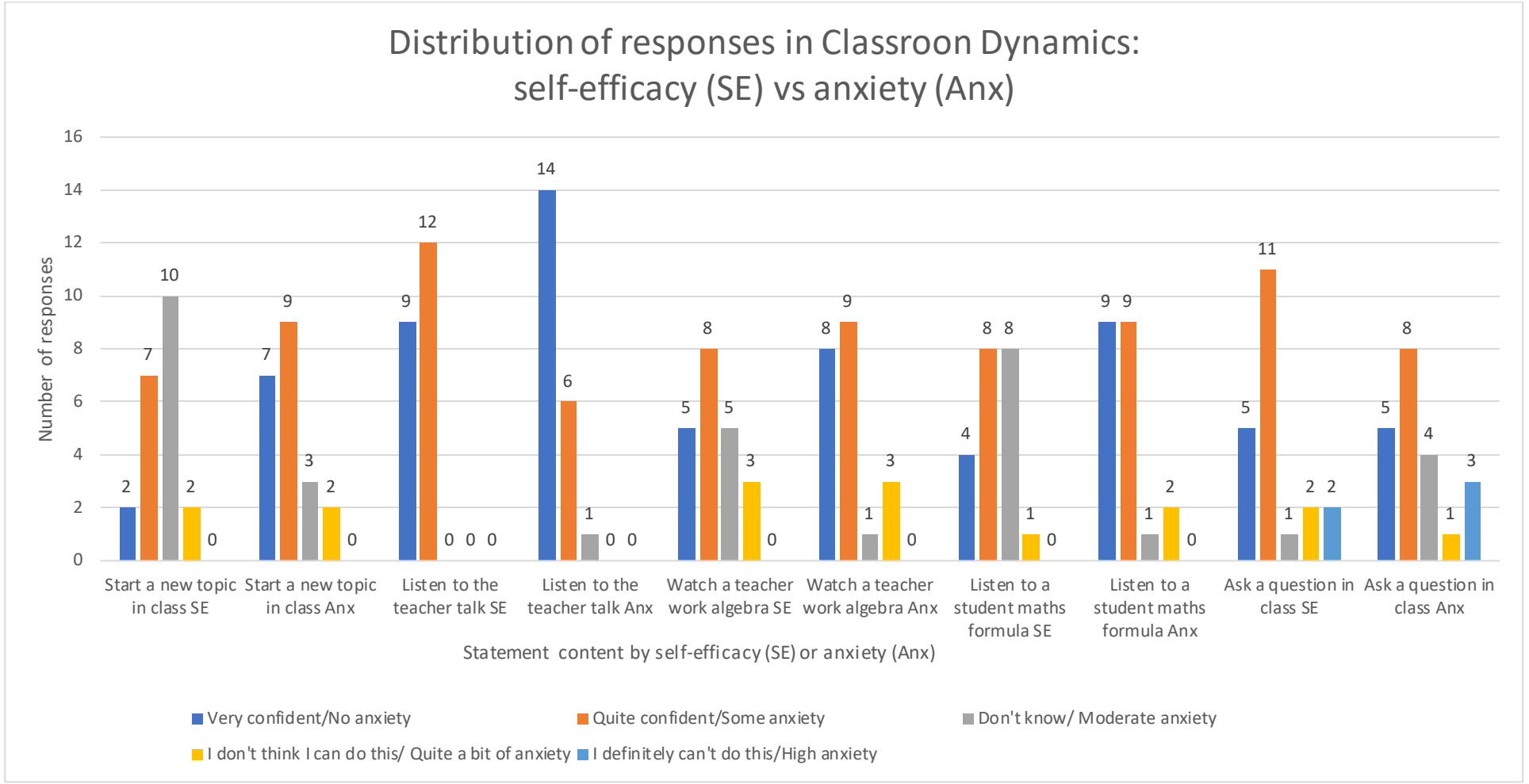


Figure 4: Distribution of responses in classroom dynamics

In the next part of this section these findings are combined with the comments and considered for indications of key findings for this research.

4.3.4.3 Starting a new maths topic in class

Starting a new topic in class was viewed as a challenge by over half of the participants, which could be interpreted as important for these learners as, due to the intensive time pressures on the course, new topics were likely to arise in almost every lesson.

Four learners made comments on the importance of the topic, and how that would impact of their learning: "It depends on the topic", "Just worrying about the upcoming subject would cloud my mind I think", "Do I recognise the topic?", "It's all about the topic", and "There's always some anxiety with new topics". Two of these participants had grade 3-, one had a grade 4 and one a 5+, which indicated that concern about new topics was not restricted to those who failed, that the impact of past failure was present even for those who did well, which suggested that further research may be needed.

Unusually, in terms of anxiety rankings, of the five of those who declared moderate to quite a bit of anxiety, all either withdrew from the course, or achieved a grade 3-, so none of these five participants passed. This may suggest an underpinning relationship between topics in general, or perhaps the pressure of completing the course in one intense year, which reinforced perceptions that they lacked an understanding of mathematics, and examination outcomes which requires further investigation.

<u>Key finding 8:</u> The prevalence of new topics during the courses, and the apparent relationship between new topics, anxiety, retention, and pass grades, has shown that this was an area of significance for participants, and consequently for the research.

4.3.4.4 Listening to the teacher talking at the front of the maths class

For this whole cohort of participants, the relationship with their teacher emerged as an important factor, as all of them declared 'very' or 'quite' confident when listening. Twenty declared no or some anxiety, and only one person said that their anxiety was moderate, but their comment showed that this was due to the topic, rather than the teacher, as they said, "Just worry that I might not understand the subject".

Comments on this question, both after the self-efficacy and anxiety rankings, indicated a more relaxed attitude in class, for instance, one said, "I can listen and concentrate in

class pretty well" which could indicate the lack of pressure this participant enjoyed when no personal performance was required of them. Another emphasised the importance of the student/teacher relationship with "Depends upon how well I get on with the teacher as to how anxious I may feel".

Two possible explanations for the generally positive response to the teacher from these participants could be that those who did not feel confidence in the relationship either had already left the course, or, due to the insider research nature of this investigation, were not prepared to complete the questionnaire.

4.3.4.5 Watching a teacher work an algebraic equation on the board/ Listening to another student explain a maths formula.

Both of these statements were interpreted by participants as concerned with algebra. The comments on algebra were not restricted to these two statements as they appeared in other sections of the questionnaire, which indicates a topic that troubled some of the participants, especially the grades 3-, 4 and withdrawn students, more than those who achieved a grade 5+. The distribution of ranked responses can be seen in Figure 4.

There was a split for this cohort of participants in how they perceived algebra, which was shown by the extreme responses that were given, which contrasted with other aspects of the course content. For instance, with the statement that mentioned an algebraic equation, anxiety, and confidence were generally closely matched for all learners, e.g., for three learners 'quite a bit of anxiety' and 'I don't think I can do this', were given, but equally five participants gave 'very confident' and 'no anxiety' responses. This contrasted with word problems when only one learner gave the latter responses.

Comments which demonstrated a lack of confidence often combined with anxiety when watching a teacher work an algebraic equation included "Algebra isn't one of my strong subjects", "Algebra has always been hard for me to comprehend.", and "I think it depends on how simple the equation is…I think I'd be worrying that I can't do it whilst listening to the explanation". When 'listening to another student explain a maths formula' the following comments were made: "I think I'd be anxious about whether or not I understand the steps to solve the equation.", and "I'd be fine listening to the explanation, but not sure if I'd understand the problem, even after being walked through

it." Additionally, from the 'new topic' statement: "Algebra is worrying me." One explanation for these concerns may be the perceived additional level of analysis required prior to formulating an answer, which may indicate a similarity with word problems with their additional level of text interpretation prior to the formulation of an answer.

In addition to the comments relating to the algebraic aspects of these statements, one participant, who achieved a grade 5+, wrote "I might be next!", and rated it as 'some anxiety', which indicated an anticipation of being asked to speak in class as viewed negatively. This kind of negative response could stop that learner from engaging in the material, as their thinking is blocked (Skemp, 1987), which could support the view, common in adult classes, that teachers should ask for volunteers to answer questions, rather than select students to answer, as is usual in a school environment.

This last response was related to the responses to the next section, on asking a question in class, as it shows a fear of public performance in front of peers. However, the responses of the participants about algebra led to the next key finding:

Key finding 9: Algebra was a topic which caused concerns about their ability and anxiety for many of these participants, often linked with lower examination results. This indicates a potential link between success with algebra and the top grades of 5+, which may indicate that more curriculum time on this topic was required by some learners.

4.3.4.6 Asking a question in a maths class about something you have not understood.

While many of the participants had little or no concerns about asking a question in class, four participants had an extremely negative response in terms of self-efficacy and anxiety as can be seen in Figure 4. While two of these responses came from those with grades 3-, and one from a learner who withdrew, one was made by a learner who achieved a grade 5+, the top grade. None of the four participants made comments about this aspect of the questionnaire, but comments from other participants identified fears about what their peers would think of them, especially if they had not understood an aspect of the mathematics. This was covered in some older publications about mathematics anxiety showing how relevant some older work still is today (Buxton, 1981; Skemp, 1987).

The comments from other participants were “I can ask questions if I don't understand. I'd be worried what others in the class would think of me though”, and this worry about loss of face in front of peers was echoed elsewhere, with “I can ask questions, but I’d be wondering what the other students would think about my ability”, and “Am I the only one who doesn’t understand?” These fears might have been alleviated by a stronger sense of community in the classroom, which is explored in more depth in Chapter 5.

Key finding 10: Some of these participants felt unable to ask questions in class, and this affected participants across the range, including the most, as well as the least, able as judged by examination outcomes.

Key finding 11: The negative responses from some participants on asking a question in class justified the inclusion of this statement in the data collection phase of this research. Further research is needed to establish whether this statement correlates with either self-efficacy or anxiety and should be included in other surveys on perceptions of mathematics, and whether anxiety is often driven by a fear of the perceptions of peers.

4.3.4.7 Conclusion for classroom dynamics

The responses to the statements in the classroom dynamics category revealed that some learners are very concerned about tackling new topics, especially those considered to be algebraic, that some expressed issues with loss of face in front of peers, and others who felt unable to ask a question in class, the latter including a learner with one of the best grades. Whether or not these factors influenced the final grades that these participants achieved, it seems likely that knowledge of their perceptions could have been beneficial to those involved in classroom delivery.

In this section of the questionnaire, most learners showed that self-efficacy and anxiety levels were matched, e.g., ‘some anxiety’ and ‘quite confident’, were used together, although for some, doubts about their ability outweighed their anxiety, in contrast to other parts of the questionnaire.

4.3.5 Assessment

4.3.5.1 Introduction

This section of the questionnaire was designed to obtain an overview of how the participants responded to various aspects of assessment. As previously explored, the statements used were all drawn from the AMAS questionnaire, with one addition,

namely the question on other, i.e., non-mathematics, examinations. This inclusion was justified by the responses in the pilot study, which indicated a difference between the two.

The assessment section contained 5 statements which participants were asked to respond to, again in terms of their self-efficacy and anxiety, each with opportunities for comments. Initially the scales' responses are covered, followed by development through the comments collected. Key findings are identified at each stage.

4.3.5.2 Responses to the scales for assessment

To recap, the five statements in the assessment section consisted of 'doing a quiz in a maths class', 'being given a homework assignment of difficult maths problems which is due in next class', 'thinking about an upcoming maths test one day before', 'taking the maths GCSE exam at the end of your course', and 'taking any GCSE or other exams'. It is the last statement that was original to this research.

The totals of various responses are shown in the bar chart in Figure 5. What was remarkable about these totals was that they were quite different from the totals for course content and classroom dynamics, which indicated that for this group of participants' assessment issues far outweighed the others, in terms of both self-efficacy and anxiety. As the first questionnaire was completed earlier in the course than the second questionnaire, it might have been expected that other matters would have been more important to the participants, but assessments were considered the most important issue for almost all. This claim can also be seen in the totals shown in Table 4.

Overall, in terms of self-efficacy, between zero and two participants declared 'very confident', and between one and five participants 'no anxiety'. Thinking about a test one day before caused as much 'high anxiety' as the GCSE mathematics examination (n=5), but 'quite a bit of anxiety' doubled from four to eight participants.

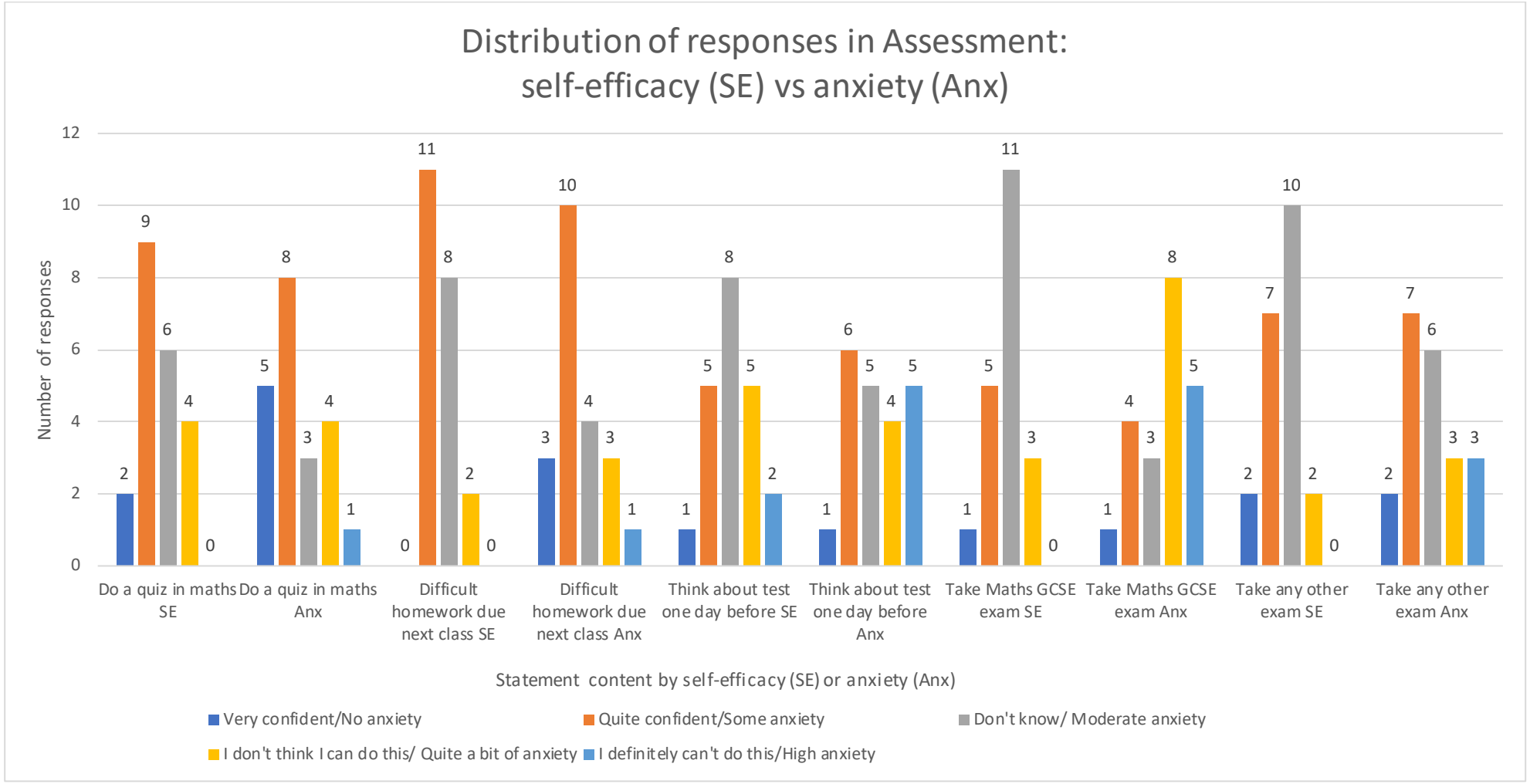


Figure 5: Distribution of responses for assessment

Self-efficacy responses were very similar for mathematics and other examinations, with 14 and 12 respectively declaring 'don't know' or 'I don't think I can do this', but 13 recorded 'quite a bit…' to 'high anxiety' for mathematics; only six participants recorded those responses for other examinations. One possible explanation for this result is that the participants were not taking other examinations, as the Access to HE courses are assessed by assignments and portfolios, but it is likely that some were also taking GCSE English or Biology.

It was evident that for some of these participants, all forms of assessment were viewed in the same way, as shown by one participant (grade 3-) who ranked all of the mathematics assessment statements at 4 s and 5s, which equates to 'I don't think I can do this/I definitely can't do this' in self-efficacy, and 'quite a bit' to 'high' in the anxiety scale, so equally challenging. Another, a grade 5+ participant, ranked all assessments with only two exceptions at 'no anxiety', and self-efficacy with mostly 'very confident'. The two exceptions were quizzes and homework, which were 'quite confident' for this participant, so most assessment was viewed as unchallenging.

In the next part of this section, these findings are combined with the comments and considered for indications of key findings for this mixed methods research.

4.3.5.3 Doing a quiz in a maths class

A quiz in a class could be seen as low risk in this assessment category, but it drew some initial responses which demonstrated the concern felt about assessment by this group of participants with "It always brings anxiety". One participant immediately linked quizzes with tests and examinations, which only appeared further on in the questionnaire: "I get nervous and my mind blanks in exams/tests".

The time restriction even in this low-key form of assessment, where only the learners (and possibly the teacher) will be aware of the final score also caused issues for this participant: "The worry of a time constraint makes my mind numb, so I think I'd panic."

In addition to re-use of the words of the questionnaire, in this case 'anxiety', key words that demonstrated the emotion felt by participants included 'nervous', 'worry' and 'panic', and the anxious responses came from one grade 5+ participant in addition to some of those with grades 3- and 4.

4.3.5.4 Being given a homework assignment of difficult maths problems which is due in next class.

As can be seen in Figure 5, many learners expressed less concern about this aspect of assessment, as eleven were quite confident, and 13 expressed no or some anxiety. Participants demonstrated independent learning strategies with their comments, which included "If I had support or could research the information easily, then I think I would be ok. Given time on my own to research suits me better", and "As long as I have access to any sort of source, to any books, I am confident that I could do it".

However, again note the mention of time above and in this quotation: "I prefer to take time, so I can process the information without pressure", and the lack of time restraints which alleviated 'pressure' on learners. This was the one statement in the assessment section where the time pressure was not present in the same way as it was with the other statements, as learners had some control over how much or how little time they allocated to the task. The lack of key emotional words here was notable, as was the qualification of the comments made.

Participants recognised that it would depend on the topic as to how they would feel with "Depends upon what topic it is", "If I was nervous to begin with about the work being done in class, I think I'd panic if I didn't know what I was doing".

Key finding 12: In terms of assessment, for some of these participants time restrictions combined with a reliance on memory, rather than access to resources, imposed by some forms of assessment, were determining factors for levels of self-efficacy and anxiety.

4.3.5.5 Thinking about an upcoming maths test one day before

A lack of self-efficacy and moderate to high anxiety was expressed by most participants when thinking about a test the following day, and these were usually drawn from grade 3- and grade 4 learners, but there were exceptions, such as a grade 5+ learner who fell into this category, and a learner with a 3-, who did not. One participant showed an awareness of how out of practise they were with test situations with "Been a long time since last test!", whilst another showed that anxiety would be likely to have a negative impact on the test results: "My nerves would really impact on my performance."

Strategies by participants to reduce adrenalin in their systems, to enable thinking to still take place, was demonstrated by others: "I'd try to keep myself calm and I'd encourage

myself that I'd do fine", but other comments included "The anxiousness would put my mind in a spin". Thus 'nerves' and anxiety were acknowledged as having an impact on thinking.

Key finding 13: Some of these participants have reported a discrepancy between their performance in class and their performance under tests conditions.

4.3.5.6 Taking the maths GCSE exam at the end of your course

This statement drew the most anxious response from participants regardless of final grades, as 13 out of 21 awarded it 'quite a bit' or 'high' anxiety. In terms of self-efficacy, 15 out of 21 either said 'don't know' or I don't think I can do this'. The strongest language about mathematics examinations came from one of the first participants: "The prospect of the exam was terrifying, due to Covid our exams have been replaced with assessments, while this has reduced anxiety a little, the pressure of maintaining a sense of calm over several assessments is difficult." This participant, who was being given TAGS, recorded their anxiety over the assessments that would replace them, indicating that it was not only the examination process that caused anxiety, but also test situations.

Several participants from the second year of data collection, who were faced with actual examinations, were aware of the impact that anxiety could have on their performance with comments such as "I have every confidence that (my teacher) can help me, but I still think I will stumble when it comes to the actual exams", indicating examination anxiety, and "I'm not a confident person, and the thought of me actually taking and passing the exam is really scary for me". Thus, key emotive words included were 'scary' and 'terrifying'.

An acknowledgement of the changes to the language of the mathematics questions troubled another participant: "As before is more the language than the maths".

For ten of the participants their anxiety ranked higher than their self-efficacy, e.g., one participant said that she was 'quite confident', second on the self-efficacy scale, but had 'quite a bit of anxiety', which was the fourth option on the anxiety scale. This was an important finding for the research, as for these participants their anxiety responses did not reflect their belief in their abilities. This group included two participants, both of whom achieved grade 5+s, thus the higher grades.

A potential explanation for the strength of this response could be that all of the participants were taking this examination, and had onward journeys that depended upon it, but the data gathered was important for this group of learners, and therefore for this study. The data collected supported key finding 13 in the previous section.

4.3.5.7 Taking any GCSE or other exams

The responses to the 'other examinations' statement, showed that ten of the participants responded 'don't know' when asked about their self-efficacy, but were likely to have moderate to high anxiety. Another eight were 'very' or 'quite confident', with 'no' or 'some' anxiety. The other three were more mixed in their responses.

Some of the participant comments showed a fear of examinations generally, which may indicate examination anxiety, and an acknowledgement of the impact that might have on their results: "There are some things, such as English and computing, that I'm quite confident with, but I know my anxiety would get the better of me", and "I don't do well with exams, and I worry in test conditions." Another showed a lack of confidence with examinations with "Very seldom been confident going into an exam", but clearly not all participants felt this way, as one of the withdrawn participants identified clearly that she had no issues with other examinations, which contrasted completely with her response to mathematics examinations. These differences are discussed in more depth in the next section.

4.3.5.8 Comparison between mathematics and other examinations

I compared the overall responses of learners on the two key questions of mathematics examinations compared to other examinations, using the two sets of self-efficacy and anxiety data. Participants in this study split into three groups, one of which contained those who viewed all examinations as equally challenging in terms of their self-efficacy, with little or no anxiety (n=5). Three of these learners achieved grade 5+, but one had a grade 4 and one a grade 3-, which showed that for these participants, grades were not necessarily allied to either self-efficacy or anxiety.

Four of the six participants who viewed all examinations as challenging, with usually 'quite a lot of' or 'high' anxiety, achieved a mix of grades 3- and 4s.

Finally, there were those who viewed mathematics examinations as usually highly challenging but did not declare the same feelings for other examinations, and these

learners all withdrew or achieved grade 3-. For instance, one of the participants who withdrew from the course declared 'don't know' and 'quite a bit of anxiety' for mathematics examinations, but 'very confident' and 'no anxiety' for other examinations which may have indicated mathematics anxiety, rather than anxiety about examinations. Another, with a grade 3-, declared 'I don't think I can do this' and 'high anxiety' for mathematics examinations, but 'quite confident' and some anxiety' for other examinations, which again showed the difference in opinion.

One possible explanation for this is that the surveys were completed exclusively by mathematics learners, and a much more comprehensive survey would be needed to draw any conclusions about the perceptions of the wider population on this issue, but it was certainly highlighted as one of importance for these participants. Further research in this area seems indicated.

Key finding 14: The perceptions of mathematics examinations did not predict the perceptions of other examinations, as although some participants declared anxiety and self-efficacy issues with all examinations, others indicated that there were issues experienced in mathematics that were not present in other examinations.

4.3.5.9 Conclusion for assessment

It might have been expected that those participants who withdrew or achieved a grade 3- in the examinations would have been more likely to express low self-efficacy and high anxiety across the whole five statements in assessment, and this was indeed the case, but some of those with pass grades of 4 and 5+ also expressed concerns, especially about tests and final examinations. A possible explanation for this could be that participants were clear about the importance of the final examinations for onward journeys into, say, Higher Education, as they were aware of universities' minimum requirements.

It is evident that for some of these learners all forms of assessment were viewed similarly when self-efficacy and anxiety rankings were compared, at both ends of the scales. This is evidenced by one participant who ranked all of the mathematics assessment statements at 4 s and 5s, which equated to 'I don't think I can do this/I definitely can't do this' in self-efficacy, and 'quite a bit' to 'high' in the anxiety scale, and another who ranked all assessments at 'no anxiety' and self-efficacy with mostly 'very', or 'quite' confident.

It also seemed clear that some of these participants may have experienced examination anxiety, whereas for others it was specifically mathematics examinations that were linked with anxiety, which supported key finding 14.

Key finding 15: There seemed to be a clear need to include preparation for assessments in classroom delivery, as for most of these participants all forms of assessment were considered challenging when compared to other aspects of the questionnaire, regardless of grades achieved.

4.3.6 Conclusion for research question 1

The first research question concerned establishing some of the perceptions that these adult participants carried with them into the GCSE mathematics classroom. In this section it has been established that the perceptions of these participants in GCSE mathematics classes displayed wide variations, with an equally wide variation in grades, and that the two did not necessarily relate. Whilst some learners were confident about their ability and lacked anxiety, others were just the reverse.

In addition, some learners displayed issues within the main categories, such as incomprehension when faced with word problems, fear when faced with algebra calculations, or an inability to ask a question in class.

Anxiety about all forms of assessment, especially in examinations was widespread in this group, and for some that was particularly about mathematics examinations.

The emotive language revealed within the categories varied. In the classroom dynamics section 'worry' was frequently seen, but in course content and assessment, 'fear', 'panic', 'nervous' 'scary' and 'worry' were used by the participants. It was in assessment that 'absolutely terrifying' was recorded. There were very few positive comments, but a number of participants expressed confidence in their ability and a lack of anxiety through the scales given on the questionnaire.

This research has revealed some of the issues faced by certain individuals within this under researched group on their return to mathematics classes, some of which correlated with other research findings, but some of which could be interpreted as original, which could indicate that further investigation with adult GCSE mathematics learners could be beneficial.

These key findings are discussed in Chapter 5, along with some possible implications for the wider mathematics education research community, as this research has demonstrated a potential need for specific questions based on topics such as drawing charts and graphs and word problems.

In the next section I have analysed the data collected from ten of the participants who answered the questionnaire on two separate occasions, to see if perceptions changed over the duration of the GCSE mathematics courses in which they participated.

4.4 CHANGES IN ADULT LEARNERS' PERCEPTIONS DURING THE COURSES

4.4.1 Introduction

In this section the changes evidenced by participants between the two questionnaire completions are evaluated to investigate whether, for these participants, there was a change in their perceptions. A total of ten participants completed the questionnaire twice (n=10). This section addresses the second research question, which asked if courses in FE colleges changed adults' perceptions of mathematics and examinations and, if so, how, and by how much? The first completion was generally early on in the course, in the first term, and the second completion was later, in term 2 or the start of term 3 for both cohorts, as can be seen in Figure 2, the timeline for the research.

This section draws on the data gathered by questionnaire and interview, both the ranking that participants gave for each statement and the comments that were made, and the final grades.

4.4.2 Attitude responses compared to grades.

Table 6 (below) shows the changes in responses to the attitude scales for self-efficacy and anxiety over the two submissions, based on the median values established in the first data collection. The first submission by a participant is shown in 'moved from' after their participation number, and the second in 'moved to'. If there was no change in the position compared to the medians, this is shown as 'no change'.

As can be seen in the table, for these ten learners, using their second completion, high self-efficacy seems more important for a pass grade than low anxiety, but there is one exception in participant 9 (P9). Those with low self-efficacy were less likely to pass, but again there is one exception in participant 4 (P4). This view of the data led to the conclusion that whilst high levels of self-efficacy were desirable for this group, they were

not essential, and that anxiety levels for most participants were less relevant than self-efficacy levels.

Participant	Moved from	Moved to	Examination grade
P5	High self-efficacy/ low anxiety	No change	Pass G5+ (TAGS)
P8	High self-efficacy/ low anxiety	No change	Pass G4
P11	High self-efficacy/ low anxiety	No change	Pass G5+
P19	High self-efficacy/ low anxiety	No change	Pass G5+
P10	High self-efficacy/ high anxiety	High self-efficacy/ low anxiety	Pass G5+
P4	Low self-efficacy/ low anxiety	No change	Pass G4 (TAGS)
P17	Low self-efficacy/ high anxiety	High self-efficacy/ high anxiety	Pass G4
P7	Low self-efficacy/ high anxiety	Low self-efficacy/ low anxiety	Fail G3-
P9	Low self-efficacy/ high anxiety	High self-efficacy/ low anxiety	Fail G3-
P6	High self-efficacy/ low anxiety	Low self-efficacy/ high anxiety	Fail G3-

Table 6: Movements in self-efficacy and anxiety between two data collections

The movement for participant 10 (P10) from high to low anxiety was due to lower anxiety levels for word problems, drawing charts and graphs, doing quizzes, and asking a question in class. Anxiety levels for the examinations remained at 'quite a bit of anxiety', but there was also a slight improvement in self-efficacy. The change in anxiety levels, which was more dramatic, could have been a result of improved self-efficacy, which indicated that for this participant relatively slight changes in self-efficacy led to a greater change in anxiety.

Another finding that emerged from this review was the decline of self-efficacy levels for participant 6 (P6), combined with an increase in her anxiety levels as the examinations' approached. These changes were mainly due to a decline in self-efficacy for new topics and algebra, and a decline in self-efficacy and increased anxiety for all examinations. This may indicate that P6 had examination anxiety, principally as she recorded 5s ('I definitely can't do this' and 'high anxiety') on both scales for both statements in the

second questionnaire ('taking the maths GCSE exams at the end of your course' and 'taking any GCSE or other exams').

This investigation led to another key finding:

Key finding 16: Whilst some participants did improve their self-efficacy and reduce their anxiety, for others, especially those with high self-efficacy in the first data collection, there was little change, and these participants were more likely to pass. However, for one participant, who did not pass, self-efficacy declined, and anxiety levels rose, which may indicate examination anxiety.

4.4.3 Comparison of comments between first and second data collections

Two learners out of the ten who completed questionnaires on two separate occasions made comments on both, and generally, the comments reflected an improvement in their self-efficacy and a reduction in anxiety, as seen in Table 6, above. These two participants were P9, a male who achieved a grade 3-, and P17, a female who passed with a grade 4. Examples included a move from 'I'd be anxious' to 'I'm usually ok' from one participant commenting on drawing charts and graphs. The other participant also improved their opinion on this topic, as they moved from 'I quite enjoy…' to 'I enjoy…'.

On the percentages statement, both remarked on how much better they would perform with calculators on these types of questions. One had moved from 'I panic when I see the % sign…' to 'Not totally bad, (better) with a calculator', and the other showed that whilst they could calculate 10% by dividing by 10, they would need a calculator for 12%, as they 'don't retain the method'. This showed a reliance on memory, rather than a conceptual understanding of percentages.

However, there were exceptions to these improvements, illustrated by both ranked responses and comments, such as on algebra made by P9, which was 'I don't like algebra' on the second completion, which followed on from 'Algebra has always been hard for me' on the first. This participant was positive about word problems though, as he commented "I don't mind wordy questions, it helps me relate the numbers to a problem", which showed an improvement since his first completion.

Word problems were still a struggle for P17, who remarked 'I find it hard to determine what maths I need' on the second completion, which followed on from 'I always struggle

with wordy questions' on the first. This participant remarked that her opinion of algebra had changed, however, with the comment 'I don't mind algebra now and find it quite interesting…'. These comments illustrated that whilst progress had been made in some topic areas, others had remained a challenge for these participants, which led to the next key finding:

Key finding 17: Comments and ranked responses revealed that whilst progress was made over the duration of the course in certain topic areas, the topics were varied for different individuals, which indicated that 'spiky profiles' may have persisted for these participants.

Both of these participants, P9 and P17, were reticent to ask a question in class about something that they had not understood on the first questionnaire, and this was revisited by one learner on the second completion with "I am a very shy and nervous person, so I have trouble speaking up", but the other learner noticed an improvement in her ability to ask questions compared to her school experiences, when she would not have felt as confident.

In the section of the questionnaire on assessment the responses to a challenging homework assignment and an upcoming test were much more positive than first submission, although it was acknowledged by both participants that this was topic dependant, and in both cases also mathematics dependant, as "I do get quite nervous before tests of any kind, but maths in particular", and mathematics and science subjects were identified as "more scary" than other subjects for the other learner. This may be due to the focus on mathematics in this research.

The difference between mathematics and other examinations became clearer for these participants between the two questionnaires, but they acknowledged the time pressure in all examinations as a negative factor on success. This aspect is covered in Section 4.6 on additional themes that emerged from the data.

4.4.4 Conclusion for research question 2

To conclude, some learners improved their self-efficacy scores as they became more confident, and anxiety levels generally fell as the course progressed, especially for participants 9 and 17, but there were notable exceptions to those, such as participant 6, who became more anxious and whose self-efficacy declined as the dates for the

examinations got closer. It may be that the latter participant was experiencing a phobic reaction to the examinations, which may not have emerged without the questionnaires.

It was also notable that the participants who responded with comments on their second questionnaires were P9 and P17, who expressed the most improvement in their perceptions, and the language expressed in their comments was modified compared to their first submissions. This may suggest that, for this group of participants, those whose perceptions were improving were more likely to make comments.

In the next section participants' responses and results will be evaluated from the perspective of their characteristics, such as age, gender, and first language.

4.5 LEARNER CHARACTERISTICS, QUESTIONNAIRE RESPONSES AND EXAMINATION GRADES

4.5.1 Introduction

This section addresses the third research question, which was to evaluate whether the responses to any of the questions on perceptions of mathematics or examinations, or final grades achieved, varied by age, gender or first language, whether that was English, or another first language. First language English speakers are denoted as L1s, and those with other first languages as LX (Dewaele, 2018).

The rationale for this strand of the research was found in the literature review, which identified learners' characteristics as indicative of perceptions about mathematics, e.g., that females are more likely to be anxious than males, although there is other research which challenged this view (Evans J. , 2000; Watts, 2011). Research which generalises from data can enable the development of stereotypical views of learners, which can weaken learners' self-efficacy if they are aware of them (Holloway, 2013).

As stated, there were 21 participants in total, who were all self-selected volunteers. They attended at least two different colleges in the East Midlands and South Yorkshire, and were drawn from different classes, so from several different teachers.

4.5.2 Age

The ages of participants varied from 19 years old to over 60 years old. To describe and evaluate the data collected from this diverse group of participants, I have broadly followed the government's categories, by separating out the 19- to 24-year-olds from

the older participants (Gov.UK (1), 2020), although I have also looked at the under 30s, as their results were also revealing. I have not separated out the over 50s, in line with the government categories, as there was only one person who fell into that category and the inclusion of that person with the over 30-year-olds has protected their identity.

Four of the participants out of the total of 21 were 19 to 24 years old, and all were female. Whilst one of the four achieved a grade 5+, one withdrew before the examinations, and the other two failed, with grades at 3-. In fact, the one who achieved a grade 5+ was the only participant of the six under 30 years old who passed the examination. This contrasts with the 30 years and over group, where 12 out of the 15 passed. Just two of the 30+ learners failed, and one withdrew.

Both of the younger learners who did not pass and the withdrawn participant in the 19- to 24-year-old age band identified as low self-efficacy and high anxiety, P14 and P15 on their only questionnaires, and P6 on her second. This latter participant was the one I have identified who perhaps had examination anxiety.

In addition, none of the 19- to 24-year-olds made comments on the questionnaires or came forwards for an interview. Only one person under 30 made any comments, the other eight were all in their 30s or older.

Key finding 18: In this group of 21 participants the six 19- to 29-year-olds, with one exception, displayed high anxiety and low self-efficacy compared to the older learners, and were less likely to pass.

4.5.3 Gender

Three males participated in this research, compared to 18 females. One male expressed high self-efficacy and low anxiety, although his scores were closer to the median value than some of the females, and he passed with a grade 5+. Another declared low self-efficacy and was on the cusp for low anxiety and achieved a grade 4 pass. The last male was P9, who did not pass the examination, but who moved from low self-efficacy, high anxiety, with some of the highest scores on each on his first questionnaire, to high self-efficacy, low anxiety, with just below the median scores on his second questionnaire completion.

Pass rates were similar regardless of gender in this small sample, as roughly two thirds of each passed, but all four of the participants who felt that they could not ask a question in class, and who rated it at 'quite a bit' or 'high' anxiety were female.

All three of the males made comments on their questionnaires, compared to six out of 18 females. In fact, out of approximately 120 comments, almost 80 of them were made by the males.

I found this very surprising, as if I had been asked to predict what proportion of comments would come from each gender, I would have predicted an 80:20 split, with the 80% being from the females, but it was the reverse. This implied that my gender stereotyping was potentially very deep-seated.

Key finding 19: The three male participants in this small-scale research were just as likely to express low self-efficacy and high anxiety as the females. In addition, proportionally they were more likely to make comments as all three of them did, compared to six out of the 18 females.

4.5.4 First language

There were four LX learners among the 21 participants, compared to 17 first language English speakers. One of these LX participants withdrew, but the other three all passed with grades 4 and 5+. The grade 5+ learner had the highest belief in her ability and the lowest anxiety of any participant, but the other three had low self-efficacy, and two also had high anxiety.

Three out of the four LX learners made comments on the questionnaires. These included the participant who had high self-efficacy in a correct calculation for a percentage, but less self-efficacy for an equally correctly calculated word problem. The LX learner who withdrew from the course expressed doubts about her ability and anxiety about word problems and algebra. In contrast to the other LX learners, she also identified the mathematics examination as causing more doubts and anxiety than other examinations; the other three ranked them equally.

Key finding 20: The four LX participants in this research were more likely to pass the examination and to make comments than their L1 counterparts (n=17).

4.5.5 Conclusion for research question 3

The perceptions and achievements of the participants in this research, analysed by their characteristics of age, gender and first language, confounded traditionally held stereotypical views about students of mathematics, and this is discussed in Chapter 5.

Whether this conclusion has been found because the research is small scale with a small sample, because they are adults, or that this cluster of participants was unusual, or for some other reason, is unknown, but it may indicate that adult learners re-engaging with mathematics after a break, sometimes of many years, could warrant further research, as they may differ in some ways from those on traditional pathways in education.

Age was a particularly significant factor as only one of the four 19 to 24-year-olds, who may have been continuing their education, and therefore on more traditional pathways, passed the examination.

In the next section some additional themes that emerged from the data analysis are explored.

4.6 ADDITIONAL THEMES THAT EMERGED FROM ANALYSIS

4.6.1 Introduction

In this section of the data analysis, I will identify several additional sub-themes that emerged from the data that were not specifically related to statements within the questionnaire or interview, and which emerged from responses to statements across the main themes of course content, classroom dynamics and assessment. These add to the findings in 4.3.3.7 from the first questionnaire submissions, when the language of mathematics and a belief in innate ability were both identified. The findings in this section, combined with those from 4.3.3.7 have answered research question 6.

These additional sub-themes were time pressure, the importance of the topic to participants, a fatalistic approach to examinations expressed by some participants, indicating a lack of control, and the important role of a sense of community. Each section includes comments made from both the first and second rounds of data collection.

4.6.2 Time pressure

The pressure caused by a restraint on the amount of time available for particular tasks, including tests and examinations, was exhibited by many comments, collected from the

interview and from the comments on the questionnaires. These included “I think (my anxiety) would be largely down to the time limit than the subject itself”, which was made on the ‘other examinations’ statement, and “I’m ok but I find I read too much into it and panic so takes me a while to get the answers” from the statement on word problems. In addition, on the fraction statement, “I'm not brill with fractions, but I can usually figure it out if I have enough time”, and “If I had support or could research the information easily, then I think I would be ok. Given time on my own to research suits me better”, on the difficult homework statement.

Comments about mathematics tests and examinations included “The worry of a time constraint makes my mind numb, so I think I’d panic”, “I'm not a confident person, and the thought of me actually taking and passing the exam is really scary for me”, and “I think doing the actual exams you are given a time, and it is stressful knowing that you have only got that set time”. One learner showed evidence of developing a strategy for examinations with “nobody is looking at you and when you are in the room you can go into your own little world and just focus on answering the questions”, but not everyone may be able to focus this way.

Whilst participants have reflected the wording of the questionnaire with their use of ‘confidence’ and ‘anxiety’, additional emotive words associated with time constraints include ‘scary’, ‘panic’, ‘worry’, ‘numb’, and ‘stressful’, indicating the strength and depth of feeling evoked by time pressures.

There may have been significant time pressures on the adult participants, who were 25+ at the time of the data collection that may not have occurred for the other younger participants, as younger students on traditional pathways may have studied mathematics for many years when they take their examinations, but non-traditional pathway learners like older adults have probably experienced a break in their mathematics learning, sometimes of many decades. As one learner said, “Been a long time since last test!”, thus, non-traditional pathway adults may have to deal with the passage of time, have little time in which to assimilate the curriculum, which is generally delivered in one year, and could require more time in examinations to engage successfully with questions.

Key finding 21: Most of the nine participants who made comments on the questionnaire noted the pressure caused by restricted time allowances and showed an awareness of the impact that had on their ability to demonstrate their knowledge and skills in mathematics.

This finding raised the question of what was being tested in mathematics examinations for these participants, was it their knowledge and skills, or was it their ability to function under pressure?

4.6.3 The importance of 'the topic'

One of the emergent themes from the research with these participants was that they gave varied responses to different topics, and the comments these generated occurred in the statements on new topics, mathematics quizzes, homework, charts and graphs, and in a comment on the content of examination papers, which expressed a hope for 'a nice paper', e.g., one with which the participant could engage successfully.

'Nice' and 'enjoy' are positive words which indicated liking some aspects of mathematics, and the link between enjoying something and being able to do it are well established and make perfect sense. The opposite, enjoying something that we attempt but cannot do or are bad at is associated with masochistic tendencies; the more 'normal' reaction is to avoid engagement altogether, or to avoid trying if engagement is compulsory but motivation is lacking (Brown, Brown, & Bibby, 2008; Dalby, 2012). Adults may need the GCSE mathematics qualification to make progress into another area, such as a course in HE, so motivation could be present, and they must overcome the hurdle of attempting something that seems to be, for many of them, unpleasant.

There was hope for these participants, however, as it was not all aspects of the mathematics that caused negative feelings, so it could be seen as important to emphasise any aspects of mathematics that cause positive feelings. A way to facilitate this could be by using the ESOL concept of 'spiky profiles' in classroom for adults studying mathematics (Colquhoun & Delaney, 2009; Department for Education and Skills, 2002). This will be developed further in Chapter 5.

Key finding 22: In this research many of the participants exhibited 'spiky profiles' and were less anxious when studying topics in which they could be successful.

4.6.4 Fatalistic approach to examinations

Comments from the section on mathematics examinations that included a fatalistic approach to examinations included “Once I'm in the exam room and sat down, it will be what it will be”, and “I'm unsure if I'm really ready, but If it's not in my head yet, it never will be.” One learner commenting after an examination said “I felt nervous going into the room and the whole process of sitting down and getting ready, that was quite nerve racking but 5 minutes in I did have to think to myself, well, I have just got to do my best, no one is judging me at this point, so I have got this time and I’m just going to do what I think and hopefully give the right answers”.

These comments seemed to demonstrate a belief that these learners had little or no control over the grade that will result from their efforts, with key emotive words such as ‘nervous’, ‘unsure’, ‘never’ ‘nerve racking’ and ‘hopefully’.

There was also an indication that these learners were reliant on memory recall, rather than understanding.

Key finding 23: Some of the participants in this research showed a fatalistic approach to examinations, which could indicate a belief in a lack of control over the outcomes.

4.6.5 Sense of community

An emergent theme which was evident in both the pilot study and the main study was the importance of the sense of community among the participants.

When conducting the pilot study with a class, after the presentation, assurances of anonymity and completion of the attitude scale in the questionnaire, in which participants scored their own responses, the room erupted into a 10-minute discussion and comparison of responses and scores. Participants, when asked about this later, mentioned how reassuring it was to know that everyone, even those who seemed to need little help in class, experienced the same issues and concerns. Thus, the sharing of experiences was therapeutic for these learners, and perhaps helped to counteract the feelings generated by struggles with content.

A comment came from the main data collection, which supported this aspect of the importance of being part of a group, rather than alone: “I … enjoyed being with my

peers, my age group. They also obviously struggled with maths. We did feel like we were very much in it together going through this process and I think that really helped me."

From this evidence it does seem that, in addition to providing teachers and practitioners with information about their learners' perceptions, one of the main benefits of including questionnaires into teaching time may be the fostering of the sense of community in classrooms, and that promotion of the inclusion of questionnaires could make aa original contribution to the field.

Key finding 24: Participants in the pilot and some from the main data collection identified the importance of knowing that they were not alone in their struggles with a subject in which they had previously failed to get the required grades.

4.6.6 A metacognitive benefit

There was evidence that more metacognitive approach to the mathematics, encouraged by participation in this project, was beneficial for some participants. This was commented on by one participant, who said "Filling out the questionnaire (has) made me think about how I engage with maths and how I deal with maths, I think that has been quite a cathartic process for me."

The recognition and mention of a difference in performance in class compared to in examinations was further evidence of a meta cognitive approach from participants (Key Finding 13).

Evidence from the pilot study included comments from participants which revealed that they had found the participation in the process beneficial, as it had almost given them permission to be anxious (Stacey, 2022). There was a lack of understanding prior to the questionnaire that everyone in the class was struggling with some aspect of the content. The questionnaire countered the pervasive view of participants that they were the only ones who were struggling, and that their peers were all performing well and feeling much better than they were.

Key finding 25: There is some evidence from the participants in both the pilot and the main study, that a metacognitive approach could positively influence perceptions, whether or not it improved grades.

4.6.7 Conclusion for additional themes

In conclusion, in response to research question 6, the five additional sub-themes that emerged from the analysis of the data were issues of time pressure, the importance of the topic to learners, a fatalistic approach to examinations, the importance for some participants of feeling part of a community and of thinking about their perceptions of mathematics and examinations. These are in addition to the two additional themes from Section 4.3.3, which were innate ability and the language of mathematics.

Some of these sub-themes correlate with the findings of other research, and all are included in the discussion in Chapter 5.

In the next section self-efficacy and anxiety levels are assessed individually and compared to each other, to assess their relationship with examination grades.

4.7 SELF-EFFICACY AND ANXIETY- A COMPARISON

4.7.1 Introduction

In this section I review the data collected by self-efficacy and anxiety to evaluate for this group of learners, which of the two ways of collecting the data was more efficacious. This section addresses both research question 4, whether a positive level of self-efficacy was necessary for or related to examination success, and research question 5, whether low levels of anxiety were related to or necessary for examination success, both in terms of achieving a grade 4 or better, for the participants who contributed to the research.

The approach taken by this research was original from the aspect of self-efficacy, as unlike other research it did not use a self-efficacy check alongside calculations, although as seen, some participants interpreted it that way. The advantage of this alteration in the methods applied by other research was two-fold: firstly, it allowed the participants to think about the statements in the questionnaire away from the potential stress of calculations and secondly, it allowed participants to respond to the statements away from the classroom if they wanted to.

It was also different in that it applied a scale from 1 to 5, but where the 1 is attached to 'very confident' and the 5 to 'I don't think I can do this' which was the reverse compared to other research. For anxiety the approach was also unusual, as it started with 'no anxiety', rather than 'low anxiety', but was usual in that it allocated 1 to no anxiety, and 5 to high anxiety.

4.7.2 Comparison by clusters based on high/low scores.

The approach taken by the research was to take the median value of the data of self-efficacy and anxiety, which in both cases was 34, and use the median values to separate the learners into clusters. This was shown for the first questionnaire completions in Table 5 (n=21), and the second questionnaire completions in Table 6 (n=10).

From this way of analysing the data, it was seen that both participants who left the course had low self-efficacy and high anxiety (Table 5). Also, that participants who attained a grade 5 or better all had high self-efficacy (Tables 5 and 6).

Most participants with high self-efficacy and low anxiety on their first questionnaire, (Table 5), passed the examination with a grade 4 or better, but two of them did not, participants 6 and 18, both L1 learners, both females. Equally, although three participants with low self-efficacy and high anxiety achieved the grade 4 pass, four failed and two withdrew from the course, so this was the most vulnerable group in terms of being less likely to stay the course and pass.

For those learners who completed two questionnaires, (Table 6), again those with high self-efficacy and low anxiety all achieved the required grade of 4 or better with one exception (P9), but for those with low self-efficacy, whether their anxiety was above or below the median value, the results were more mixed, with grade 3-s and grade 4s.

This seems to indicate that in this research self-efficacy was a better guide to pass rates for these participants than anxiety, but an interrogation of the data in more depth adds a different perspective, as can be seen in the next section.

4.7.3 Discrepancies greater than one between self-efficacy and anxiety

When the data was interrogated to show which participants have expressed a difference of two or more ranking points between their self-efficacy and anxiety responses on questionnaire completions, some further insights emerged about the perceptions of the adult participants. This analysis was important as it added to our understanding about whether gathering data on self-efficacy or anxiety was most appropriate for these participants, which could inform future research.

Two thirds of the participants had discrepancies of more than one on their responses (n=14); the other seven participants did not show any discrepancies more than one. One

of the participants who showed discrepancies greater than one was male, the rest were female. An example of this discrepancy included one learner who, on the percentages question, ranked her self-efficacy as 4 (I don't think I can do this), but her anxiety as 2 (some anxiety), to show that although she cannot yet do the question, she was less anxious about it.

Seventeen out of 33 of the discrepancies occur in the assessment category, with anxiety ranked higher than self-efficacy in every case except one which was on the quizzes question. Eight of the differences were on the GCSE mathematics examination question, with two on each of other examinations, quizzes, and homework. Three were on the statement on tests the next day. This demonstrated that anxiety about assessment was more marked for these participants than self-efficacy.

For course content a more mixed picture emerges of some learners who felt quite confident about the task but ranked anxiety higher (n=3), and others who knew that they cannot yet do the task but were less anxious (n=3). Four out of the six ranked responses were on percentages, and two on charts and graphs.

In classroom dynamics 7 of the 10 responses showed a lack of self-efficacy but had little anxiety, and just three were quite confident, but had quite a bit of anxiety. Two were on new topics, two on listening to the teacher, and one on asking a question in class, but five were on listening to another student, which showed that some participants might have had doubts about whether the other student's explanation was correct and were concerned about this.

Key finding 26: For this group of participants either self-efficacy or anxiety scales could have been used for the questionnaire sections on course content and classroom dynamics, but for assessment the anxiety scale revealed more relevant information on participants' perceptions.

4.7.4 Conclusion: Self-efficacy vs Anxiety

Overall, both the self-efficacy and anxiety scales have revealed insights about the perceptions of this group of participants. Whilst it is clear from this group of adult learners that those with high self-efficacy and low anxiety were more likely to pass with a grade 4 or better, the results were mixed for those with low self-efficacy or high

anxiety, but those participants who displayed both low self-efficacy and high anxiety were more likely to withdraw and to fail, with a grade 3 or lower.

When self-efficacy and anxiety were considered as alternatives, overall self-efficacy was marginally the better marker for success for this group, which may reflect adults' self-knowledge about their ability, as some demonstrated an awareness about whether they have developed sufficient skills or not, but the anxiety scale on assessment was more revealing.

In the conclusion for the whole data analysis section, I will summarise the answers to each of the research questions.

4.8 CONCLUSION FOR CHAPTER 4

The first research question asked what perceptions adult learners had about their GCSE mathematics courses, in terms of course content, classroom issues and different types of assessment, and whether their perceptions correlated with grades. The 21 adults who participated in this project showed a wide range of views on the 15 statements that they were presented with on the questionnaire, in both ranked responses, comments, and in the discussion during the interview. Whilst some participants were unfazed by mathematics, others were clearly finding various aspects challenging, such as word problems, algebra, drawing activities, asking questions, tests, and examinations, which justified the inclusion of the additional questions in the questionnaire.

Whilst pass grades were generally associated with those with higher self-efficacy, there were exceptions to this, as not all those with high self-efficacy passed. In addition, fail grades were usually associated with lower self-efficacy and higher anxiety, but again, there were notable exceptions. However, the two withdrawals from the courses were both associated with low self-efficacy and high anxiety.

The second research question sought to establish for these participants if their perceptions changed during the course (n=10). Two of the respondents showed a substantial improvement in their perceptions, and these were the only two who made comments, which may be significant. Others in this group showed some reduction in anxiety and improvement in self-efficacy, but there were exceptions, especially one whose anxiety increased, and self-efficacy declined.

Whilst pass grades generally followed the same pattern as above, there were examples of participants whose perceptions improved, but who did not pass.

The data analysis of both these research questions, 1 and 2, has indicated that some topics within the course content were more critical than others for successful outcomes in terms of pass grades, namely word problems and algebra; although it was not necessary to be good at everything, it was necessary to be good at some topics. The research indicated that spiky profiles persisted for the participants.

In research question 3 the data was reviewed by learners' characteristics, namely age, gender and first language. The findings of this research were that the older participants, aged 30 plus, were less anxious than the under 30s and more likely to pass, and that the three males who participated were just as anxious as the females and more likely to make comments. The four non first language English speakers (LX) included the participant with the most confidence and least anxiety of any respondents, although when the medians are compared other LX learners had slightly less self-efficacy and more anxiety than the L1 English speakers. The LX speakers in this research were more likely to pass than their L1 peers.

Several additional themes emerged as important for some members of this group, such as the negative effects of time pressure, spiky profiles for preferences on topics, fatalistic approaches to examinations, beliefs in innate ability, an awareness of mathematical language issues and the beneficial effects of a sense of community.

Analysis of the data gathered from the two scales used in the questionnaire, compared to examination results, answered research questions 4 and 5, about whether self-efficacy or anxiety were markers for successful outcomes in terms of final grades. It was clear that the participants with high self-efficacy and low anxiety were mostly successful, and that those with low self-efficacy and high anxiety were more likely to either leave or fail, but there were exceptions to both these statements, highlighting the need for caution when considering the relationship between perceptions and outcomes for these participants, and a need for further research in this area.

There were 26 key findings identified in this research. In the next section, Chapter 5, these are summarised, discussed and compared with the findings from other research.

5 CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

In this chapter there are five main sections. The first section is the introduction, and the second contains discussions of how the key findings relate to each research question, based on the conclusion sections from Chapter 4, and evaluates whether they have implications for the findings of other research discussed in the literature review in Chapter 2. Key findings which make an original contribution are identified and discussed.

In the third section there is a brief reflection on the theoretical framework used for the research, and the fourth on the choice of methods for the data collection, again with reference to the appropriate literature, as discussed in Chapter 3.

In the conclusion of this chapter, I briefly summarise how the key findings support or challenge those of other researchers. Conclusions on the contribution to knowledge will be discussed in Chapter 6.

5.2 ANSWERS TO THE RESEARCH QUESTIONS COMPARED TO OTHERS' FINDINGS

5.2.1 What were the perceptions of participants in terms of self-efficacy and anxiety compared to grades? What other findings emerged from the data? Research questions 1 and 6

5.2.1.1 Introduction

This section contains a comparison of the research key findings with other research findings and includes the findings from research questions 1 and 6, thus the themes and sub-themes that were constructed in the questionnaire, and the emergent themes from the comments, such as a belief in innate ability, and the additional pressure caused by time restricted assessment.

Generally, high self-efficacy was a marker for success for the participants who achieved the top grades, but it was less of a marker for those whose grades were around the pass/fail boundaries. The links between self-efficacy and achievement have been identified by a number of researchers, and this research supports those views (Dodd, 2016; O'Sullivan, Robinson, Keogh, & O'Neill, 2018).

In addition, whilst there were exceptions, those with low self-efficacy and high anxiety were less likely to pass, and more likely to leave the course. The link between self-

efficacy and anxiety has been noted by Dodd and O'Sullivan et al, both researching with adult learners, and also with school aged students in other research (Foster, 2016). Knowledge of who had a combination of low self-efficacy and high anxiety by teaching staff might have led to more successful outcomes for some of them.

5.2.1.2 Curriculum/course content

Further analysis of the data collected to answer the first research question on perceptions revealed challenges for these lower-level participants particularly with word problems and algebra, when a lack of self-efficacy was usually linked to higher anxiety levels.

Whilst the challenges faced by many learners when trying to engage with the abstract concepts involved in algebra are acknowledged by many sources (Richardson & Suinn, 1972; Evans J. , 2000; Swan, 2006), which these findings supported, the inclusion of a statement on word problems in the questionnaire is original to this research. Word problems like the one included in this research, which asked how long it would take two people to fit a kitchen that took three people five days, have not been included in other research instruments, such as that by Evans (2000), Watts (2011), or Nielson and Moore (2003), all of which had sections on 'perceived competence'.

The move of mathematics curricula away from algebraic or geometric foci to more word based, 'practical' mathematics was noted by Brown over 20 years ago (2001), and the challenge of word problems has been identified by Tobias (1993), in addition to others (Buxton, 1981; Boaler, 2016; Skemp, 1987), but if these findings are substantiated by a larger study, it may be that research instruments in mathematics have not followed this change as closely as they might have done. This includes the more recent Mathematics Calculation Anxiety Scale (MCAS) (Hunt, Bagdasar, Sheffield, & Schofield, 2019), which was designed to be specifically focussed on the GCSE mathematics curriculum but does not contain any examples of word problems. This scale, which could be of use to teachers towards the end of GCSE mathematics courses to test for self-efficacy in content knowledge, would not necessarily be helpful at the start of courses as it could be perceived as intimidating by those with low self-efficacy.

The word problem given could be seen as relatively complex, as it required multiplicative rather than additive reasoning, which has been identified as an issue for adult learners

(Kontogianni & Tatsis, 2019). However, other research suggested that as adults bring life skills and experiences to the classroom, they should be better able to engage with this type of problem compared to younger students (Gal, Grotluschen, Tout, & Kaiser, 2020). Recent research has subsequently suggested that designing word problems that initially relate to known contexts for FE learners could be important for the development of self-efficacy and reasoning skills (Dalby, 2021; Preece, 2023; Ginsburg, 2022).

As shown in the findings of this research, the word problem raised significant issues for these participants, as they had to interpret the question accurately and then select appropriate methods for solving the problem which, as Barwell (2009) and others have identified, involves a complex set of procedures (Ginsburg, 2022). It may require time and interventions to enable learners to familiarise themselves with this type of question (Dalby, 2021; Vershaffel, Schukajlow, Star, & Van Dooren, 2020). I propose that attention needs to be given to this issue in future research instruments and, from a practitioner perspective, in today's GCSE mathematics classrooms.

These findings indicated that views expressed by both Piaget and Bandura respectively on the need to nurture confidence in learners, to encourage persistence in engagement with solving problems, and the importance of a belief in success, can contribute to success in mathematics (Bandura, 1997; Wadsworth, 1996), although from these research findings it would seem that these qualities, whilst desirable, are not necessarily essential.

The links between self-efficacy and anxiety were established by most participants in this research, as participants were less anxious studying topics in which they expressed self-efficacy (key finding 22) and were more anxious about those topics when they lack self-efficacy.

'Interpretation of charts and graphs' occurs in a number of other questionnaires (Evans, 2000; Suinn, 1972), but this may have been insufficient for the GCSE mathematics candidates who participated in this research, as the construction statement revealed some participants' concerns about self-efficacy and anxiety, which led to the 4th key finding, that the inclusion of a statement on drawing, rather than interpreting, was justified, and adds to the contributions of this research. However, the contribution

would have improved if both statements had been included, as mentioned in the section on the limitations of the research.

The existence of spiky profiles was evidenced by the finding on drawing charts and graphs, which emerged as a topic which engendered low self-efficacy and high anxiety for some participants. However, there were exceptions, as some participants knew they were weak in the topic but expressed little or no anxiety, which indicates the nuanced views of participants, and the complexity of research on non-traditional pathway learners identified by other researchers in England (Dodd, 2016; Avis, Fisher, & Thompson, 2019).

5.2.1.3 Classroom relationships/dynamics

A number of significant findings emerged from the analysis of the data collected in the classroom dynamics section of the questionnaire, some of which has contributed to our understanding of these participants in this small-scale study.

Older research found that a level of anxiety does not necessarily reduce examination outcomes, as long as student have been given enough time to assimilate the material (Mandler & Sarason, 1952), and this research supports that view, as the key findings identified a relationship between the pressure of curriculum coverage, the volume and importance of new topics for participants, and the anxiety that they caused, which may have had a negative effect on retention and attainment. Lower retention and attainment by non-traditional pathway learners have been identified by other research (Robinson, et al., 2019).

It may be that there is a gap in the existing research which is identified by this qualitative research. The identification of a gap has made a contribution to our understanding of these participants studying GCSE mathematics, and further research is required to establish whether the pressure of attempting to cover an extensive curriculum within a limited time frame has a negative impact on both retention and attainment for adult learners more generally, as found in other countries, such as Australia (Robinson, et al., 2019).

In my study all of the participants expressed confidence in their teachers, and the importance of classroom relationships built on trust, that is responsive to individuals'

needs and seen as different to school experiences have been identified in other research in FE as important contributors to success (Jarvis, 2010; Dalby, 2021; Preece, 2023).

One of the contributions made by this research was the finding that some participants were unable to ask a question in class about something that they had not understood (key finding 10), regardless of their ability as judged by examination outcomes. This statement was included in the research by Evans (2000), but responses were perhaps not given the attention that they have received here as it was a much larger study with substantially more data. However, this aspect has been identified in other more recent research , which identified that some adults may have a fear of humiliation (Johnston-Wilder & Marshall, 2017), and that others may have a fear of failure in front of peers (Marshall, Staddon, Wilson, & Mann, 2017).

The finding that some would not ask a question in class can be linked to the comments that concerned expressions of fear of what their peers would think of them, if for instance, they got a question wrong, or that the question asked was considered simple by others (key finding 11). The impact of anxiety caused by forced public performance in classrooms, with consequent reductions in self-efficacy, self-esteem and performance, especially for the lower attainers in groups has been documented (Black P. , 1998; Skemp, 1987), but only one reference was found to the possibility that a student might be confident about an answer but still not prepared to speak out (Hardy, 2009).

Hardy's (2009) research was conducted with trainee teachers, and found that, with one exception, there was a stereotypical belief among the trainees that confident students would speak out, which implied that they believed that those who did not speak out were not confident in their answer. This research has shown that supposition to be false for some of these participants, which may have implications for future research.

5.2.1.4 Assessment

There was evidence that participants' performances in test conditions or examinations were impaired by pressure, as shown in a number of the key findings. Previous research has shown that high levels of mathematics anxiety were related to higher levels of test anxiety and lower results (Betz, 1978; Lukowski, et al., 2019), which was partially supported by this research, as although not all participants with anxiety failed, test

anxiety levels were higher than course content for most participants. A factor which may have influenced these findings is that many of the participants are likely to have already failed the GCSE mathematics examination at least once, and are thus likely to display additional anxiety to those who had not previously failed, as found by other research (Marshall, Staddon, Wilson, & Mann, 2017).

These findings also partially concurred with those in other studies, that the more important the examination, the higher the anxiety, the poorer the performance (Ashcraft & Moore, 2009; Perez-Fuentes, et al., 2020). There was one participant who particularly seemed to show these features in this research, namely Participant 6, who demonstrated anxiety about all examination, including mathematics.

However, many of the adults in this sample were more anxious about mathematics examinations than other examinations, indicating that the incorporation of techniques to help learners overcome their fears of examination situations could be beneficial, such as short rests, calming breathing techniques, and writing about their emotions, as advocated by the findings of other research (Beilock & Willingham, 2014; Wilder & West, 2023).

The common theme that emerged from these key findings for assessment issues was a recognition by participants of the detrimental impact of raised levels of anxiety caused by most forms of assessment. This evidence supports the findings of other research (Skemp, 1987; Yerkes & Dodson, 1908), including that which has shown that timed testing depleted working memory, leading to a deterioration of performance (Ashcraft & Kirk, 2001; Hunt & Sandhu, 2017). However, it was notable that in this research some participants were anxious about all examinations, but for others, it was specifically mathematics examinations that were of concern (key finding 14). This raised the question of what was being tested in mathematics examinations for these participants, was it their knowledge and skills, or was it their ability to perform under pressure?

The findings of other research have linked perceptions to performance in various forms (Dodd, 2016; Foster, 2016; Swan, 2006; Evans, 2000), but not in the UK, as far as I have been able to establish, to final examinations, although the impact on final examinations would be a challenge to establish, as the content is unknown prior to the examination so a comparison is impossible. The links between self-efficacy, anxiety levels, and final

grades in this research were mixed, as might be expected with such a small group of participants; this may indicate that a larger study would be beneficial in improving our understanding of any mechanisms that might exist between the variables.

However, the findings from research completed in the USA by Clarke (2021), which was conducted with community college adults, thus a similar cohort to this one in England, although she was working with a larger sample of 72 participants. Clarke concluded that mathematics anxiety levels were not a predictor for final grades, whereas for the participants in this research the findings are more nuanced, as for some participants high anxiety was linked to poor performance, and all forms of time restricted assessment raised anxiety levels.

There was no evidence in this research on 21 participants that any were overconfident in their ability, which led to an underperformance compared to the more anxious, as found in other research (Evans, 2000; Wang, et al., 2015).

5.2.1.5 Additional themes that emerged from comments

There were a number of additional themes that emerged from the data, as a result of the inclusion of comments and an interview. These answered the sixth research question, namely 'What other findings emerged from the data?'

For some participants the findings on how low self-efficacy combined with higher levels of anxiety were linked to a belief in an innate ability in mathematics (key finding 7), and this finding supports those of researchers who have worked with adults (Buxton, 1981; Skemp, 1987), in addition to those who have researched with younger students (Boaler, 2016).

A belief in innate ability in mathematics has been shown by other research to be present in older and FE populations, e.g. those who have already experienced failure in their mathematical experiences (Apostolidu & Johnston-Wilder, 2023; Norris, 2023). A belief in innate ability could be linked to a fatalistic approach to mathematics examinations, which was evidenced by some participants who made comments on having little or no control over the results of the examinations, as shown in key finding 23. This may be linked to the findings of Knowles et al (2015), who identified that some adults may feel additional pressure compared to younger students because adults are used to being in control of their own lives, and often the lives of others, such as dependants or work

colleagues. Thus, a lack of perceived control, in terms of the content of the paper or on the time that can be spent on answering the questions, can result in additional levels of anxiety for adults which might not be experienced by students on traditional pathways in education.

A number of additional comments made in the main study and the vocal responses to the pilot study questionnaire, which was conducted in class, led to another key finding for this research (24), which was an acknowledgement of the importance for participants of knowing that they were not alone in their struggles with mathematics, and that even those who appeared to be the most able had their concerns and weaker areas. These findings indicate that a community of learning approach in classrooms could be found to be beneficial for adults, and that a negotiated, rather than a prescriptive way of working, as described by andragogy, could be helpful for learners whose education is no longer compulsory, which supports the findings of a number of other researchers (Knowles, Holton, & Swanson, 2015; Rogers, 2003; Safford-Ramus, 2008; Dalby, 2021; Preece, 2023; Syyeda, 2021).

Finally, the benefits of the participants' consideration of their perceptions indicated a meta-cognitive approach to their thinking and an evaluation of both their perceptions and the potential effect of those perceptions. This was considered as beneficial by some of the participants, which supports the findings of other research with adults trying to improve their mathematical competencies (Liu, 2021; Wilder & West, 2023).

5.2.2 Did the perceptions of participants change over the duration of the course (research question 2)?

The findings for this second research question were that for the ten participants who engaged, participants who showed little or no change in perceptions were generally those with higher levels of self-efficacy, lower levels of anxiety, and were more likely to pass (key finding 16). However, not all of those who made progress in terms of higher self-efficacy and lower anxiety did pass, and spiky profiles and perceptions in some topics persisted, namely in algebra and word problems (key finding 17).

Although this was a small scale study, whose findings have not been established by further research, they can be interpreted as linked to those of other researchers, who found that brain activity in the area used for mathematical reasoning was reduced by

mathematics anxiety (Young, Wu, & Menon, 2012). This might have impacted particularly in topics where a two-stage process is required, such as in word problems. In the word problem example used in the questionnaire a decision was required on what mathematics operations to employ prior to the calculation (Ginsburg, 2022), which, similarly to algebra with its mix of numbers and letters, required the application of mathematical reasoning (Dalby, 2021). As previous failure can lead to anxiety which interferes with working memory (Ashcraft & Moore, 2009), successful mathematical reasoning could become progressively less likely.

The findings also agreed with the view that re-engagement with mathematics can reduce perceptions of fear and anxiety (Skemp, 1987; Syyeda, 2021), and that an increase in self-esteem and confidence, which could be described as self-efficacy, can lead to a reduction in anxiety (Newmarch, 2005). However, this was not the case for all participants, as there was one notable exception, whose self-efficacy declined and whose anxiety increased as the examinations approached.

This participant, who showed a marked decline in self-efficacy and a rise in anxiety in many areas of the curriculum and in most areas of assessment, such as tests and examinations, seems likely to have general examination anxiety, especially as mathematics and other examinations were ranked as equally challenging. The possibility of the existence of general examination anxiety among adults is acknowledged by other researchers (Tobias, 1993; Barton & Stone, 2013).

From a research perspective, the value of asking participants to complete a second questionnaire later in the course was confirmed by the changes that a number of participants exhibited and the learning that resulted from the second data collection, including that about the individual whose perceptions had deteriorated. Knowledge about the perceptions of adult learners present in GCSE mathematics classes could be highly valuable from a teaching perspective. This could be an important contribution to our understanding of adults in GCSE mathematics classes if substantiated by a larger study.

5.2.3 Did questionnaire responses or final grades show any variation by participants' characteristics, such as age, gender, or first language (research question 3)?

5.2.3.1 Introduction

It has been a common approach in previous research to consider students' characteristics in the analysis of research findings, as seen in Appendix 8.7. In one table it was shown that gender was the most considered characteristic, and many researchers have referred to the gender of participants when evaluating their findings. There has been less consideration of the age or ethnicity of participants in England, but more research which factors in these characteristics in the USA. In this section I cover each aspect in turn as they appeared in Chapter 4, thus a consideration of the findings for age is first, followed by gender, then first language.

5.2.3.2 Age

The key finding for the section on age was that the older participants generally displayed more self-efficacy, lower anxiety, and were more likely to pass than younger participants (eleven out of fifteen, compared to one out of six passed). Older participants were also more likely to make comments, as eight of the fifteen 30+ year-olds made comments, but only one of the six 19- to 29-year-olds commented.

Most of the findings of other research that has focussed on adults have the opposite view to this finding, as researchers have found that generally older learners have shown lower self-efficacy and lower test outcomes than younger adults in adult basic education classes and HE in the USA (Watts, 2011; Wang, et al., 2015). Other research that looked at anxiety found that older participants on non-traditional pathways into HE in the USA were more anxious than their younger peers (Betz, 1978; Jameson & Fusco, 2014). However, Watts and Clarke (2021), both of whom researched with adults in community colleges in the USA, which are similar to England's FE colleges, found that anxiety levels were similar for all learners regardless of age.

This contrast in research outcomes may be due to the small sample size of this research, differences between the participants, the level of qualifications, or the two countries, and more research is required to establish whether these findings are applicable to the wider population of adult mathematics learners in England. Research that has taken

place in England has generally been on younger, school-aged children (Boaler, 1997), 16 to 18-year-olds in FE (Dalby, 2012), or those on traditional pathways in HE (Evans, 2000). Whilst some older learners were present in the latter two pieces of research, the foci were different from the focus of this thesis, and it may be that in the wider population, there is a peak in terms of age-related mathematics and anxiety, after which a more balanced view emerges, but this is speculative, and more research is required.

The focus of this discussion section now moves to gender.

5.2.3.3 Gender

A summary of the research findings will be shown first in this section, and these will then be contrasted with the findings of other research. The key finding was that males were just as likely to express low self-efficacy and high anxiety as females and more likely to make comments. However, in contrast to the key finding (19), it was noted that all of those who were very unlikely to ask a question in class and both the participants who withdrew from the courses were female.

Key finding 19 contrasts with the findings from other research both in England and in the USA, as generally females have been found to be more anxious about mathematics than males. This was true for school aged students in England (Hunt, Clark-Carter, & Sheffield, 2011; Szucs, McLellan, & Dowker, 2017; Boaler, 2009), and for HE students on non-traditional pathways in the USA (Betz, 1978; Jameson & Fusco, 2014; Safford-Ramus, 2008). However, Evans (2000), in his research with HE students in England suggested that, rather than females being more anxious than males, it might be that females were more likely to express anxiety than males, but again, that was not the finding from this research, as all the males made comments and expressed their concerns.

Time pressures emerged as a significant issue for participants in this study, whether that was in examinations, or in tests in classrooms, regardless of gender, and strategies may be needed that encourage learners to develop a self-awareness of the impact of the effects of anxiety on performance (Johnston-Wilder & Marshall, 2017). Performance and its relationship with anxiety was found to be more marked for females than males by Devine et al (2012), as females were found to be more negatively affected by anxiety in test situations, and this finding was also made by Tobias (1993). These findings have

been challenged by other researchers who have found no significant differences between the genders (Evans, 2000; Watts, 2011; Clarke, 2021). The qualitative research findings in my study were similar to these latter sets of findings, but one male was among the most anxious on the first data collection and did not pass.

Speaking up in class to ask about something that you have not understood was identified by Boaler as an issue particularly for females in her study (1997), as girls were more unwilling to ask questions due to concern about the opinions of their peers. This outcome is not supported by the findings of this research, because whilst it is true that four females in this research expressed extreme reservations about speaking out in class, two out of the three males also made comments about experiencing concerns over peer opinions.

To summarise, this research challenged much of the previous research on gender differences, which may suggest that a more nuanced approach may be required for adults on mathematics courses, especially if stereotypical assumptions by teachers, other learners or themselves could have a negative impact on participation or performance (Holloway, 2013).

In the next section the discussion focuses on the findings viewed from first language differences between participants.

5.2.3.4 First language

As previously discussed, the identity of those whose first language is not English was protected by using the label LX, whilst those whose first language was English were described as L1 speakers (Dewaele, 2018). There were four LX participants in this research, one of whom withdrew from the course; all four made comments. The three remaining LX participants all passed the examinations, compared to nine out of 17 L1 participants.

In addition, some participants, regardless of first language, identified word problems as an issue as they struggled to identify which mathematical operations to apply, especially those whose results were grade 4 or below (key finding 6). The language of mathematics has been identified as challenging for adult LX learners in England (Woolley R. , 2013), but from the findings presented in this research, the language constituted a challenge for many participants. This agrees with research that compared English and Arabic

speakers' performances in word problems, which found that the former outperformed the latter in tests, and that the English speakers' performances were dependant on their computation skills, whilst the Arabic speakers, whose mathematical skills were generally higher, were impeded by reading comprehension and computation skills (Saad, 2021).

In other research the performances of LX learners were found to be lower than their L1 peers, due to a lack of understanding of either the language or the cultural context in questions on mathematics (Maphosa & Oughton, 2021). Researchers, such as Adler (2001), who researched in South Africa and Kersaint et al (2013) in the USA, both working in multi-language schools, have both reported on this, but it was not a finding in this research, as the LX participants passed the examination with grades 4 or 5+. The LX person who did not pass withdrew from the course, rather than failed.

Possible explanations for these findings may be that Adler (2001) and Kersaint et al (2013) were working with younger, school aged learners, so the age was a factor in the findings, or that this was qualitative research with small samples of participants, so not indicative of the wider population, or that all of these LX participants had relatively high English language skills, but as one took over an hour to complete the questionnaire, compared to 10 to 15 mins for L1 participants, the latter explanation does not seem likely. Further research may be beneficial to improve our understanding of both the relationship between mathematics and language levels in different examinations, and the range of mathematical experiences that LX learners bring to classroom settings.

The remaining research in the relevant section of the literature review was concerned with strategies that could help LX learners to maximise their chances of successful performances, namely vocalisation and discussion of mathematical problems (Adler, 2001), paired generation of word problems to share with peers (Barwell, Mathematical Word Problems and Bilingual Learners in England, 2009; Kersaint, Thompson, & Petkova, 2013), and an appreciation of the spiky profiles that adult LX learners bring to classrooms, both in mathematics and in English skills (Colquhoun & Delaney, 2009), which may all help LX learners to succeed.

Further research is needed to establish whether the strategies used for LX learners could benefit L1 English speakers, although the importance of translating the mathematical

register into 'normal' English for adult learners has been established (Safford-Ramus, Misra, & Maguire, 2016).

Finally, there was no evidence to support the concerns of Aronson et al (1999) and Holloway (2013) that stereotypical assumptions about LX learners can have a negative impact on their final results, as those who remained on the course all passed, but no conclusions can be drawn from this, as it may indicate that those LX participants did not experience the influence of stereotypes from either their teachers or peers, or that LX learners who experienced stereotypical influences did not participate in the research.

5.2.4 Self-efficacy and anxiety: a comparison of the scales (research questions 4 and 5)

One original approach of this research was the use of both self-efficacy and anxiety scales on the same document and with identical statements. The links between self-efficacy and anxiety in student populations have been noted by many researchers across the English speaking world (Dodd, 2016; Foster, Confidence and competence with mathematical procedures, 2016; O'Sullivan, Robinson, Keogh, & O'Neill, 2018; Jameson & Fusco, 2014; Everingham, Gyuris, & Connolly, 2017), although their work has not investigated the links between the two, as has been explored in this research.

In this research the first key finding was that high self-efficacy was a marker for a grade 5 or better, the top grades that this group could achieve. This agreed with the findings of two sets of unpublished research from the USA (Clarke, 2021; Watts, 2011). The second key finding was that those with low self-efficacy and high anxiety were a high-risk group for both low pass rates and withdrawals from the mathematics courses, which correlates in part with other USA based research, which found that as anxiety increased, performance declined, but this effect was moderated by high levels of self-efficacy (Palestro & Jameson, 2020). Knowledge of who had low self-efficacy combined with high anxiety by teaching staff might have led to more successful outcomes for some of the participants in this research, as previously stated.

The questionnaire used did not attach self-efficacy to calculations, as seen in the research of Swan (2006) and Foster (2016), although some participants did treat the statements on course content in this way. The advantage of not attaching self-efficacy rankings to calculations was two-fold: firstly, it allowed the participants to think about

the statements in the questionnaire away from the potential stress of calculations, and secondly it gave participants the opportunity to think about the statements in isolation, away from any potential peer knowledge or influence, which may be important for adults (Marshall, Staddon, Wilson, & Mann, 2017; Zientek, Fong, & Phelps, 2019).

The inclusion of both self-efficacy and anxiety scales contributed to the understanding of the participants in this study, and this has been acknowledged in other research which also used two scales (Palestro & Jameson, 2020). However, the use of both allowed for additional insights, as can be seen in the case of one participant, who expressed doubt about his correct answer to the word problem, along with increased doubts about his ability and raised anxiety, thus demonstrating the link. This connection between self-efficacy and anxiety is noted in other research (Zientek, Fong, & Phelps, 2019).

It was also clear from the data analysis that both participants who left the course had low self-efficacy and high anxiety. This supported the observation that those with low self-efficacy and high anxiety are likely to disengage from situations where their ability to control the situation is in doubt (Bandura, 1997).

The findings of this research agreed with the research that under test conditions low self-efficacy often correlated with low test scores (Nielsen & Moore, 2003; Watts, 2011), although there were exceptions to this finding, which perhaps revealed the individuality of these participants. Previous research has identified self-efficacy, rather than anxiety, as an important aspect for successful mathematics learning for adults (Clarke, 2021; Dodd, 2016; Watts, 2011), but the finding (26) for this section of the research was that for this group of participants either self-efficacy or anxiety scales could have been used for the sections of the questionnaire concerned with course content and classroom dynamics, but for assessment the anxiety scale revealed more relevant information on participants' perceptions, especially, perhaps, from a teaching perspective.

5.3 REFLECTIONS ON METHODOLOGY

My journey in this mixed methods/qualitative research has followed a critical realism path, although it differed from that followed by those working in more quantitative research, which is more likely to aspire to offer proof for supporting or counteracting hypotheses, which cannot be claimed here, due to the qualitative nature of the data (Bazeley, 2018; Buchholtz, 2019), in addition to the sample size (Cohen, Manion, &

Morrison, 2018). Qualitative research, based on its inference of the feelings and perceptions of others (Wittgenstein, 1968) is value loaded, but can still be used to expand the thinking of myself and others, and it was in this way that I aspired to make an original contribution to the field.

The transformational model of social activity, TMSA, as defined by Bhasker (2020), made an important contribution to my thinking on this journey through the thesis, as it gave me a focus for the longer term by helping me to keep in mind the additional work that will need doing. The additional work required will be to establish whether the findings from this research are reflected in the wider adult mathematics learners' community (Greene & Hall, 2010; Bazeley, 2018). However, whether the findings are more widely applicable or not, the value of this study has been clear, as it highlighted how some participants' perceptions can differ both from each other, and from those on more traditional pathways in education.

The role of the qualitative researcher when communicating their findings must be to emphasise the descriptive and to avoid the prescriptive mode (Buchholtz, 2019; Morgan, 2018), which has highlighted the continuing development of myself as researcher both during and after completion of this thesis.

The thesis, and the process of the Doctorate in Education itself, have developed over time, and moved through many iterations prior to this version. The iterations reflect and are part of the journey of movement between teacher focussed practitioner and researcher, a movement which was quite fluid in some respects but has become much more clearly defined on a personal level, which has justified the choice of paradigm for this research, which was pragmatism (Tashakkori & Teddlie, 1998; Morgan, 2007). A pragmatic approach in this research has allowed adaptions for many challenges, such as a global pandemic, and has accepted that change due to these challenges are an integral part of the process of developing the research into a form that can make a contribution to the field.

The use of pragmatism, with its epistemological acceptance of both objective and subjective data fitted well with the mixed methods approach of this research (Biesta, 2017; Pole & Lampard, 2002; Creswell, 2015), although the objectivity was restricted to the numbering of the attitude scales in the data analysis to enable comparisons between

the participants. This process is open to challenge, as it can quite correctly be claimed that one participant's chosen response, although the same as another's, cannot lead to the assumption that their feelings or perceptions are the same, but it has given me a useful way to examine, evaluate and compare the voices of the participants (Morgan, 2018; Scheiner, 2019).

The responses of participants were analysed using thematic analysis. Thematic analysis has been employed in two ways, firstly by using the research questions themselves as themes, and secondly by analysis of the comments. This has both enhanced the understanding of the themes and highlighted emergent themes that were not included in the questionnaire. The process of the use of themes to evaluate data is commonly found in qualitative research, and was in use before it was formalised as a valid approach by Braun and Clarke (2006 ; 2013), as evidenced by Evans (2000) among others.

The use of thematic analysis (Braun & Clarke, 2013) was valuable in both the pilot and main data collection, as it enabled a focus on key issues that arose for participants in a structured and thorough way and has helped in the blending of the quantitative content of responses from the attitude scales, and the qualitative comments gained from the questionnaire and the interview (Scheiner, 2019). Thus, the use of thematic analysis enhanced the value of the mixed methods approach and supported my development as a researcher.

Whilst a mixed methods approach benefitted the data collection in the main research, the use of an action research approach to the pilot study yielded a number of improvements to the main data collection tools due to the insights gained (Cohen, Manion, & Morrison, 2018; Munn-Giddings, 2017). These insights were combined with almost 20 years of teaching experience of adult learners to produce the questionnaire in its final form, and this is the subject of the next section, which focuses on the choice of methods for the data collection.

5.4 METHODS OF DATA COLLECTION: QUESTIONNAIRE WITH COMMENTS AND INTERVIEW

The use of questionnaires in research with students of mathematics is common for both self-efficacy and anxiety for all ages, from school children (Hunt, Clark-Carter, & Sheffield, 2011) to HE students (Evans, 2000) and this research supports the view of the

efficacy of this method of data collection. MMR is an acknowledge theoretical approach for data collection in applied settings, especially in education (Bazeley, 2018), as the quantitative and qualitative data can inform and support each other and be merged or integrated for analysis (Creswell & Plano Clark, 2018; Greene & Hall, 2010), hence the inclusion of comments on the questionnaire.

The use of a multifaceted questionnaire that allowed for expressions of self-efficacy and anxiety to gather information for this research was, overall, a justified choice, as it revealed insights which one scale alone would not have revealed, such as that some participants identified that they feel they cannot complete algebra questions, but are relatively less anxious about those, whereas with word problems it was the reverse, with relatively lower self-efficacy scores, but higher anxiety. These differences enhanced the understanding of the participants.

The use of 'no anxiety' at the start of the anxiety scale, in line with the research of Dodd (2016), who identified the need for those who were not anxious to say so, was used in this research, and was validated by the numbers of participants who chose this option.

The inclusion of comments at every stage of the questionnaire was an important feature of the research, and led to in number of key findings, including the identification of additional themes, such as innate ability in mathematics (key findings 7), and the

fatalistic approach to final examinations held by some participants (key finding 23). There was also an in-depth view of the effect of time pressures on performance, that participants valued knowing that they were not alone in their perceptions (key finding 24), and that participation was identified as cathartic for some (key finding 25).

Thus, the research gained much from the inclusion of comments throughout the questionnaire. The inclusion of comments was particularly valuable as only one participant came forward for an interview. The use of comments sections as an effective alternative or addition to data collection by interview was identified by Tymms (2017), and this research, although small scale, has supported that view.

Overall, the combination of scales and comments in the questionnaire revealed a wealth of qualitative data from the 21 participants, which contributed to our understanding of those participants studying GCSE mathematics in FE colleges and revealed some

potentially important insights, including certain aspects of course content, namely the challenges of word problems and drawing charts and graphs.

The data gathered on participants' characteristics was also justified, as, although this was a small-scale study with 21 participants, it challenged stereotypical views on gender, age and for those whose first language was not English. Evidence for this claim included that one of the most anxious participants with the least self-efficacy, and who made many comments was male, and the most self-efficacious and least anxious participant was a female LX learner. If these qualitative findings are supported by further research (Buchholtz, 2019) it will highlight a potential difference for adults in the FE sector.

The use of a questionnaire with a diverse group of learners has yielded some evidence from participants that a meta-cognitive approach could be beneficial for some learners and could positively influence perceptions (key finding 25). This has been found by other researchers, such as Foster (2016) and O'Sullivan et al (2018), both of whom noted an improvement in confidence for those who participated in their research from very different populations of mathematics learners, as one worked with secondary school pupils, whilst the others worked with HE adult learners. Both sets of research also noted an improvement in results, but this research cannot speculate on that aspect.

5.5 CONCLUSION TO CHAPTER 5

In conclusion, the data collected in this research has revealed a number of interesting and potentially original findings, in addition to both supporting some and challenging other aspects of the findings of other research. Where differences have been found this may be because the samples were not comparable, in terms of age, gender or first language, or in educational experiences, as many researchers have researched those on more traditional pathways in education, whereas this research included only a few participants on traditional pathways.

It may also be that the sample of participants who self-selected for this research were not representative of the wider population of adult learners on GCSE mathematics courses, due to issues around volunteer and other biases (Spiegelhalter, 2019).

However, whilst acknowledging the limitations of this study, the findings have concerned an under-researched population of significant numbers, as over 30,000 adults of 19 years or over were on GCSE mathematics courses in England in 2020

(Gov.UK (1), 2020). Many of these were re-engaging with mathematics after a perceived failure in the subject in school, or migrating into England, with or without qualifications from other countries.

These findings have produced some significant insights into the variation in perceptions of this adult population, the diversity of the population, and newly identified areas of challenge in both course content and assessment which adds to our understanding of these learners.

The contribution made by this research is summarised in the next chapter, which concludes this thesis.

6 CHAPTER 6: CONCLUSION OF THESIS

6.1 INTRODUCTION

In this chapter there are 4 main sections which cover firstly a summative overview of the research findings, secondly a reflection on the benefits and limitations of the research and its process from both general and personal perspectives, thirdly the potential implications for future research indicated by the findings within research instruments, the FE sector and adult learners, and fourthly the implications for practice.

The last section concludes with a summary statement which relates the findings to the title of this thesis.

6.2 SUMMARY OF KEY FINDINGS

This research has contributed to the exploration of what works, or what could work, in the field of mathematics education for adults who have an identified need to build their skills, and who could be seen as being socially or economically vulnerable in a changing world (Gal, Grotluschen, Tout, & Kaiser, 2020). However, the complexity and variety of the context of the FE sector in England, in terms of the learners, curriculum and settings, can mean that research outcomes look contradictory when they perhaps should be considered as nuanced but adding to our understanding of this complex field (Avis, Fisher, & Thompson, 2019). In this research a number of significant findings have emerged. These included that for this group of participants, perceptions of self-efficacy and anxiety were often, but not always, linked to final grade.

The importance of high levels of self-efficacy for the final grade, although not essential, was beneficial. It may be important in the early stages of the courses to ensure that learners are successful in tasks during lessons and using their past or everyday experiences of mathematical knowledge to build confidence (Watts, 2011; Bélanger, 2015). Existing skills with, say, money and time, could be presented to learners as positive spikes in their mathematics knowledge, compared to other topics where their skills are lower.

Consequently, it could be highly beneficial to consider that adults returning to mathematics learning, after what is sometimes a break of 20 or more years, be considered as having spiky profiles (Coben, Swain, & Tomlin, 2004). An awareness of those spiky profiles in, say, algebra or drawing activities could mean that teachers might

exploit those who have the skills in specific areas to help those around them, building their confidence and creating or reinforcing bonds among the peer groups.

Whilst the addition of a consideration of spiky profiles for mathematics is, perhaps, unusual in this thesis, many other aspects of what has emerged as important from the study are not, such as the need to stimulate and encourage discussion among learners (Boaler, 2016; Sfard, 2013), to support both the language content of mathematics and to reinforce learning. This may benefit LX learners, who may enter the classroom with language needs, but could also benefit L1 learners, many of whom may enter with more psychological needs (Safford-Ramus, 2004), but who could also have language needs.

In this study the questions on word problems generated significant responses for teaching and learning. The application of techniques advocated for LX learners in mathematics classes, such as asking learners to generate their own word problems and solve them, could give learners are an understanding of how these types of questions are constructed (Barwell, 2009), to improve their understanding of which number operations to apply in different problems. Additionally, an improvement in self-efficacy could improve learners' ability to try a method, and if it is unsuccessful, to try another, an approach which successful mathematicians often employ (Boaler, 2016).

Within the classroom the facets that emerged as significant from this study were firstly that some learners are unable or extremely unlikely to raise their hands in class to ask a question. If teachers are aware of who falls into this category, they can use other techniques to establish whether these learners have understood the topics under discussion, such as a personal approach while walking around the classroom. Additionally, some learners expressed concerns about listening to another student explain a formula, because they would be uncertain whether it was correct or not. To deal with this aspect it is perhaps important to ascertain in advance if learners have a correct method or answer before asking for their contribution. Adult learners do not have much time to engage with the content of the curriculum, so it is important that what they hear is accurate, as far as possible.

It was seen in both the pilot and the main study that from the learners' perspectives, the realisation that they were not alone in their perceptions seemed to be an important part of reducing feelings of isolation.

There was an increased risk of anxious responses in mathematics examinations compared to other examinations; if this is corroborated by a larger study it could be helpful for learners to be aware of this. A classroom discussion on the detrimental effects of too much adrenalin in the system with learners, including the barrier that it might raise in terms of the ability to think, and raising awareness of techniques that could be used to calm their minds could help learners to control the effects.

In addition, the realisation that there were exceptions to links between anxiety, self-efficacy and final grades could be very reassuring for adult learners.

In the next section I consider the implications of this research for future research.

6.3 IMPLICATIONS FOR FUTURE RESEARCH

This study was a small-scale qualitative piece of research, using a mixed methods approach. Whilst this study may have value for those engaged in adult education in a practical capacity, it could be highly informative to run a larger scale study on adult learners to see if the insights that emerged from this group exist on a larger scale, and if any further insights emerge. If the insights gained here are confirmed, they could have implications for policy and practice in the FE sector.

Statements in the questionnaire which were original to this research included the statements on drawing charts and graphs, word problems, taking non-mathematics examinations, and asking questions in class, although the latter was found in some research (Evans, 2000). The first two were highly relevant for mathematics at GCSE level, and the latter two for enhancing our understanding of the perceptions of learners present in classrooms. I argue that these require further testing to see if they should be included in other research conducted with adults about the affective domain in mathematics.

Further research is also required to evaluate whether the drawing of charts and graphs, rather than the interpretation of them, generates different responses from learners, especially for those studying GCSE mathematics.

The findings from these participants indicated that there seems to be a particular need to test whether it is important to insert statements on word problems into attitude scales, to pick up on a facet of mathematical content which has been emergent since

the late 1990s (Brown T. , 2001). As identified in other research, many scales have been developed with undergraduate students in universities, and other cohorts of learners may be different (Hunt, Bagdasar, Sheffield, & Schofield, 2019). Although this was a small sample of participants, I believe this is an area which is relatively under researched, in terms of an analysis of how adult learners might choose which number operation to apply, and whether or not learners have the self-efficacy to try alternatives in the event of an unsuccessful outcome.

Differences identified between this research and other studies in terms of gender may indicate that some benefit would accrue from developing an awareness of the psychological impact on males of perceived failure in mathematics examinations, and if it is generally greater than the impact on females. This may also apply to other subjects, e.g., science and technology.

I would suggest that more research be undertaken investigating the differences between learners' perceptions of mathematics compared to other examinations, as information about this, including establishing how early in pupils' lives there starts to be a difference between their perceptions of examinations generally and if they differ from their perceptions in the case of mathematics, could be of benefit to all the teaching and learning communities involved. Other research has also indicated that there may be something specifically about mathematics that undermines self-efficacy, which has been identified as important for success (Palestro & Jameson, 2020), although this was conducted with undergraduates and, as previously identified, FE adults may be different.

There was an indication in this research that questionnaire responses made on phones did not include comments, whereas those made on paper or computers did. Researchers may want to be aware of this when planning and implementing data collections.

Drawing on the limitations identified, in a larger research study it could be beneficial to include other providers offering courses in mathematics, such as Local Authorities, private providers, and the WEA, in addition to FE colleges. The research could also be extended to include adults studying for FS qualifications, as many of these may move into the GCSE provision.

Another recommendation arising from the limitations to this study is that data gathering and analysis using the same methods could be repeated, and evaluated for changes which might result from conducting research with adults on GCSE mathematics courses in less pandemic-effected academic years.

I would also recommend that some evaluation be undertaken into pilot studies, as I found the pilot study invaluable in terms of informing and improving the main data collection (Stacey, 2022), but it emerged during discussions at the CERME online conference in 2022, that a number of universities do not ask for pilot studies from doctoral students. This would seem to be a lost opportunity in terms of improving the quality of doctoral research.

6.4 IMPLICATIONS FOR PRACTICE

The findings of this research suggest that it could be beneficial for teachers to have more information on their learners than would be provided by initial and diagnostic assessments, and that this could be done with a questionnaire, as the use of a questionnaire in this study was an effective way to gather information. For teachers of adults, especially perhaps those who are 25 years old or more, it emerged from this research that stereotypical assumptions about learners may be misplaced and incorrect, and potentially detrimental to performance, and if this confirmed by a quantitative study, this was an important finding. It seems that either a self-efficacy or anxiety-based questionnaire could be used, or one that contains a mix of the two, but this requires testing.

The use of a questionnaire could also help teaching staff to establish which learners feel confident about their skills in specific topics which, if substantiated by evidence, could lead to a development of an appreciation of different strengths and weakness among individuals. This could be reflected in discussions around 'spiky profiles' (Coben, Swain, & Tomlin, 2004), a concept which is accepted in the ESOL provision (Colquhoun & Delaney, 2009), but seems to have got lost in my college in mathematics classes. An awareness of this could build confidence, and perhaps lead to more peer support in topics, enhancing feelings of community.

The inclusion of comments sections on the questionnaires was highly beneficial for both the research and the participants, as they yielded a wealth of information, and there

was evidence from both the pilot and main study that a meta-cognitive approach which involved sharing their feelings was cathartic for learners, whether it improved final grades or not. If learners could be surveyed in class this could generate discussion and builds bonds, which could be beneficial for adult learners, as confirmed by other, admittedly also small scale, research (Wilder & West, 2023; Syyeda, 2021).

It seems most likely that completing questionnaires early in the course might benefit learners and teaching staff, but a repetition could have additional benefits for some learners, as whilst it might have been expected that self-efficacy would have improved and anxiety declined as the courses progress, this was not true for all participants in this study. Again, further research is needed to establish if this was an anomaly in this research or indicates a more generalised issue for learners but, in the interim, teachers could use the information to identify who is likely to need more support as the examinations approach. The monitoring of self-efficacy and anxiety levels to evaluate whether they are improving, in the same way that end of terms' testing is carried out, was advocated in the unpublished USA research of Watts (2011), and I advocate for this in adult classrooms in the UK, as a way of maximising our understanding of adult learners and potentially improving their results.

In addition, this research confirms that anxiety around assessment was an important issue for the participants, which suggests that calming techniques, as recommended by other research, including regulation of breathing, may need to be included in teaching (Johnston-Wilder & Marshall, 2017).

There seems from this and other research to be an argument for fast tracking competent LX learners who experienced education in English (Maphosa & Oughton, 2021), or who have high levels of English and/or mathematics (Saad, 2021; Syyeda, 2021), into November examinations and/or onto Higher Tier papers, rather than May/June Foundation papers, as the latter may contain more language, if this meets the needs of the learners involved. More work is needed in these areas, and perhaps a greater appreciation of the individuality of learners' perceptions and needs.

In the next section of this chapter, I explore the limitations of this research.

6.5 LIMITATIONS OF THE STUDY

There are several issues arising from this study which could be considered as limitations on its applicability for other organisations teaching adults mathematics.

Firstly, this was an exploratory, qualitative study which drew participants from a relatively small geographical area in the Midlands and as such it was in a specific context (Lawson, 1998). It is unknown if the same information would be revealed by looking at other groups of learners, whether in other parts of the country or not, who are also studying GCSE mathematics in FE colleges, or if the same patterns would emerge if a larger number of learners participated. Some discrepancies between this research and others may be due to the specific characteristics of this small group of participants, or due to outside influences, such as the pandemic.

Both of the two groups of participants who participated in this study were affected by the pandemic, as the data was collected in the academic years 2020/21 and 2021/22. Group 1 was affected by a lack of face-to-face contact with peers and their teachers, combined with uncertainty about how, when and where they would be finally assessed. Group 2 had the experience of face-to-face teaching but may have been unsettled by uncertainty around how long it would last, and whether their formal examinations would go ahead, or whether they would be given a final grade by their teachers using the formative assessments, usually applied every 6 weeks or so in my college. This may have added to their perception of the importance of those assessments and distorted the results obtained.

Secondly, GCSE mathematics was not the only funded qualification on offer to adults in FE, as there was also Functional Skills provision and examinations. At the time of the research, these were often the qualification of choice for those adults in apprenticeship provision, as they were more flexible in terms of examination provision, as exams could be booked at any time of the year, and the format could be either online or paper based. This contrasted with GCSE provision with only a paper-based option, restricted to two opportunities for examinations in the academic year (November and May/June). Learners on the FS provision were not included in the offer of participation, and different insights might have emerged if they were.

Thirdly, adult learners at FE colleges were offered the opportunity to participate in this study and self-selected for inclusion; different insights may have emerged had other adults been selected for inclusion or if it had been the norm for all the adults in certain classrooms to participate.

Additionally, these participants completed the survey tools themselves, so it was their perceptions that were captured, and these may vary between learners, in terms of how they perceived the attitude scales, and what comments they felt were appropriate. For instance, two participants may have ranked feelings about word problems as 'some anxiety', but one may have had a more extreme response than another, as judged by fear responses or observation. Equally, some may have felt that, in deference to the researcher, they could not express themselves fully in the comments sections.

The inclusion of comments on the questionnaire was highly valuable as it elicited information on perceptions about the main themes and identified additional themes for the research. However, comments also revealed that some participants had misinterpreted the statement on using a times table grid, as they read this as using the grid method of multiplication. This raised two points: firstly, it was impossible to know if others also misinterpreted this statement, and perhaps others in the questionnaire, and secondly it highlighted the value of including examples on questionnaires in the future to improve clarity for participants and researchers.

Some additional issues that arose for the questionnaire content included that a statement on interpreting as well as drawing graphs and charts would have been beneficial for the research, and that the statement on solving a word problem could be considered as quite a complex problem, which may have influenced the responses. These issues will need to be reconsidered in a larger study.

Pure qualitative data came from the inclusion of comments and from the interview; more participants may have come forward for interview if I had selected them and asked for an interview, rather than offered it as an option for their consideration (Bryman, 2016).

In addition to the data gathering being affected by learners' perceptions or misinterpretations, there are also my own perceptions, experiences and beliefs which

may have distorted my interpretation of that data, and this should also be considered (Lawson, 1998).

The division into L1 and LX participants in this study worked to protect the small number of participants who were not first language English speakers, but in a larger study where identities are protected by greater numbers than this, the categorisation should perhaps be more nuanced around whether or not those participants were taught in English in the countries of origin (Maphosa & Oughton, 2021).

Apostolidu and Johnston-Wilder (2023) collected information on participants current work, and reasons for studying mathematics, and this approach could have improved my research, although from personal experience I am aware that not all learners will answer questions on future plans accurately, perhaps because it might expose them to public failure if they do not achieve the necessary grades. This research also noted that it was exploratory and required further testing with larger cohorts of learners which is, again, the case here.

Finally, a question on whether participants were taking other examinations in addition to GCSE mathematics would have been informative for the discussion on why participants ranked the latter with higher anxiety responses.

In the last section I conclude this thesis.

6.6 FINAL CONCLUSIONS

In conclusion, I contend that this research has made a significant and original contribution to our knowledge of some of the adults studying GCSE mathematics.

Firstly, it would appear from this study that the wording of the questionnaire with comments sections, whether it is phrased around self-efficacy, or anxiety, or some combination of both, was important for gathering information from learners, and revealed new insights into the variety and intensity of their perceptions. These perceptions varied across the main themes of course content, classroom dynamics and assessment. Insights have been gained about much of the content, including insights into drawing graphs and charts, and particularly word problems.

Timed testing emerged as the most significant challenge for these adult participants, which has added to our understanding of this research area. Although this has been a

small-scale, largely qualitative study, there seemed to be sufficient evidence of the discrepancy between anxiety responses to mathematics examinations compared to other examinations which, if confirmed by a more comprehensive study with a larger number of participants, for this to be an important contribution to our understanding of the trials faced by adult learners in their attempts to progress in their lives and careers.

The cathartic nature of questionnaire completion for some participants may have improved their sense of community and decreased feelings of isolation, which could have led to higher levels of engagement, more constructive discussions in the classroom, and possibly better grades.

This research, although small scale, also challenged stereotypical views around age, gender, and first language, which has added to our understanding of the diversity of both the participants and their perceptions in GCSE mathematics classes.

Finally, on a personal note, this research and the subsequent thesis have contributed substantially to my personal journey of developing research skills and understanding.

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8 APPENDICES

8.1 INFORMATION LETTER FOR THE QUESTIONNAIRE

The Information letters and consent form contained the SHU logo in the top left-hand corner as required by the university:

Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety and examination performance.

Participant information sheet

Dear Adult Learner, I am currently a student at Sheffield Hallam University, which undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of public tasks that are in the public interest. A full statement of your rights can be found at https://www.shu.ac.uk/about-this-website/privacy-policy/privacy-notices/privacy-noticefor-research. However, all University research is reviewed to ensure that participants are treated appropriately and their rights respected. This study has been approved: Converis Number ER24593031. Further information at https://www.shu.ac.uk/research/ethicsintegrity-and-practice I am completing a Doctorate in Education assessing the levels of self-efficacy (e.g. confidence in their ability) and anxiety (e.g. apprehension or fear) in adults (19+) in mathematics and examinations, and whether there is a link between those levels and exam results. I would be very grateful if you would participate in this study. The study could help students and maths educators both here in the UK and, potentially, in other parts of the world. The first phase of participation will consist of completing a questionnaire which I expect would take about 15 minutes. There is a 'Participant Consent Form' form to complete at the same time. You are under no obligation to answer any or all of the questions, and it is entirely an 'opt in' study. In the second phase I will ask you to complete the questionnaire again later on, so that I can compare your answers. In the third phase in August I will contact you to request your GCSE mathematics exam results, which I will then compare to your questionnaire responses. There will be no consequences to your future treatment by me, the researcher, or by your teacher, whether you decide to participate or not. If you do choose to participate, I may use your anonymised results and comments in the thesis, in other writing, such as reports, books,

presentations and papers, and present the research findings at conferences, teacher-training sessions, and the like. Your anonymity will be protected as I will not use your name, but refer to participants in groups, e.g. by gender, or age, or by using a letter, e.g. Learner A. The questionnaires themselves will only be seen by me, and any member of SHU involved in assessing the project. Paper based questionnaires will be kept in a locked container, separately from the key which identifies individuals, and the consent forms. The key will be destroyed three years after completion of the thesis, at the latest by December 2028. Information on the project and online questionnaires will be stored on a secure research drive in the Sheffield Hallam University computer system. You can change your mind at any point, or withdraw from this study at any time up until two weeks (14 days) after you complete the questionnaire. You can withdraw from the exam results comparison up to 7 days after the results are published. There is evidence from other countries that participation in this type of survey prior to exams can be beneficial to students. However, if you are negatively affected in any way, please speak to me as soon as possible, or your maths teacher, or contact Student Support at your college. Staff are willing to help any student who is concerned, whether or not it arises from the survey. Further help is available from the Maths Anxiety Trust website at www.mathsanxietytrust.com This research project is not designed for anyone diagnosed with anxiety as a medical issue. Please note that the last question on the consent form asks if you will allow your data to be used by other researchers once it has been anonymised. You can participate in this study without giving permission for data access to other researchers. Please retain this information sheet for your records. If you have any questions or issues with this study please contact me in the first instance. If you wish to discuss any queries or concerns further please contact the project supervisors, Dr Iain Garner (i.garner@shu.ac.uk) or Dr Peter Rowlett (p.rowlett@shu.ac.uk) at Sheffield Hallam University. There are more contacts at SHU below. Thank you for taking the time to read this far, Jennifer M. Stacey Doctoral Student, SHU a0025098@my.shu.ac.uk You should contact the Data Protection Officer if: • you have a query about how your data is used by the University • you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) • you would like to complain about how the University has used your personal data DPO@shu.ac.uk You should contact the Head of Research Ethics (Professor Ann Macaskill) if: • you have concerns with how the research was undertaken or how you were treated

a.macaskill@shu.ac.uk Postal address: Sheffield Hallam University, Howard Street, Sheffield S1 1WB

8.2 CONSENT FORM: QUESTIONNAIRE AND INTERVIEWS

The Information letters and consent form contained the SHU logo in the top left-hand corner as required by the university:

PARTICIPANT CONSENT FORM TITLE OF RESEARCH STUDY:

Adults studying GCSE mathematics in Further Education: Confidence levels and examination performance.

Please answer the following questions by ticking the response that applies YES NO 1. I have read the Information Sheet for this study and have had details of the study explained to me. 2. My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any point. 3. I understand that I am free to withdraw from the study within 14 days of completing the questionnaire, as outlined in the Information Sheet, without giving a reason for my withdrawal or to decline to answer any particular questions in the study without any consequences to my future treatment by the researcher. 4. I agree to provide information to the researcher under the conditions of confidentiality set out in the Information Sheet. 5. I wish to participate in the study under the conditions set out in the Information Sheet. 6. I consent to the information collected for the purposes of this research study, once anonymised (so that I cannot be identified), to be used for any other research purposes.

Participant's Signature: _____ Date: _____ Participant's Name (Printed): _____

Contact details:

_____

_____

Researcher's Name (Printed): Jenny Stacey Researcher's Signature: J. M. Stacey Researcher's contact details: Jennifer M. Stacey, Sheffield Hallam University, City Campus, Howard Street, Sheffield, S1 1WB; a0025098@my.shu.ac.uk Please keep your copy of the consent form and the information sheet together.

8.3 POWERPOINT PRESENTATION DISTRIBUTED TO COLLEGES IN LIEU OF VISITS

05/09/2022

Adults studying GCSE Mathematics in Further Education: confidence in ability, anxiety and examination performance

Doctorate in Education
Jenny Stacey
A0025098
Sheffield Hallam University
February 2021

1

Aims and Objectives: The Research Questions

- Do courses in FE colleges change adult learners' perceptions of mathematics or examinations? If so, how?
- Is there a relationship between confidence in ability, anxiety and the grade learners achieve in the GCSE maths exams?

2

A picture of your researcher!

In a pre-pandemic world I would have visited you to tell you about my project and ask for your help and participation, but now this whole project will be conducted on line. There is a link to a survey form which can be completed on your phone, or you can use the one attached to the email, save it, and return it to me.

3

Three phases to the research

- Complete the first questionnaire and submit
- Complete the second questionnaire when I send you the link in April or May
- E mail me your exam grade in August please!

4

Ethical Considerations

- Your identity will remain anonymous. I will refer to you in groups, such as 'females', 'learners over 50 years old', or 'Learner A'. Storage on a secure drive at SHU, or securely in locked containers.
- Please do not take part if you have a medical diagnosis of anxiety
- Ill effects? Then do not continue. Contact me, your teacher, help at the college...

5

Why participate?

- Evidence that participation in this type of survey can be beneficial.
- Improve our levels of understanding of the stories that adults bring with them to their maths classes
- Understand if confidence is necessary for success, which could inform classroom practice
- Jenny Stacey at a0025098@my.shu.ac.uk

6

8.4 THE QUESTIONNAIRE

GCSE Mathematics and Examinations Questionnaire

Name…….

Date……. Gender……..

Ethnicity…… First language…… Age…….

In which country did your schooling take place? .....

Please think about the situation described and firstly rate how confident you would feel about your ability in that situation, then secondly how anxious it would make you feel. Add a comment if you would like to on the lines/ in the boxes provided. The questionnaire should take about 15 minutes:

Course Content

Q1) Using a times table grid: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q2) Drawing graphs and charts: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q3) Working out 12% of £42: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q4) Finding two thirds of £42: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q5) Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how many days would it take 2 people?: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety GCSE Comment……

Assessment

Q6) Doing a quiz in a maths class: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q7) Being given a homework assignment of difficult maths problems which is due in next class: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q8) Thinking about an upcoming maths test one day before: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q9) Taking the Maths GCSE exams at the end of your course: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q10) Taking any GCSE or other exams: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

In the classroom

Q11) Starting a new maths topic in class: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q12) Listening to the teacher talking at the front of the maths class: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q13) Watching a teacher work an algebraic equation on the board: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q14) Listening to another student explain a maths formula: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

Q15) Asking a question in a maths class about something you have not understood: a) Very confident Quite confident Don't know I don't think I can do this I definitely can't do this

Comment……

b) No anxiety Some anxiety Moderate anxiety Quite a bit of anxiety High anxiety Comment……

If you have any other comments relating to confidence or anxiety about the maths course or any of your exams, please make them here: ……

……

……

……

Thank you for your time. If you have any questions or suggestions about this survey, please contact me on my email: a0025098@my.shu.ac.uk

Best wishes, Jenny Stacey

8.5 INFORMATION LETTER: INTERVIEWS

The Information letters and consent form contained the SHU logo in the top left-hand corner as required by the university:

Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety and examination performance.

Participant information sheet: Interviews

Dear Adult Learner, I am currently a student at Sheffield Hallam University, which undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of public tasks that are in the public interest. A full statement of your rights can be found at https://www.shu.ac.uk/about-this-website/privacy-policy/privacy-notices/privacy-noticefor-research. However, all University research is reviewed to ensure that participants are treated appropriately and their rights respected. This study has been approved: Converis Number ER32452066. Further information at https://www.shu.ac.uk/research/ethicsintegrity-and-practice I am completing a Doctorate in Education assessing the levels of self-efficacy (e.g. confidence in their ability) and anxiety (e.g. apprehension or fear) in adults (19+) in mathematics and examinations, and whether there is a link between those levels and exam results. I would be very grateful if you would participate in this study. The study could help students and maths educators both here in the UK and, potentially, in other parts of the world. I would like to interview you to follow up on your responses to the questionnaire. This should take about 20 to 30 minutes of your time, and will be in a Zoom meeting online, so we do not need to meet face to face. If you agree, please email me with a suitable day and time, and I will respond with a link for our meeting. I would like to record the interview so that I can transcribe it later but, if you prefer, I can make notes instead. The recordings or notes that I take during the interview will only be seen by me, and any member of SHU involved in assessing the project. Any paper copies will be kept in a locked container, separately from the key which identifies individuals, and the consent forms. The key will be destroyed three years after completion of the thesis, at the latest by December 2028. Information on the project, online questionnaires and transcriptions of recordings will be stored on a secure research drive in the Sheffield Hallam University computer system. You can change your mind at any point during the

interview, refuse to answer any question without giving a reason, or withdraw from this study at any time up until two weeks (14 days) after you complete the interview. You can withdraw from the exam results comparison up to 7 days after the results are published. If you do choose to participate, I may use your anonymised results and comments in the thesis, in other writing, such as reports, books, presentations and papers, and present the research findings at conferences, teacher-training sessions, and the like. Your anonymity will be protected as I will not use your name, but refer to participants in groups, e.g., by gender, or age, or by using a letter, e.g., Learner A. There will be no consequences to your future treatment by me, the researcher, or by your teacher, whether you decide to participate or not. There is evidence from other countries that participation in this type of survey prior to exams can be beneficial to students. However, if you are negatively affected in any way, please speak to me as soon as possible, or your maths teacher, or contact Student Support at your college. Staff are willing to help any student who is concerned, whether or not it arises from the survey. Further help is available from the Maths Anxiety Trust website at www.mathsanxietytrust.com This research project is not designed for anyone diagnosed with anxiety as a medical issue. Please note that the last question on the consent form asks if you will allow your data to be used by other researchers once it has been anonymised. You can participate in this study without giving permission for data access to other researchers. Please retain this information sheet for your records. If you have any questions or issues with this study please contact me in the first instance. If you wish to discuss any queries or concerns further please contact the project supervisors, Dr Iain Garner (i.garner@shu.ac.uk) or Dr Peter Rowlett (p.rowlett@shu.ac.uk) at Sheffield Hallam University. There are more contacts at SHU below.

Thank you for taking the time to read this far,

Jennifer M. Stacey Doctoral Student, SHU a0025098@my.shu.ac.uk

You should contact the Data Protection Officer if: • you have a query about how your data is used by the University • you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) • you would like to complain about how the University has used your personal data DPO@shu.ac.uk You should contact the Head of Research Ethics (Professor Ann Macaskill) if: • you have concerns with how the research was undertaken or how you were treated

a.macaskill@shu.ac.uk Postal address: Sheffield Hallam University, Howard Street, Sheffield S1 1WB

8.6 INTERVIEW SCHEDULE

Interview Schedule- Jennifer M Stacey Adults studying GCSE mathematics in Further Education: Self-efficacy, anxiety and examination performance. 06/04/2021 Final version

Introduction Estimated time for completion is 25 to 30 minutes. Interview schedule 1. Opening remarks: Thank you very much for agreeing to talk to me today. My name is Jenny Stacey, and I am doing an investigation into how adults, who are 19 years or older, feel about GCSE mathematics classes, courses and examinations. This is for a Doctorate in Education, and the information I collect will be used in my thesis, in academic papers, and for presentations for fellow researchers and teachers in mathematics and further education. I will be linking your questionnaire responses and the interview today. You will remain anonymous; you have already been given a reference to conceal your identity, and I will use this reference. I will also hide your identity by generalising your age, for instance rather than saying "X, who is 35", I will say "X, who is in their 30s", or similar. The recording will be stored on the university's secure drives for confidential data, along with the questionnaires. I expect this will take about 30 minutes, if that is okay? May I record this session, so that I can transcribe it later? (Turn on recording device) [If no or prefer not, say "No problem, I will make notes as we go along then, if that is okay with you?"] Can I just check that you have seen the information letter, and have filled in the consent form? Perfect! [If no, complete now, before starting] You have a 14-day cooling off period after we finish today, which means that you can withdraw without giving me any reason. Can I check that you have my email address? Please drop me an email if you change your mind. You can also stop the interview at any point or choose not to answer any question. Do you have any questions at this stage?

2. General information: Can I ask about your motivation for the GCSE Maths course? Did you have any concerns about the maths course when you signed up for it- if so, what were they? Are you doing any other courses? If so, what are they? What exams, if any, are you taking this year in addition to GCSE maths? How did you feel about exams when you were at school?

3. Course Content: Open question: Can you talk me through how you have found the course content so far? Are you enjoying it? Closed question: On the questionnaire you mentioned …- can you say why you put that? [Prompt questions: What topic do you feel most confident about? What topic do you feel least confident about? Are there any topics that make you feel anxious or worried?}

4. Classroom dynamics: Open question: Next I would like to ask you about the classroom- has your course been face to face this year, or online, or a mix of both? Can you talk me through how you have found it so far? Closed question: On your questionnaire you mentioned …- can you give me a bit more detail? [Prompt questions: How confident do you feel in class? Are you enjoying it?]

5. Assessment: Open question: Finally, let us talk about assessment, quizzes, tests and exams. How do these make you feel? Why do you think exams etc make you feel this way? Closed: Do you attend on days when you know there is a test in class? I noticed that you said… on the questionnaire- could you tell me a bit more about that? [Prompt: how confident do you feel about your ability to pass the GCSE maths exam? What makes you say that? Where do you think that confidence/lack of confidence comes from? How do you feel in exams generally? Is this any different for maths, compared to other subject exams you may have taken in the past? Why do you think that is? What grade are you hoping to achieve? How confident are you that you will achieve this? Why do you say that?]

6. Closing remarks: That is all from my point of view. Is there anything else you would like to add? Thank you so much for your time, I really appreciate it! Please feel free to email me if you have any comments or concerns about what we have discussed today. Best of luck with your studies and thank you again.

8.7 PUBLICATIONS THAT INFORMED THE QUESTIONNAIRE CONTENT

This appendix contains a summary of initial publications that were reviewed to develop the literature review and subsequently the questionnaire.

The first table below shows publications that discussed various aspects that could impact on adults returning to education after a break, including past experiences and parental pressure, but was also of interest because of the number of them that identified gender as a factor that could have a bearing on anxiety in mathematics. Comparatively fewer mentioned age as a factor, and it is only more recent publications that consider the potential implications of the ethnicity of participants.

Publication / Themes	(Buxton , 1981)	(Skemp , 1987)	(Tobias , 1993)	(Davidson & Levitov, 2000)	(Evans J. , 2000)	(Bernard , 2016)	(Boaler , 2016)
Gender	Y	Y	Y	Y	Y	Y	Y
Age					Y		Y
Ethnicity						Y	Y
Symptoms of maths anxiety		Y		Y	Y		
Past experiences	Y	Y	Y	Y	Y	Y	
Parental pressure	Y		Y			Y	Y
Ability grouping	Y						Y
Innate ability	Y	Y	Y				Y

Subsequently, I looked at these publications for course content. As can be seen in the table below, in contrast with the self-efficacy and anxiety scales, four out of seven of these publications recognised that learners could experience difficulties with word problems, although not as many as those who mentioned the potential for anxiety caused by algebra problems, and fractions, decimals, and percentages, which appeared in five out of the seven publications.

Publication/ Course Content	(Buxton , 1981)	(Skemp , 1987)	(Tobias , 1993)	(Davidson & Levitov, 2000)	(Evans J. , 2000)	(Bernard , 2016)	(Boaler , 2016)

1)Number calculations		Y	Y		Y		Y
2)Times tables	Y						
3)Negative numbers			Y				
4)Division	Y	Y			Y		Y
5)Place value		Y			Y		Y
6)Word problems	Y	Y	Y				Y
7)Algebra problems	Y	Y	Y		Y		Y
8)Fraction, decimal, %		Y	Y	Y	Y		Y
9)Geometry & spatial	Y		Y		Y		Y
10)Maths language			Y		Y	Y	Y

I then reviewed the same publications for content that involved classroom dynamics. In this instance peer to peer relationships featured less than teacher pupil relationships, even though some advocated collaborative working in class:

Publication/ Classroom dynamics	(Buxton, 1981)	(Skemp, 1987)	(Tobias, 1993)	(Davidson & Levitov, 2000)	(Evans J. , 2000)	(Bernard, 2016)	(Boaler, 2016)
1)Teacher/student relationship	Y	Y	Y			Y	
2)Class discussion			Y				Y
3)Peer relationships		Y					
4)Collaborative working	Y	Y					Y
5)Environment							
6)Listening to teacher					Y		
7)Use of manipulatives		Y				Y	

8)Ask a question in class					Y		
9)Waiting for class to start					Y		
10)Pre-prep for class				Y		Y	

Finally, I examined these publications for assessment issues:

Publication/ Performance anxiety	(Buxton, 1981)	(Skemp, 1987)	(Tobias, 1993)	(Davidson & Levitov, 2000)	(Evans J. , 2000)	(Bernard, 2016)	(Boaler, 2016)
1)Maths exams		Y		Y	Y		
2)Other exams					(Y)		
3)Maths tests				Y	Y		
4)Maths homework						Y	Y
5)Maths quizzes				Y	Y		
6)Answer a question in class	Y	Y			Y		
7)Working on the board				Y		Y	
8)Get the right answer	Y	Y	Y	Y		Y	Y
9)Time pressure	Y	Y	Y	Y		Y	Y
10)Be watched while you answer a question					Y		