Exploring changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school

Charlotte Hosking

Supervised by: Dr Jane Waters-Davies and

Professor Anne Watson

Submitted in partial fulfilment for the award of the degree of PhD

University of Wales Trinity Saint David

2022

Acknowledgements

I would like to thank all of those who have been so patient in encouraging me to complete this thesis. In particular my thanks go to the study school for allowing me to conduct this research, especially the now retired head teacher, the pupils for consenting and embracing all the different aspects of the study and the Mathematics Department for their friendship and support; my supervisors Dr Jane Waters-Davies whose constant encouragement and support has been invaluable and Professor Anne Watson who had the difficult task of becoming my supervisor midway through, but whose input, experience, support and time has been crucial to the completion of this thesis; and to my family who have put up with me trying to juggle being a wife and mother with completing this degree. I hope you think it was worth it.

Finally, I would like to thank Dr Howard Tanner for without him, I would never have embarked on this journey.

Thank you.

DECLARATION SHEET

This sheet MUST be signed and included within the thesis

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .... (student)

Date 30/03/22 ....

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used the extent and nature of the correction is clearly marked in a footnote(s). Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed .... (student)

Date 30/03/22 ....

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for deposit in the University's digital repository.

Signed .... (student)

Date 30/03/22 ....

Contents

Contents of figures

Contents of tables

Contents of histograms

Contents of bar charts

Abstract

The UK is not alone in facing a mathematics crisis with falling levels of functional mathematics skills, reduced attainment and declining numbers choosing to study mathematics post-sixteen. Mathematics often generates negative emotions and motivation should be improved to increase engagement, attainment, and post-sixteen participation. This study aims to explore the changes, and identify the factors, which impact the motivation and attitudes of pupils towards mathematics, as they move up through one study secondary school in an area where there is secondary selection.

A mixed methods pragmatic design allowed for the use of qualitative and quantitative methods to explore the research aims. 123 year 6 and 141 year 9 pupils completed a questionnaire in the summer term and participated in focus groups involving open questions and cartoon pictures. The research was repeated the following year after key transition points, at the end of year 7 and 10, respectively. Throughout the academic year regular interviews were held with mathematics staff to give a varied perspective on the reasons behind any motivation or attitude changes.

To synthesise the range of data, factors with different dimensions: personal, system and general, were collated and discussed along with the interaction between them. The implications for understanding mindset are also discussed. Staff views illuminate an unintentional, but not unknown tension between knowing ways in which the pupil experience could be improved, and the constraints staff feel are preventing them from enacting these changes.

This research gives a complex and deep insight into the range of factors such as mathematics anxiety, grouping by prior attainment and pupil experiences, which contribute to the decline in motivation and attitude witnessed in the study school. These factors have been presented in a pupil model which allows us to understand the complex experience of the learner and the complexity and interrelationship of the factors.

As a teacher researcher, I have provided a voice for the constraints on staff in the department and a voice for the pupils, illuminating how the staff lack agency and autonomy, apparent victims of a system. This study identifies levers for pupils, staff and policy makers, that may be pulled into play to empower the department to implement the changes to their pedagogy which they themselves identified would help to stave off the witnessed decline in motivation and attitude towards mathematics.

Chapter 1 Introduction

1.1 “We’re never going to win now”

> *I am in my first year of teaching and have just pulled up to a local engineering company who are running a competition for the higher attaining mathematicians in local schools. Our journey has been exuberant with lots of chatter and laughter as the feeling of excitement builds among the pupils. We join several coaches in the car park and get ready to disembark when I hear a pupil say, “well we’re never going to win now”. Looking out of the window I see the distinctive uniform of a neighbouring grammar school and as I feel the atmosphere on our coach deflate, I make a wish that I do not care who wins, as long as it was not that school. I do not want the highest attaining pupils in our school to be right: that the neighbouring school wins because they are a grammar school, that our pupils are not good enough, that the self-efficacy of our highest attaining pupils is so fragile that the sight of pupils from a grammar school deflates them and makes them feel like they have failed, before they have even begun.*

This introduction provides contextual information about the research project and outlines the purpose and significance of the topic and how it relates to previous research. It explains how the research seeks to enhance our understanding of the pupil perspective behind the changes in motivation and attitude that we see in our mathematics classroom as pupils move up through secondary school. Issues affecting motivation and attitude are discussed briefly, as well as why these are important. The structure of the thesis is also described.

This research consists of qualitative data in the form of pupil focus groups and qualitative and quantitative data from pupil questionnaires, collected over two academic years from pupils in year 6 into year 7 and year 9 into year 10. A series of interviews with staff throughout the academic year adds depth to the data. The aim of this research is to explore the changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school. Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of ‘case study’ (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to ‘study school’ to clarify that my research and results are bounded by the single site of my study. This approach was used to explore, firstly, what motivation and attitudes were demonstrated by the pupils towards mathematics and secondly, what influences the motivation and attitudes in the study school.

Throughout this thesis, for consistency I have opted to use the word mathematics, unless maths is used in a quotation, or it is more appropriate e.g., when discussing pupil views. I have chosen to discuss data as a singular item so throughout the thesis I will refer to 'data is' as opposed to 'data are'. I would like to have used the words prior attainment to describe pupils and sets because it reflects what pupils have achieved in the past in what we, as teachers have chosen to measure, whereas the use of the word 'ability' implies a pre-existing, innate and fixed trait. However, I have felt obliged to use the word ability in the following cases –

- throughout the literature review if that is the term used by the authors
- if ability was used in a quotation
- if ability was used by a pupil or staff member and I am describing their thoughts
- when ability is the appropriate word to use i.e., to describe a pre-existing, fixed trait.

1.2 Motivation and attitude

There are many theories of motivation and attitude which are discussed in further detail in Chapter 2 of this thesis, however this section summarises some of the key definitions of these constructs and concludes with the thesis definition of motivation and attitude.

Motivation is used in every day speech to explain the reasons why somebody behaves in a certain way or the reasons behind the drive to accomplish something (Oxford English Dictionary, 2020), whilst the study of motivation is concerned with what causes people to think and act in the way that they do (Graham & Weiner, 1996). In an educational setting, motivation helps to explain why some pupils persevere with a task despite experiencing difficulties, whilst others give up very easily, as well as why some pupils set themselves unrealistically high targets (Graham & Weiner, 1996).

1.2.1 Competency and expectancy

Competency and expectancy theories include self-efficacy theory which is the belief that someone has in their ability to solve a problem by organising and executing a suitable course of action (Bandura, 1997). Individuals can have varying levels of self-efficacy with some believing they will only succeed on simpler tasks (Bandura, 1997). Control theory suggests that individuals should expect to succeed to the degree that they feel in control of their success or failure with children feeling more competent if they believe they can control their achievement outcomes (Connell & Wellborn, 1991).

1.2.2 Engagement

Engagement theories cover theories such as self-determination theory, flow theory, interest theory and goal theory. Self-determination theory describes how humans seek out activities which are challenging and provide an optimal level of stimulation which they find intrinsically motivating (Deci, 1975). Flow theory describes a feeling of being immersed in an activity without any self-consciousness (Csikszentmihalyi, 1988), but is only possible if there is a match between challenge and skill level (Massimini & Carli, 1988). Interest theory consists of individual interest which describes relatively stable feelings towards a subject and situational interest which is a temporary interest in a task (Hidi & Harackiewicz, 2001). Goal theory describes the variety of goals; either academic or social, which pupils want to achieve in class.

1.2.3 Integrating expectancy and value

Attribution theory explains that how achievement outcomes are interpreted determines an individual's subsequent achievement aims (Weiner, 1985), i.e., this covers the explanations that pupils give to explain their achievements. Modern expectancy-value theory explains the effort, choice and achievement of pupils in academic and non-academic areas (Guo, et al., 2015). Self-worth theory is discussed because in an academic sense it explains why pupils avoid failure to protect their feeling of self-worth (Covington, 1992).

As a result of detailed reading of these and other theories, and to integrate the ideas above, the term motivation in this thesis is used to explain the reasons behind the level of effort that a pupil puts into learning mathematics.

1.2.4 Attitude

Attitude is used colloquially to describe how we think, feel, or behave towards something (Dictionary, 2020b), whilst attitude towards mathematics remains a construct which is used without a proper definition (Hannula, 2002). There are two different models of attitude discussed: the tripartite model and the functional model. The tripartite model of attitude involves three components: cognition, affect and behaviour but this model should be used with caution as it relies on consistency between the three parts and people often do not react in a way that they themselves think that they should (Pennington, et al., 2016). The functional model of attitude addresses why people have attitudes and what psychological function they serve so that we can generalise human behaviour (Katz, 1967).

From reading literature around attitude, in this thesis I understand attitude to be the relatively stable (stable across a period of time, rather than fluctuating daily like emotions) thoughts and feelings that pupils have towards mathematics and the reasons behind them.

1.3 Why are motivation and attitude important?

The UK is among many countries in the world facing a mathematics crisis as the number of adults with functional mathematics skills decreases (National Numeracy, 2014). Although it is widely agreed that mathematics is an important subject it is also one that generates many negative emotions (Martino & Zan, 2011) as policy makers try to improve attainment and increase post sixteen participation (Noyes, 2013). There needs to be more young people entering into STEM (science, technology, engineering and mathematics) subjects (Roberts, 2002) but research has shown that curriculum changes do not have a big impact in mathematics (Galton & Hargreaves, 2002).

This research addresses reports that have identified declines in the attitude of pupils towards mathematics as they transfer to secondary school (Middleton & Spanias, 1999) and many studies which have seen mathematics described as boring and disinteresting by pupils (Lewis, 2013; Nardi & Steward, 2003; Vogel-Walcutt, et al., 2012). Trends in International Mathematics and Science Studies (TIMSS) has documented a consistent decline in the attitude and confidence of students as they get older (Lewis, 2013) with other reports raising concerns about the large number of secondary pupils becoming disengaged and disaffected in the classroom (Smith, et al., 2005).

Motivation and attitude towards mathematics are therefore significant issues in mathematics classrooms and have an impact on the engagement in classrooms, post sixteen participation, attainment, and enjoyment of pupils. Motivation is a prerequisite for learning and helps to predict achievement, determination to learn as well as school dropout rates (Stroet, et al., 2016). There is a need to continue to investigate the reasons behind the changes in pupil motivation and attitude towards mathematics as pupils move through secondary school to contribute towards the quest to find a solution for the mathematics crisis in the UK and further afield.

1.4 Context of the study

1.4.1 Location

This research was conducted in a single-site secondary school. The school is located on the edge of a small market town, known for its independent shops, bohemian spirit, and a local culture which is underpinned with environmentally sustainable activities. In 2014, when the research was carried out, the population of the town and district was estimated to be around 115,000. Data from the 2011 UK Census showed that around 32,500 people lived in the town itself and ethnically, the population was predominantly white British. The Census showed that 6,120 residents were born outside the UK (5.4% of the population which is lower than 7.7% for the county and 13.4% nationally) and of these 1,740 (28%) were migrants who had arrived since 2004.

When the research was carried out around a third of the district was ranked within the 20% least deprived areas in England and there were no areas ranked within the top 20% most deprived in England. The manufacturing sector accounted for over a fifth of employees in 2014 and the district had nearly 5,800 businesses which accounted for over a fifth of the county total. The workforce in the district was highly skilled and the number of people claiming Job Seekers Allowance was at its lowest for around thirty years, however the town itself had a relatively high level of unemployment for the area.

According to the 2011 Census most houses in the town were owned by the occupier which is higher than the county, regional and national average, however the mean house price, although in line with the county average was lower than the national average. In 2013 around 10% of households in the town were in fuel poverty and crime rates in the town were considerably higher than regional and national rates.

1.4.2 Education

There are six primary schools in the town and another seven in the surrounding area. There are no middle schools so after primary school pupils go straight to one of the three secondary schools in the town. One of these is a County Council maintained comprehensive school and two are selective school academies. There are two other comprehensive schools in the local area and one private school.

Post sixteen education is provided in the three secondary schools as they all have sixth forms and there is a local sixth form college. Further afield there are two universities in the area as well as another sixth form college.

In the town the proportion of children who achieved a good level of development at the Early Years Foundation Stage was lower than the national average, with referrals and initial assessments for Child Protection being the third highest in the county for children in the town but the number of children who had a Child Protection plan was the second lowest in the county. The town had the third-lowest rate of Children in Care in the area. The number of children in the town with special educational needs was broadly in line with the county average and the most common category of need was Behavioural, Emotional and Social Difficulties which differs from the most common county reason of Speech, Language and Communication Needs.

The number of sixteen- to eighteen-year-olds Not in Education, Employment or Training (NEET) in the district had declined from a high in 2011 of almost 150 to 26 people in 2015. In 2011 around a third of residents in the district aged sixteen and over had Level 4 qualifications and above, which is well above the national (27%) and county (30%) averages. 18% of the over-sixteen population had no qualifications.

1.4.3 Study school

The study school is a larger than average comprehensive, co-educational school for pupils aged between eleven and eighteen. The school is set on the edge of the town and has playing fields and other sports facilities such as cricket nets, rugby and football pitches, a full-sized running track, tennis courts and a hockey Redgra. There is also a heated indoor swimming pool and a sports centre which has a dance room, gym, and sprung-floor hall. The school boasts excellent sports facilities and has some famous ex-pupils who are sports people as well as one who is a famous musician.

Pupils join the school at age eleven from over twenty different primary schools. From the 2013 Ofsted report the school has a below average proportion of pupils who are pupil premium, disabled or have special educational needs as well as a smaller number of students who speak English as an additional language or are from minority ethnic groups than the national figures. However, the 2019 Ofsted report found that the proportion of pupils who had special educational needs and/or disabilities was above average. The number of pupils who were supported by an education, health and care plan was average and the proportion of pupils who were supported by pupil premium funding was below average. Although the 2013 report is the most relevant for the time of the empirical data collection the 2019 report provides context for trend changes in the school.

The mathematics department has historically been one of the stronger departments in the study school and the current head of department had been in post for eight years when this research was conducted. Generally, the staff turnover in the department is low, but three members of the department retired together, a member of staff left due to medical reasons and a last minute promotion of a staff member to another school left the department with gaps to fill in the years preceding the research.

At the time of the research Key Stage 3 consisted of years 7, 8 and 9 and Key Stage 4 was years 10 and 11. Pupils were entered for early entry mathematics at the end of year 10 as a way of ‘banking’ a grade in year 10 in case any pupils failed to complete year 11 but also to spread the amount of work for the pupils over two exam sessions so they could concentrate on some subjects at the end of year 10 and the rest (plus any re-takes) at the end of year 11.

The school has capacity for just over 1200 pupils and in the research years had just over 1100 pupils on roll, about 150 of which were in the sixth form. Data from the last three years from now shows that pupils in the school are making ‘below average’ progress at GCSE. The percentage of pupils achieving a grade 5 or more in English and mathematics is ‘below average’ but the percentage achieving a grade 4 or above in English and mathematics is around the national average.

As a teacher in the school for eight years when the research was carried out, I found that despite the best efforts of the staff some pupils felt that the school was not ‘academic’, and it was not seen as ‘cool’ to be good academically. Of course, there were exceptions to this rule and many pupils achieved outstanding results and seemed immune to some of the negative opinions and behaviours around them, but I frequently witnessed pupils who would start school in year 7 saying that mathematics was their favourite subject but by year 11 appeared to endure mathematics as they waited for it to be over once they took their GCSE exam.

1.5 Current literature

Previous research has identified factors that could affect motivation and attitude, and these are summarised in the following section, and considered in depth in Chapter 2.

The mindset pupils develop about mathematics can impact them in different ways, such as when an overemphasis on being naturally good at something can leave pupils vulnerable if they are faced with failure (Dweck, 2007). Mathematics is often viewed as a subject in which you must have natural aptitude and so pupils feel that there is little point in working hard at it because they are never going to achieve. Teachers can believe that mindsets are fixed and cannot be changed, and this belief can influence how they interact and help pupils (Rattan, et al., 2012). Learners who believe they are unable to do well in mathematics can develop negative attitudes towards the subject which may result in avoidance behaviours which perpetuate the cycle (Hurst & Cordes, 2017).

Pupils need to develop mathematical resilience when faced with failure, which is when pupils have a positive approach to mathematics that allows them to overcome any challenges they may face in their learning (Johnston-Wilder & Lee, 2010). Teaching which fosters resilience enables pupils to develop a growth mindset, persistence, and perseverance and to recognise the value of mathematics (Johnston-Wilder & Moreton, 2018). As there can be frequent changes to the curriculum content and a strong emphasis on examinations, pupils need to be resilient to be successful (Yeager & Dweck, 2012).

Key adults in the pupils' lives such as parents and teachers play a large part in influencing their motivation and attitude towards mathematics. Parents can unintentionally establish attitudes in their children, encourage or undermine a child's confidence or encourage them to believe that they cannot change their behaviour to achieve in mathematics (Cockcroft, 1982). Teachers should be caring and supportive to increase enjoyment and motivation (Kyriacou & Goulding, 2005) as well as creating a classroom atmosphere conducive to learning with meaningful and relevant tasks.

Emotional reactions to numbers, including feelings of helplessness and dread (Batchelor, et al., 2017; Zakaria & Nordin, 2008), known as mathematics anxiety, can overshadow mathematical activities not just in the classroom but in everyday activities as well (Batchelor, et al., 2017). Increased levels of mathematics anxiety can result in lower mathematics achievement and reduced participation in non-compulsory courses

(Hembree, 1990). Some triggers of mathematics anxiety are the transition to secondary school and pupil grouping (Carey, et al., 2019) with many pupils placed into prior attainment groups when they start secondary school.

Prior attainment grouping has been shown to have a negative impact on middle and lower attaining pupils with no impact on higher attaining pupils, whereas mixed prior attainment groups have a positive impact on middle and lower attaining pupils and do not have a negative effect on high attaining pupils (Boaler, 2013). However other research has shown that prior attainment grouping does not have an effect on any prior attainment level (Slavin, 1990; Francis, et al., 2016) or whilst higher attaining pupils may make small achievement gains, there is a negative impact on lower attaining pupils (Taylor, et al., 2017). How schools manage sets can compound these effects with more effective teachers being given high sets (Black & Wiliam, 1998).

As previously mentioned, the study school is in a grammar school area and selective schools are believed to set pupils on a trajectory of higher academic achievement, greater places at university and higher potential earnings (Smith-Woolley, et al., 2018). The feelings of ‘rejection’ for not getting into a grammar school can stay with pupils for life; for example, pupils who feel that they have been placed in a school with a poor reputation can experience low self-esteem and a decreased perception of their capabilities (Gamoren & Berends, 1987; Oakes, 1985; Ahmavaara & Houston, 2007). Research by Jesson (2006) showed that lower attaining pupils achieve better in true comprehensive schools rather than non-selective schools in a selective area (Ahmavaara & Houston, 2007).

Throughout secondary school the pupils go through the period of transition between childhood and adulthood known as adolescence, and early adolescence can be the start of a downward spiral which results in academic failure and school dropout (Eccles, et al., 1993). The transition from primary to secondary school creates many challenges for adolescents such as the increased expectations of schoolwork, a variety of teachers, large school environment and interactions with a new peer group (Coleman, 2011).

This introductory section has briefly covered some of the factors which can impact the motivation and attitude of pupils towards mathematics. This chapter has also introduced the mathematics crisis in the UK and elsewhere, where there is a decline in the number of pupils choosing to study mathematics, an accepted view in society that mathematics is a hard, boring, and sometimes irrelevant subject, and that some people are not born with the capability to succeed.

Previous research has identified the many factors affecting the motivation and attitude of pupils and this study seeks to extend the previous work in this field to establish what these factors are, how they interact with each other and to what extent they have an impact on pupils in the study school, in order to suggest ways to improve the enjoyment, achievement and selection of mathematics.

Therefore, the aims of this thesis are as set out below.

1.6 Aim and research questions:

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

1.7 Methods

The research questions are investigated through a questionnaire to all consenting pupils in years 6 and 9 in the study school, with the purpose of investigating the motivation and attitude of the pupils and the factors which contribute to them. Pupils also take part in focus group discussions to elicit details about the pupils' feelings towards mathematics and these include cartoon images to spark discussion amongst the pupils. The thoughts, feelings, and attitudes towards mathematics from male and female pupils of all abilities are investigated and their perceptions about mathematics, learning mathematics, the value of mathematics and possible improvements to mathematics lessons are explored.

This whole process was repeated with the same pupils at the end of years 7 and 10 as both sets of pupils have experienced a key transition point in their education. Questionnaires and focus group discussions are repeated so that any differences in attitude and motivation can be tracked. Another perspective is gained by interviewing staff in the mathematics department throughout the academic year about the motivation and attitudes of their pupils, which allowed for teachers' and support staff's perception of their pupils' engagement, motivation, and attitude, as well as reasons behind these to be examined.

The qualitative and quantitative data are analysed to identify key factors which contribute to the deterioration in motivation and attitude witnessed in the study school, as pupils go through secondary school. The findings from the study, although pertinent to the study school, contribute to a deeper understanding of the reasons behind the visual decline in enjoyment seen in many secondary school mathematics lessons. This study offers insight into the support and tools which may assist the implementation of changes to reduce this decline.

1.8 Structure of the thesis

This introductory chapter has outlined the background to the research and the main aims of the study. The following section details the structure of the remainder of the thesis.

Chapter 2 sets the scene for the reader and identifies why it is important to research the motivation and attitude of pupils. The chapter continues with a review of relevant literature on motivation and attitude. Motivational theories and two attitude models are discussed before a thesis definition of both constructs is explained.

The remainder of the chapter details the variety of factors which have been previously found to impact upon the motivation and attitude of pupils in mathematics. This section has been organised under three headings: *Personal factors, System factors* and *General factors.*

Chapter 3 explains and justifies the methods used for conducting the study and how the data is analysed. The research design is outlined including the use of a single-site study school and a reflexivity section. An explanation of the research tools includes a description of the focus group discussions, the instruments used for data collection and the methods used for analysing the data.

Chapter 4 reports the results of the qualitative data, which includes questionnaire data (qualitative questions only), focus group discussions, cartoon discussions and staff interviews. The findings are synthesised and reported in themes:

- expressions of greater negative feelings in year 10
- the importance of primary schools
- achievement breeds success
- effects of disruptive pupils
- the importance of stability of teachers
- students' experiences of mathematics lessons and suggestions for improvements
- changes in pupil mindsets
- the perceived relevance of mathematics.

Each theme is split into student view and staff view where appropriate.

Chapter 5 reports the quantitative data and details how the data was analysed, the creation of an attitude scale and investigation of normality. The quantitative data from the questionnaire is reported under questions such as *'Is there a relationship between year group and pre and post attitude values?'* as well as individual questions from the questionnaire where appropriate.

Chapter 6 discusses the findings from the research in the light of the literature and the school context and generates both my responses to the research questions and my conclusions. The insights from the qualitative and quantitative data are amalgamated under the headings of *Personal, System* and *General factors*. Conclusions are drawn from the findings, which are summarised in a pupil centred target diagram, a teacher centred target diagram and a Venn diagram illustrating who has the ability to make changes to improve the pupil's experience. To synthesise the findings further the fictitious learning experience of pupil P is described.

A summary of the findings and the research contributions of the study are discussed in Chapter 7, the final chapter, followed by the implications arising from the findings for practice and my own pedagogy and the limitations of the study. The chapter concludes by making suggestions for further research in this field as well as monitoring of my pedagogical changes.

Chapter 2 Literature review

2.1 Setting the scene

Wherever possible I have tried to refer to UK research but at times I have used research from the USA. In these sections I have referred to the US system of grades which can be converted to a UK year system by noting year is grade plus 1 so grade 6 in the USA is year 7 in the UK, grade 9 is year 10 etc.

According to a report in 2014, the UK is facing a crisis in mathematics where the number of adults with a functional mathematics skill equivalent to a GCSE grade C has fallen from 26% in 2003 to 22% in 2011, compared to 57% having the equivalent functional literacy skills (National Numeracy, 2014). Many employers have reported concern that their employees struggle to check their numbers are sensible, resulting in higher costs to them (National Numeracy, 2014). As the socio-economic background of a child influences their achievement in mathematics by around 10-20% (National Numeracy, 2014), and less numerate people have been shown to earn less, this lack of numeracy could be contributing to a cycle of poverty (Carey, et al., 2019).

Mathematics is deemed an important subject in curricula all over the world and there is much interest in trying to improve attainment and increase participation when it is no longer compulsory (Noyes, 2013). However, many teachers are very aware that of all the subjects studied at school, mathematics is the one that can generate the most negative emotions (Martino & Zan, 2011), which can become established and block thinking processes or create an attitude of refusal from pupils (Buxton, 1981). There is a negative feeling towards mathematics in society that makes pupils feel like they "would rather die" (Brown, et al., 2008, p. 10) than study A-level mathematics, despite Wolf (2002) finding that people who take A-level mathematics earn around ten percent more than those who do not (Wolf, 2002).

There should be more young people entering into STEM (science, technology, engineering and mathematics) once leaving compulsory education (Roberts, 2002) because as soon as pupils choose their subjects, usually after secondary school, many choose not to follow STEM subjects (Hurst & Cordes, 2017). The most significant indicator for why people do not complete A-level mathematics is prior attainment, as if pupils do better in mathematics compared to their other subjects, they are more likely to study it to A-level (Noyes, 2013).

Gender also has a significant impact, with girls with similar past attainment being less likely to take A-level mathematics than boys, however social class and ethnicity have a much larger effect on GCSE performance than gender (Connolly, 2006). Despite this, Noyes (2013) found that once all other factors have been removed, pupils from more deprived backgrounds are more likely to study a form of mathematics than those from more affluent backgrounds (Noyes, 2013).

Research has shown that big changes in the mathematics curriculum do not have a big impact over time (Galton & Hargreaves, 2002) and even countries where pupils traditionally do significantly better in international tests than the UK are concerned that their pupils may not enjoy the subject (Askew, et al., 2010).

How a pupil views their mathematics capability and whether they like mathematics or not may have an impact on how well they achieve in mathematics (Askew, et al., 2010). Leung (2002) found that pupils who are over-confident may have less of an incentive to learn anything more and mean that they put little effort into studying mathematics, therefore lowering their result (Leung, 2002).

In 1999, Middleton and Spanias highlighted the decline in pupils' attitude towards mathematics in the USA when they transferred to secondary school (Middleton & Spanias, 1999) and many more recent studies have shown that a pupils' most common experience of a mathematics classroom is that it is boring and disinteresting (Lewis, 2013; Nardi & Steward, 2003; Vogel-Walcutt, et al., 2012). This may be down to the nature of mathematics which pupils view to be too abstract, unrealistic, symbolic and of no interest to them (Kislenko, 2009), but it could also be due to pupils' commitment to the subject and the nature of mathematics classrooms (Martinez-Sierra & Gonzalez, 2014). Having analysed sixty videos from six classes in the USA, Hong Kong and Germany, Jablonka (2013) found that some pupils in all of the videos lie across desks, have their eyes half closed, let their minds drift off and fiddle with their pens or the desk as an expression of boredom (Jablonka, 2013).

Trends in International Mathematics and Science Studies (TIMSS) has documented a consistent decline in the attitude and confidence of students from grades 4 to 8 (years 5-9) (Lewis, 2013). Smith et al (2005) raised concern about the substantial number of pupils becoming disengaged and disaffected in their review of what pupils aged 11-16 believe impacts their motivation to learn in the classroom (Smith, et al., 2005). A report in 2008 showed that in Britain 40% of 11 year olds felt pressure from schoolwork, 50% at age 13 and 60% of boys at age 15 and 70% for girls (Currie, et al., 2008). This is also reflected in a UNICEF report (2007) which found that children and young people in Britain had poorer emotional health than those in Europe (Coleman, 2011).

The attitudes of pupils towards school usually change once they have started secondary school with pupils generally showing less positive attitudes to school as they grow older (Coleman, 2011). Studies have shown that in most developed countries, attitudes towards school decline, with the sharpest decline after the first term in secondary school (Galton, et al., 2002). An HSBC study carried out in 2008 found that only a quarter of 15 year olds reported high levels of satisfaction with their school experience (Currie, et al., 2008) and other studies found a consistent subject specific marked decline in attitudes towards mathematics (Coleman, 2011).

Interest in investigating pupils' attitudes towards mathematics is important because of their significance in influencing aspirations and career decisions and, as emotions are a significant part of attitudes, it is vital to study how they change throughout the pupils' school life (Hernandez-Martinez & Pampaka, 2017). There has also been a focus on improving motivation in mathematics to improve standards because if affect in mathematics, and its interaction with cognition and learning can be understood, then it may be possible to improve engagement towards mathematics and therefore overall attainment (Lewis, 2013).

From the literature above, there is clearly an international need to continue to investigate the reasons behind the changes in pupil motivation and attitude towards mathematics as the pupils move through secondary school to improve enjoyment, increase attainment and encourage more pupils to continue with mathematics when it is no longer compulsory. The rest of this chapter details the relevant literature surrounding motivation and attitude towards mathematics as well as other contributing factors such as affect in mathematics education, pupil mindset and the role of adolescence.

My review of the literature started by researching the definition of motivation and investigating the numerous theories of motivation, which in this chapter are split into four sections:

- beliefs about competence and expectancy for success
- reasons for engagement in activities
- expectancy and value constructs
- links between motivational and cognitive processes.

Similar research occurred for attitude and covers two attitude models:

- the tripartite model
- the functional model.

Reading about attitude, I realised that it came under affect in mathematics, which also contains beliefs, values, and emotions, so that is the next section of literature reviewed in this chapter.

The aim of this thesis is to explore the changes in pupil motivation and attitudes towards mathematics as they move up through one secondary school and as one of the research questions is to investigate what influences pupils' attitudes and motivation in mathematics in the study setting, I needed to look into what factors may be affecting the motivation and attitude of the pupils. This section of the chapter covers the following headings, which have been organised into a collection of factors with different dimensions:

Personal factors	**System factors**	**General factors**
Mindset	Prior Attainment Grouping	The Role of Stereotypes in Mathematics
Resilience in Mathematics	Selection	Female Underrepresentation
Mistakes and Mathematics		The Role of Adolescence
The Role of Parents and Teachers		
Students' Experience of Mathematics Lessons		
Mathematics Anxiety		

To help orientate the reader Figure 1 shows a concept map of the literature review and how it is organised under the headings. The arrows are intended to show what headings come under each section header with the double-headed arrow showing that although I have written affect in mathematics under the attitude heading, the literature shows that attitude also forms part of affect in mathematics.

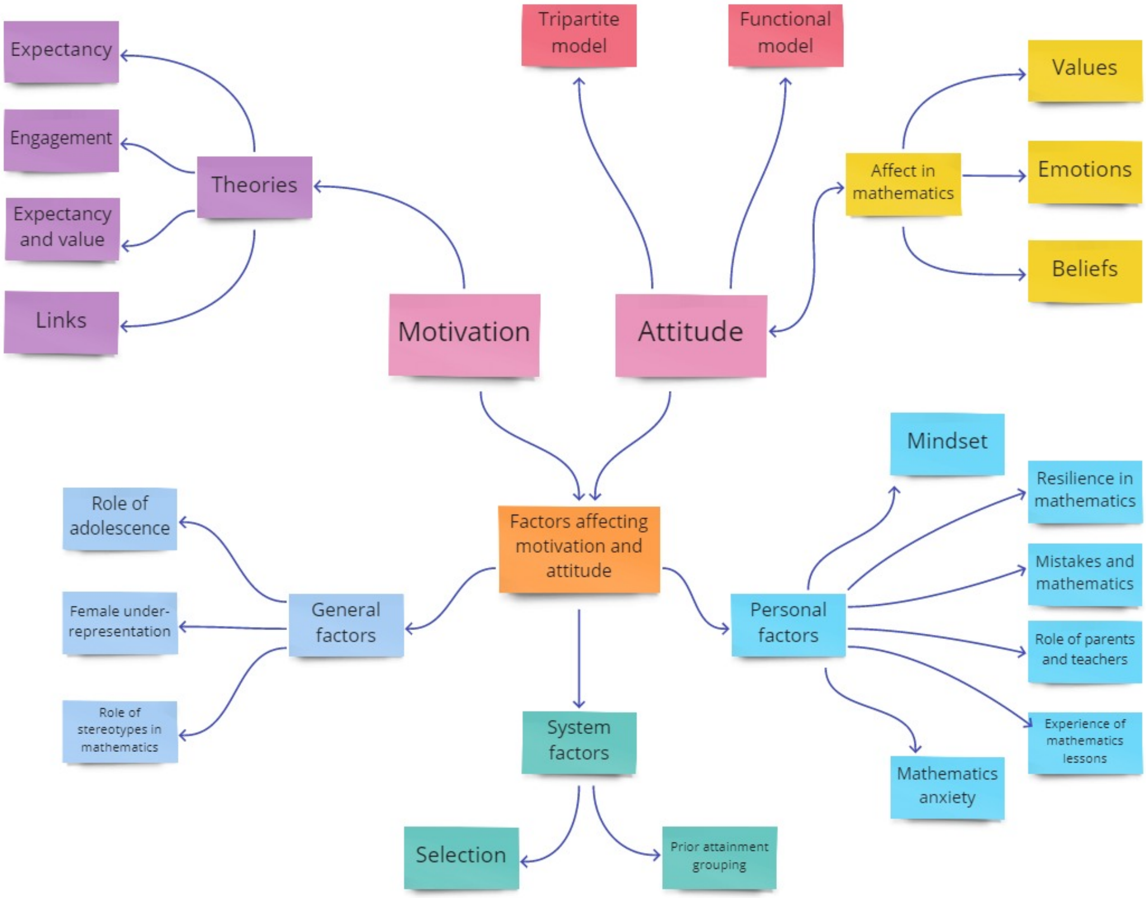


Figure 1 Concept map informed by the literature review

2.2 What is motivation?

The Oxford English Dictionary defines motivation as 'the reason why somebody does something or behaves in a particular way' and 'the feeling of wanting to do something, especially something that involves hard work and effort' (Oxford English Dictionary, 2020).

The study of motivation looks at what causes people to think and act as they do (Graham & Weiner, 1996). Derived from the Latin verb *movere*, meaning to move, motivation is the concept of being moved by something, helping us to keep going and to complete tasks. Thus, in the most basic sense, studying motivation is studying action (Eccles & Wigfield, 2002). In an educational context, motivation would cover why some pupils complete a task despite experiencing huge difficulties, whilst others give up at the slightest hurdle, or why some pupils set themselves such unrealistically high goals that they are almost guaranteed to fail (Graham & Weiner, 1996). Motivation is an important requirement for learning and has been shown to predict school achievement, school dropout rate and determination to learn over time (Stroet, et al., 2016).

The next section details theories related to motivation and is organised into four sections: beliefs about competence and expectancy for success, reasons for engagement in activities, expectancy and value constructs, and links between motivational and cognitive processes. This layout reflects the overview provided by Eccles and Wigfield (2002) as I found their review of research to be a clear and logical synthesis, summarising and comparing the relevant theories and is summarised in Figure 2.

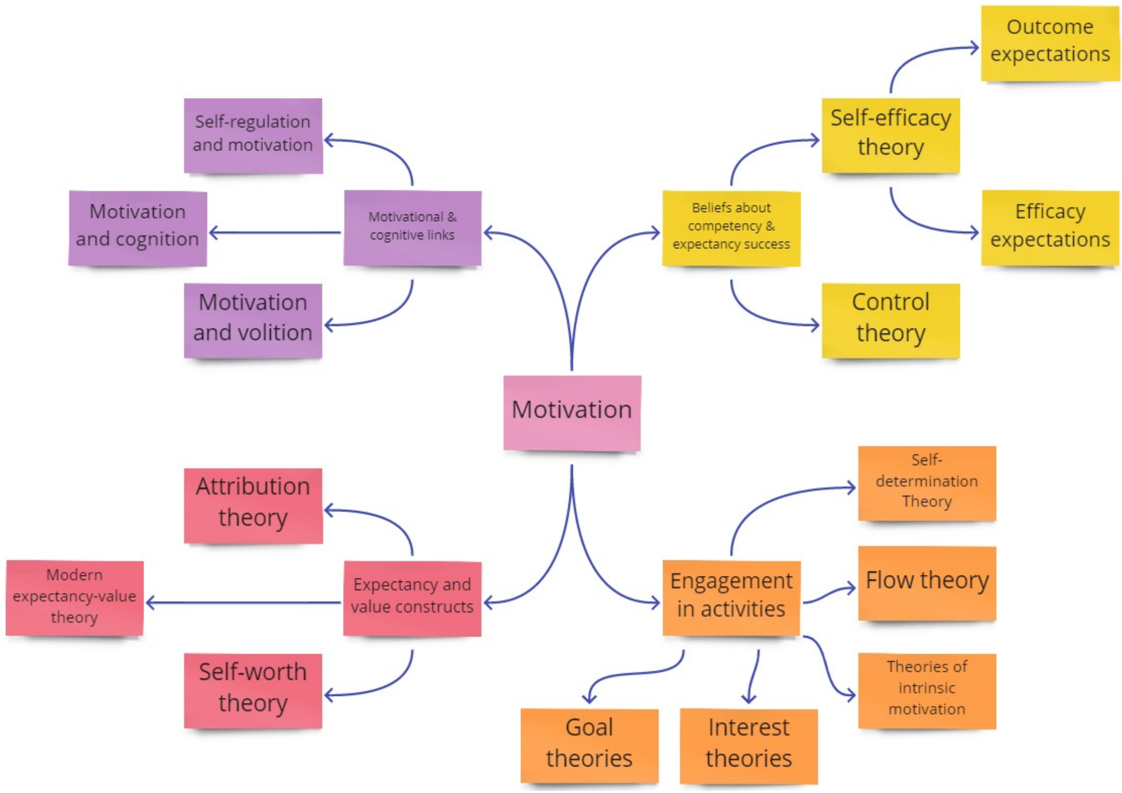


Figure 2 Theories of motivation

2.2.1 Definitions for this section

The following are my understanding of certain motivational terms used in this thesis –

- expectancies - how well an individual believes they will perform in an activity or task (Eccles, et al., 1983)
- values – the incentives behind why we do an activity
- goal – a cognitive image of what is trying to be achieved in a situation (Wentzel, 2000)
- achievement goals – the reasons someone has for pursuing an achievement task (Pintrich, 2000a)
- self-efficacy – judgements of our own capabilities to be able to execute actions to achieve a set goal (Zimmerman, 2000)

- intrinsic motivation – carrying out a task because it is innately interesting or enjoyable (Ryan & Deci, 2000)
- extrinsic motivation – carrying out a task to achieve an external goal such as a reward (Sansone & Harackiewicz, 2000).

2.2.2 Beliefs about competence and expectancy for success

Expectancy focused theories concentrate on what individuals believe about their competence and effectiveness, what they expect in terms of success or failure and how much control they have over these outcomes. These ideas are directly linked to the question ‘can I do this task?’ and generally, those people who answer this positively will perform better and are more likely to choose challenging tasks (Eccles & Wigfield, 2002).

2.2.2.1 Self-efficacy theory

Self-efficacy was described by Bandura (1997) as the confidence that an individual has in their capability to organise and execute a course of action in order to accomplish a task or solve a problem (Bandura, 1997). He proposed a social cognitive model of motivation which focused on the role of the perception of efficacy, which was categorised as a multi-dimensional construct that could vary in strength, generality, and difficulty. An individual can have varying levels of self-efficacy with some believing they are only successful on simpler tasks, whereas others favour more difficult ones (Bandura, 1997).

Bandura’s self-efficacy theory focuses on expectancies for success; however, he makes a distinction between two types of expectancy beliefs: outcome expectations and efficacy expectations. Outcome expectations are associated with beliefs that certain behaviours will lead to certain outcomes, for example practising will improve performance; and efficacy expectations refer to a belief that you can effectively implement the behaviours which are necessary to produce an outcome. These two beliefs differ because an individual may believe that a certain behaviour will produce an outcome but may not believe that they can carry out that behaviour (Bandura, 1997). Importantly, Bandura (1997) suggested that what goals an individual sets, what activities they choose and how much effort and persistence they put in is determined by whether they believe that they can carry out the required behaviour for success (Bandura, 1997).

2.2.2.2 Control theories

Control theories are another type of expectancy-based theory and suggest that we should expect to succeed to the degree that we feel in control of our successes and failures (Eccles & Wigfield, 2002). Connell and Welborn (1991) proposed three basic psychological needs: competence, autonomy and relatedness (Connell & Wellborn, 1991). These three ideas are used by Ryan and Deci to frame their work on Self-determination Theory (Deci & Ryan, 1985) (see section *2.2.3.1*), where they explain the basic psychological needs: autonomy which describes the feeling of choice and being in control, competence which describes feeling effective and feelings of mastery and relatedness which is feeling connected to and cared for by others (Deci & Ryan, 1985)[1]. Connell and Welborn (1991) made a link between competence needs and control beliefs, suggesting that children should feel more competent if they believe that they can control their achievement outcomes and the extent to which these needs are fulfilled are influenced by many factors such as family, peers and school structures (Connell & Wellborn, 1991). The amount to which these needs are met is claimed to determine the level of engagement in an activity; if the needs are fulfilled, the children will be engaged, however if one or more of the needs are unfulfilled, students may become unmotivated and disaffected (Connell, et al., 1994; Skinner & Belmont, 1993).

2.2.3 Reasons for engagement in activities

The previous section detailed theories related to explaining an individual's performance; it did not investigate the reasons why individuals engage with different achievement tasks. The theories in this section focus on why people choose to do a task or not because even if a person believes that they can achieve a task, they may not have a reason to do it (Eccles & Wigfield, 2002). These motivation theories focus on the difference between extrinsic and intrinsic motivation: intrinsic motivation is when an individual engages in an activity because they are interested in it and enjoy it, whereas extrinsic motivation is when individuals engage in an activity for other reasons such as receiving a reward (Sansone & Harackiewicz, 2000).

---

[1] Since this thesis has been written Ryan and Deci have summarised their extensive work on motivation under these three categories, which I will refer to in chapter 6 when I reflect on my findings.

2.2.3.1 Self-determination theory

Self-determination theory was proposed by Deci and Ryan (1985) and is the integration of two perspectives of human motivation (Deci & Ryan, 1985): humans are motivated to sustain an optimum level of stimulation (Hebb, 1955) and humans have a basic need for competence (White, 1959). Consequently they seek out activities which are challenging and provide optimal levels of stimulation, which they therefore find intrinsically motivating (Deci, 1975). This argument is backed up by evidence which shows a reduction in intrinsic motivation when people experience extrinsic pressures and incentives (Cameron & Pierce, 1994; Deci, et al., 1999).

These basic needs can play a role in behaviour which is more extrinsically motivated, for example a student may choose a degree, which they feel will earn them a lot of money, without any external influence or pressure but guided by a basic need for competence and self-determination, even though the reason for the choice of subject was based on extrinsic reasons (Deci & Ryan, 1985). Deci and Ryan (1985) hypothesised that an explanation for the reasons behind people internalising external goals into internal goals may be a basic need for personal fulfilment i.e. when a person is self-determined then their reasons for engaging in an action have been fully internalised (Deci & Ryan, 1985).

2.2.3.2 Flow theory

Behaviour which is intrinsically motivated was described by Csikszentimihalyi (1988) as the immediate experience that occurs when someone is engaged in an activity. Experts in their field such as dancers and composers, describe their experiences of being fully engaged as an emotional state which Csikszentmihalyi named “flow”, characterised as a feeling of being immersed and in control of carrying out an activity without any self-consciousness (Csikszentmihalyi, 1988). It is only possible to achieve flow when a person feels that there is a match between the opportunities for action in a certain situation and their competence to master the challenges. Although the challenge can be a concrete or abstract activity, for flow to occur the challenge and skill must be relatively high (Massimini & Carli, 1988).

Although these theories appear different because Csikszentmihalyi (1988) focuses on the immediate reasons for certain behaviour, whereas Deci and Ryan (1985) focus on the ultimate reasons, it can be argued that they are similar, as intrinsically motivated behaviour can be conducive to an ultimate goal, even if the individual is only motivated by an immediate incentive (Eccles & Wigfield, 2002). Experience of flow can be a reward that ensures an individual tries to improve their capability in order to rise to a challenge (Csikszentmihalyi & Massimini, 1985).

2.2.3.3 Individual difference theories of intrinsic motivation

Researchers have previously not made a distinction between a state of intrinsic motivation and a traitlike characteristic, focusing instead on the conditions, components and consequences of intrinsic motivation (Eccles & Wigfield, 2002). Educational psychologists define a long-term intrinsic motivational orientation as the preference for hard and challenging tasks, a learning that is driven by curiosity and interest and striving for competence and mastery (Gottfried, 1990). Evidence suggests that a high level of traitlike intrinsic motivation assists positive emotional experience (Matsumoto & Sanders, 1988), mastery-oriented coping with failure (regarding failure as an opportunity to learn), high academic achievements (Benware & Deci, 1984) and the use of suitable learning strategies (Pintrich & Schrauben, 1992).

2.2.3.4 Interest theories

Interest theory research can be differentiated into individual and situational interest (Hidi & Harackiewicz, 2001). Individual interest is a fairly stable orientation towards certain domains whereas situational interest is an emotional state, stimulated by certain features of an activity or task (Alexander, et al., 1994). Feeling-related and value-related valences are two distinguishable aspects of individual interest (Schiefele, 1999). Feelings that can be associated with an object or activity, such as involvement, stimulation or flow are feeling-related valences (intrinsic attractiveness or aversiveness of an object) whereas value-related valences refer to the personal importance of an object or activity (Krapp, 2002). Although there is a high correlation between these aspects (Schiefele, 1999), Eccles and Wigfield (2002) claim that differentiation is useful because individual interests may be based primarily on feelings or personal significance (Eccles & Wigfield, 2002).

2.2.3.5 Goal theories

There are several different approaches to goal theories which are detailed below. Bandura (1997) and Schunk (1990) have shown that self-efficacy and an improved performance are promoted by specific, proximal (close to where they are currently and short term) and challenging goals (Bandura, 1997; Schunk, 1990). Other broader goal orientations are:

- ego-involved goals – individuals with these goals try to maximise positive assessments of their competence and minimise negatives ones
- task-involved goals – individuals aim to master a task and increase their competence (Nicholls, et al., 1990).

Research by Dweck (1999) suggests similar goals with performance goals like ego-involved goals and learning goals like task-involved goals (Dweck, 1999). Ames' (1992) research of performance and task choice also noted the differences between performance goals, where children will try to outperform each other and are therefore more likely to perform tasks that they know they can do (like ego-involved goals) and mastery goals where children will choose a task which challenges them as they are more concerned with their own progress as opposed to outperforming others (like task-focused goals) (Ames, 1992).

Another distinction in this area is between performance approach and performance-avoid goals (Elliott & Church 1997; Midgley et al. 1998; Skaalvik 1997):

- performance-approach goals – engaging in a task for performance reasons which generally has a positive effect on motivation and achievement
- performance-avoid goals – not engaging with a task to not appear stupid (Anderman, et al., 2002).

Other researchers argue that individuals can have many different types of goals (Ford, 1992; Ford & Nichols, 1987; Wentzel, 1991). Although goals are only part of the model of motivation by Ford (1992), which is made up of emotions and personal agency beliefs, they are defined as a chosen end point which people try to reach through the cognitive, affective and regulation of their behaviour (Ford, 1992). Ford and Nichols (1987) also noted the differences between:

- within-person goals - consequences desired within an individual, including:
    - affective goals e.g. happiness and physical well-being
    - cognitive goals e.g. intellectual creativity
    - subjective organisation goals e.g. unity
- person-environment goals – desired relationship between an individual and their environment, including:
    - self-assertive goals e.g. individuality
    - integrative social relationship goals e.g. social responsibility

- task goals e.g. mastery (Ford & Nichols, 1987).

Despite Ford & Nichols (1987) developing many measures to assess all the twenty-four goals which were specified in Ford's model, Eccles and Wigfield (2002) argue that the evidence suggests that people will typically rely on a small cluster of core goals to regulate their behaviour (Eccles & Wigfield, 2002).

The multiple goals of adolescents in achievement settings were examined by Wentzel (1991, 1993) and differ from the views of theorists such as Dweck and Nichols as they focus on what the goals contain as opposed to whether the criteria of success is mastery or performance (Eccles & Wigfield, 2002). Students' school performance and behaviour are affected by both social and academic goals for example the goals which are related to school achievement comprise viewing oneself as successful and dependable, wanting to learn something new and a want to get something done (Wentzel, 1991).

There are clearly numerous goals which will be motivating pupils to achieve in mathematics and each individual will be trying to achieve one or many of these in their mathematics lessons.

2.2.4 Theories integrating expectancy and value constructs

2.2.4.1 Attribution theory

Attribution theorists stress that it is how an individual interprets their achievement outcomes that determines their subsequent achievement strivings, rather than their motivational dispositions or the outcomes themselves (Eccles & Wigfield, 2002). Weiner (1985) argued that an individual's explanations for their achievement outcomes determine further achievement strivings and therefore are important motivational beliefs (Weiner, 1985).

The most important achievement attributions have been identified as effort, ability, difficulty of the task and luck and these can be classified into three causal dimensions:

- controllability - contrasts the causes which an individual cannot control e.g. aptitude, mood, and luck, with those that they can such as skill and efficacy
- stability - influences an individual's expectancy of success. Attributing an outcome to a stable cause such as skill, has a greater influence on the expectation of future success than to an unstable cause e.g. effort (Weiner, 1985; Weiner, 1992)

- locus of control - internal versus external locus of control (Weiner, 1992).

Each of these dimensions has a unique influence on a variety of aspects of achievement behaviour, with the locus of control having the strongest link to affective reactions as attributing success to an internal cause enhances the feelings of pride and self-esteem, whereas an external cause enhances gratitude. If failure is attributed to an external cause it is linked to anger and an internal cause, to shame (Weiner, 1985; Weiner, 1992).

2.2.4.2 Modern expectancy-value theory

Modern expectancy-value theory is one of the key frameworks for achievement motivation and explains a pupils' effort, choice and achievement related to both academic and non-academic areas (Guo, et al., 2015).

Although modern expectancy-value theories are based in Atkinson's (1964) expectancy-value model because they link persistence, achievement performance, and choice directly to an individuals' expectancy-related and task-value beliefs, they differ from this model in a number of ways. The expectancy and value components are both more elaborate and are linked to a broader range of social or cultural and psychological determinants, and also the expectancies and values are thought to be positively related rather than inversely related in Atkinson's model (Atkinson, 1964; Eccles & Wigfield, 2002).

The expectancy-value model of achievement-related choices, tested by Eccles et al (1983, 1984) assumed choices to be influenced by negative and positive task characteristics that have costs associated with them because one choice may eliminate the other. As a result the relative value and probability of success of a variety of options are important determinants of choice (Eccles, et al., 1983; Eccles, et al., 1984; Meece, et al., 1990).

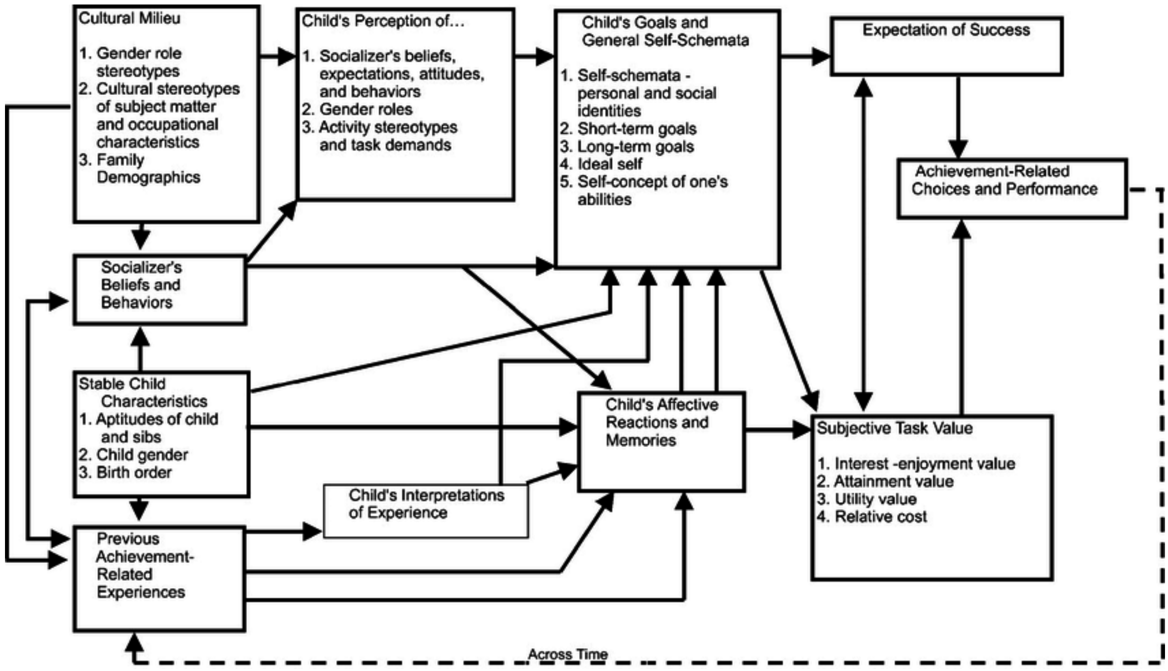


Figure 3 Expectancy-value model of achievement (Eccles & Wigfield, 2002, p. 119)

Figure 3 shows a more recent model of achievement where expectancies and values have been confirmed to have a direct influence on performance, persistence and the choice of task (Eccles & Wigfield, 2002). Eccles and Wigfield (2002) outline that expectancies and values are thought to be influenced by task-specific beliefs, such as perceptions of competence and the difficulty of tasks and an individuals' goals. These social cognitive variables are then influenced by an individual's perception of other peoples' attitudes and expectations for them, and by how they interpret their own previous achievements. How an individual perceives a task, and their interpretation of past outcomes are therefore influenced by their behaviour, beliefs, the environment and historical events (Eccles & Wigfield, 2002).

Expectancies for success were defined by Eccles et al. (1983, 1984) as beliefs that an individual has about how well they will do in an upcoming task in either the immediate or longer term choice (Eccles, et al., 1983; Eccles, et al., 1984). The expectancy beliefs are measured in a manner similar to the measures in Bandura's (1997) personal efficacy expectations, however in contrast to Bandura's claim that expectancy-value theories focus on outcome expectations, the focus in this model is on personal or efficacy expectations (Eccles & Wigfield, 2002).

Beliefs about ability were defined by Eccles et al. (1983) as how an individual evaluates their competence in different areas. In the expectancy-value model ability beliefs are broad beliefs about competence in a given field, as opposed to one's expectancies for success on an upcoming task however empirical work by Eccles et al. has shown that children and adolescents do not differentiate between these two levels of beliefs, even though they theoretically can be distinguished from each other (Eccles, et al., 1983).

Four components of task-value were outlined by Eccles et al. (1983):

- attainment value - the personal importance of succeeding on a task
- intrinsic value - the enjoyment an individual gets from an activity or the subjective interest that an individual has in the subject (similar to the construct of intrinsic motivation defined by Deci and Ryan (1985) and flow defined by Csikszentmihalyi (1988))
- utility value - how well a task relates to current and future goals. A task can have a positive value to a person even if it does not interest them because it can facilitate an important future goal for them
- cost - the negative aspects of engaging with a task e.g. anxiety and fear of failure and success; as well as the amount of effort that is needed to succeed in the task and the opportunities that are lost as a result of choosing one as opposed to another (Eccles, et al., 1983).

Ability self-concepts and performance expectancies have been shown to be predictors of performance in mathematics and English by Eccles and her colleagues, whereas predictions about courses and enrolment in mathematics, physics and English can be made from task values (Eccles, 1987; Eccles, et al., 1983; Eccles, et al., 1984; Meece, et al., 1990). They also found that career choices could be predicted by both expectancies and values (Eccles, et al., 1998). From these findings, Figure 3 could be slightly modified instead of direct paths being drawn from both expectancies and values to performance, persistence and choice; the paths from expectancies to choice could be reconsidered once prior achievement level is controlled and from values to performance (Wigfield & Eccles, 1992; Eccles & Wigfield, 2002).

When considering how an individual's competence beliefs relate to their subjective task values, ability self-concepts should influence the development of task values according to both the Eccles et al. model and Bandura's (1997) self-efficacy theory (Eccles & Wigfield, 2002). Mac Iver et al. (1991) also found that changes in the competence beliefs of junior high school students over a semester was a stronger predictor of change in children's interest than the other way around (Mac Iver, et al., 1991) and in the case of younger children, Bandura (1997) argued that children should be more interested in challenging as opposed to easy tasks because interests emerge as a result of one's sense of self-efficacy (Bandura, 1997). Wigfield (1994) proposed that despite young children's competence and task-value beliefs initially being relatively independent of each other, over time, particularly in terms of achievement, children may start to attach more value to an activity that they do well in because the positive effect they experience becomes attached to the activity due to classical conditioning (Wigfield, 1994). To maintain a positive sense of efficacy and self-esteem they may lower the value attached to difficult tasks (Eccles, et al., 1998; Harter, 1990). Consequently, competence-related beliefs and values should become positively related to each other at some point, which was demonstrated empirically by Wigfield et al. (1997) (Wigfield, et al., 1997).

2.2.4.3 Self-worth theory

This is included under the heading of expectancies and values because in an academic sense, self-worth theory links ability-related and value-related constructs to motivational behaviour. It also focuses on mental health as a key determinant of how related expectancies and values are to achievement behaviours (Eccles & Wigfield, 2002). Covington (1992, 1998) defined the motive for self-worth as the preference to create and maintain a positive image and sense of worth. An important way to maintain a students' self-worth is to protect their academic ability, because they spend so long, and are regularly assessed in school i.e. in the context of school, students need to feel that they have academic competence in order to feel that they have self-worth (Covington, 1998). As a result, students will aim to protect or even maximise their sense of academic competence to maintain their feeling of self-worth, so will often attribute their successes to ability and effort and their failures to not trying, avoiding having to attribute failure to lack of ability (Covington, 1992).

Aspects of school make it difficult for students to maintain a belief in their ability, such as competition and social comparisons. Rather than appearing to lack ability, students try other strategies such as procrastination, making excuses, avoiding a challenging task, and not trying (Covington, 1992). In fact effort was referred to as a 'double-edged sword' by Covington & Omelich (1979) because trying is encouraged by parents and teachers as it is important for success but if a student tries and fails then it is difficult for them to avoid the conclusion that they lack the ability to succeed (Covington & Omelich, 1979). Consequently, if it seems likely that they will fail, some students will not try, to avoid the threat to their ability self-concept if they try and fail (Covington & Omelich, 1979). This even applies to high-achieving students as they may avoid a difficult task to maintain their feeling of academic confidence and others' opinions of them (Covington, 1992). To allow students to maintain their self-worth the frequency of practices which involve competition, social comparison and evaluations should be reduced and students should instead focus on mastery, effort and improving their academic performance (Covington, 1992).

Other research has suggested that for some individuals' academic self-confidence is not as strong a predictor of self-worth as Covington has claimed (Eccles & Wigfield, 2002) . Harter (1990) for example showed that other self-concepts such as physical appearance and social competence are stronger predictors of self-worth than academic self-concepts (Harter, 1998). Other investigations have suggested that the power of any self-concept to influence an individual's feeling of self-worth depends on the value they attach to that domain, and they may reduce that value in order to maintain a feeling of self-worth in a task they expect to fail (Eccles, 1993; Harter, 1998).

2.2.5 Theories integrating motivation and cognition

Research in this area has largely focused on two issues: how motivation is translated into regulated behaviour and how cognition and motivation are linked (Eccles & Wigfield, 2002).

2.2.5.1 Social cognitive theories of self-regulation and motivation

Self-regulation is an active process where students set goals for their learning then monitor their progress towards these goals, controlling their motivation, behaviour, and cognition to achieve them (Schunk, 2005). Students who are metacognitively, motivationally and behaviourally active in their own learning process and in achieving their goals can be described as self-regulated learners, however not all environments allow for choices of activities or the approach towards these activities which can make self-regulation more difficult (Zimmerman, 1989).

Self-regulated learners have three important characteristics according to Zimmerman (2000). They should use a variety of active learning processes, involving agency and purpose, believe that they can perform successfully, and they should set themselves a variety of goals (Zimmerman, 2000a). These learners also engage in three important processes: monitoring their own activities (self-observation), evaluating their performance against others' (self-judgement) and react to performance outcomes (self-reactions) (Zimmerman, 1989). A student is more likely to carry on if all of these reactions are favourable, especially in response to failure, which is determined by how they interpret their difficulties and failures (Eccles & Wigfield, 2002).

The application of self-regulation in an educational setting has arisen due to research which has shown that the achievement of a student is not explained through skill and ability alone but other important factors such as motivation and self-regulation (Pintrich, 2003). Research examining if there is a relationship between self-regulation, motivation and learning has found that important links exist and consequently students who have greater self-regulatory skills tend to have more academic motivation and demonstrate better learning (Pintrich, 2003).

In summary, the social-cognitive view of self-regulation stresses how significant self-efficacy beliefs, causal attributions and goal setting are in the regulation of behaviour which is directed at achieving a task and once they have engaged in a task the students need to monitor their behaviour, judge their outcomes and respond appropriately in order to regulate what they do next (Eccles & Wigfield, 2002).

2.2.5.2 Theories which link motivation and cognition

Winne and Marx (1989) suggested that motivation should be considered in terms of cognitive processing and that the basic principle of cognitive psychology govern motivational thoughts and beliefs (Winne & Marx, 1989). A model of the relations between motivation and cognition was proposed by Pintrich et al. (2000a, 2000b) and combines components such as prior achievement levels, interactions between the students and teachers when instructions were given, motivational constructs derived from expectancy-value and goal theories (expectancies, values and effect) and a variety of cognitive constructs such as background knowledge and strategies for learning (Pintrich, 2000a; Pintrich, 2000b). They suggested that the cognitive and motivational constructs influence each other and are influenced by the social context, as well as influencing the student's involvement with their learning, therefore affecting their achievement outcomes (Pintrich, 2000b).

2.2.5.3 Theories of motivation and volition

Kuhl (1987) suggested that motivational processes only lead to a decision to act and that once an individual starts to act, the volitional processes take over which determine whether or not the intention is met (Kuhl, 1987). There are many distractions which can affect even the strongest of intentions (Eccles & Wigfield, 2002) and Kuhl (1987) suggested several volitional strategies to explain why individuals persist in the face of distractions. Cognitive control strategies help individuals to avoid distracting information and to focus on information that is relevant, which allows for optimal decision-making. Emotional control strategies are the ability to keep inhibiting emotional states such as anxiety and depression in check, motivational control strategies which involve strengthening an individual's motivation and environmental control strategy involves optimising the environment e.g. turning music off whilst studying. Individuals who have an 'action orientation' are more likely to engage in these volitional strategies than 'state-oriented' individuals (Kuhl, 1987).

2.2.6 Thesis definition of motivation

I refer again to the title of this thesis -

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

So far in this chapter I have considered the following theories of motivation, which are summarised below:

- Self-efficacy theory – the belief one has in their ability to solve a problem.
- Control theory – one should expect to succeed to the extent that they feel in control of their successes and failures.
- Self-determination theory – the motivation behind an individual's choice without any external influence and interference
- Flow theory – a state experienced when an individual is engaged and immersed in an activity which is at an appropriately challenging level for their skills.
- Interest theory –
    - Individual interest – relatively stable evaluative orientation towards certain subject areas
    - Situational interest - temporary interest due to specific features of a task
- Goal theory – what pupils want to achieve in class (can be academic or social)
- Attribution theory – the explanations that pupils use to explain why they achieved an outcome.
- Modern expectancy-value theory – the influence of a pupil's expectancy of success in a task and the value they place on the task.
- Self-worth theory – avoiding failure to protect our feeling of self-worth.

As a result of this research, in this thesis I understand motivation to be the reasons behind the level of effort that a pupil puts into learning mathematics. This includes –

- expectations of their achievement
- pupil self-efficacy
- pupil incentives for succeeding (achievement value)
- what pupils attribute their success to
- not wanting others to think badly of them
- pupil goals.

As the aim of this study is to explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school, the next section of this chapter covers research into the definition of attitude.

2.3 What is attitude?

The Oxford English Dictionary describes attitude as 'the way that you think and feel about somebody/something; the way that you behave towards somebody/something that shows how you think and feel' (Dictionary, 2020b). Although there has been a lot of research into attitude towards mathematics, many researchers (Di Martino & Zan, 2001; Ruffell, et al., 1998) have highlighted that attitude remains an ambiguous construct which is often used without a proper definition (Hannula, 2002). A simple definition of attitude towards mathematics would be 'the degree of affect associated with mathematics' (Hannula, 2002, p. 26) but this definition does not include the cognitive part of attitude (Hannula, 2002). However, a definition of attitude which includes three parts: emotional response, behaviour and beliefs, does not seem to agree with another view (McLeod, 1992; DeBellis & Goldin, 1997) which puts attitude, emotion and belief into the affective domain (Hannula, 2002). Some confusion may be due to attitudes and beliefs being put under the single term attitude, as opposed to distinguishing between them (Fischbein, 1967). It is also a concern that people discuss attitudes as if they are easy to assess and measure which can result in extensive and inaccurate beliefs about attitudes (Dawes, 1972).

2.3.1 Definitions of attitude

An early definition of attitude is

> *a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related* (Allport, 1935, p. 810).

Important features of this definition are that individuals are able to deal with people and situations as they encounter them as opposed to having to stop and think (state of readiness) (Halloran, 1967). Attitudes are learned and not innate, and although they are fairly stable, attitudes can be modified and are subject to change (Halloran, 1967). Lastly, attitudes do not lie dormant, waiting for activation but are dynamic and can result in an individual seeking or avoiding particular objects (Halloran, 1967).

Allport's (1935) definition could apply to other frames of mind such as beliefs and opinions (Halloran, 1967), and it may be inaccurate to think that attitudes are not innate as there is evidence to suggest that genetics may influence attitudes. Waller et al. (1990) investigated genetic and environmental factors in adult twins brought up together and apart and found that almost 50% of variance in religious attitudes, interests and values was accounted for by genetic factors (Waller, et al., 1990).

Using Wittgenstein's position that the meaning of words arises from the ways they are used in language (Wittgenstein, 1996), the following list shows how attitude is used in academia.

The highlighted words show similar key ideas from the definitions such as evaluate, respond, and predispose, and have informed my understanding of how the word can be used to describe a cluster of factors affecting the learning of mathematics.

> *Attitude is the predisposition of the individual to evaluate some symbol or object or aspect of his world in a favourable or unfavourable manner* (Katz, 1967, p. 459).
>
> *An attitude is an idea charged with emotion which predisposes a class of actions to a particular class of social situations* (Triandis, 1971, p. 2).
>
> *…most investigators would probably agree that attitude can be described as a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object* (Fishbein & Ajzen, 1975, p. 6).
>
> *An attitude is a disposition to respond favourably or unfavourably to an object, person, institution or event. Although formal definitions of attitude vary, most contemporary social psychologists seem to agree that the characteristic attribute of attitude is its evaluative nature* (Ajzen, 1988, p. 4).
>
> *….for the purposes of verbal measurement, most researchers seem to agree that an attitude is a state of readiness, a tendency to respond in a certain manner when confronted with certain stimuli* (Oppenheim, 1992, p. 174).
>
> *Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour* (Eagly & Chaiken, 1993, p. 1).
>
> *Attitudes are evaluated beliefs which predispose the individual to respond in a preferential way. That is, attitudes are predispositions to react positively or negatively to some social object* (Burns, 2000, p. 555).

From these definitions my understanding of attitude so far is that it involves feelings and emotions which predispose us to consistently evaluate an object favourably or unfavourably. The fact that attitudes can be learned gives them the potential to be changed.

In the definition by Burns (2000) it can be observed that there is no distinction between the idea of attitude and belief but that they are grouped together under the notion of 'attitude'. To differentiate between the two, Fischbein (1967) gave an example of two people who are equally opposed to segregation but have different beliefs about how to eliminate it, therefore sharing the same attitude but with different beliefs. Attitudes were therefore described as learned predispositions to a stimuli whereas beliefs are hypotheses which relate to the nature of the stimuli and what action should be taken (Fischbein, 1967).

There is a flaw in this comparison though, as the view that two people have the same attitude cannot be directly observed but would need to be elicited through exploration of feelings, beliefs, and behaviours. This is implied in Fischbein's (1965) distinction where beliefs relate to the nature of the attitudinal object (cognitive component) and the type of action that should be taken (behavioural component), arguably that beliefs are a cognitive component of attitude (Fischbein, 1967).

The following sections will look at two different models of attitude: the tripartite model and the functional model.

2.3.2 The tripartite model of attitude

The tripartite model involves three components to attitude: cognition, affect and behaviour. This model is summarised in Figure 4:

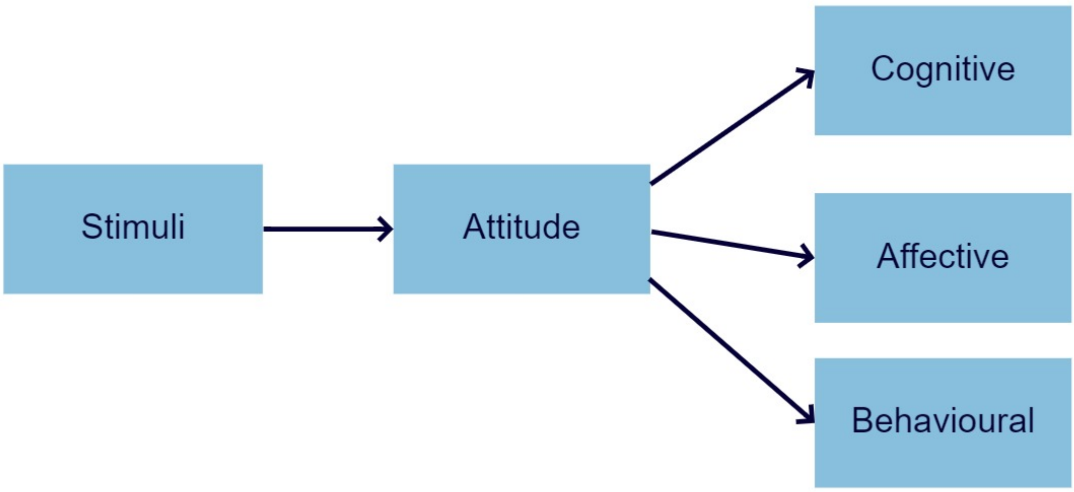


Figure 4 The Tripartite model of attitude (Pennington, Gillen, & Hill, 2016)

The cognitive component are the thoughts that an individual has about the attitude object, the affective component refers to positive or negative feelings or emotions towards the attitude object and the behavioural component refers to the intended or actual positive or negative behaviour associated with an attitude object (Pennington, et al., 1999). However, there should be caution with this model as it relies upon a high level of consistency between the three parts, but people often do not react in the way that they think or feel that they should (Pennington, et al., 2016).

To overcome the possibility of inconsistencies, Fischbein and Ajzen (1975) recommended assessing and measuring all three attitude components and warned against using partial measures to predict obvious behaviour as these cannot be seen as a fair test of the connection between attitudes and behaviours (Fishbein & Ajzen, 1975). But problems arise when all three components are not measured, which highlights the question of whether attitudes must have all three components.

A one-dimensional model was suggested by Fischbein and Ajzen (1975) which has evaluation (positive to negative and strong to weak) as the key factor i.e. an attitude is an evaluation of an attitude object which is determined by an individual's expectations about the attributes of the object (Pennington, et al., 1999). The negatives to this model are that individuals may not think carefully about their expectancies or the expectancies may not be equally important to them (Pennington, et al., 1999).

2.3.3 The Functional model of attitude

Whilst the previous model looked at components of attitude it did not address why people have attitudes and what psychological function attitudes serve which is where a functional theory of attitudes (Katz 1967) may be useful.

Katz (1967) identified the importance of this approach as focusing research on the functions of attitude so that we can generalise human behaviour; to avoid accrediting one cause to a type of attitude (oversimplifying attitude), and finally to recognise the complex source of behaviour in order to understand how attitudes can change (Katz, 1967). In summary, the functional model of attitude attempts to determine how related attitudes and attempts to change attitudes are, to the motivational structure of someone (Himmelfarb & Eagly, 1974).

When considering attitudinal change, it is necessary to understand the functions served by attitude, otherwise a method may produce an attitudinal change in one individual but little or no change in an individual whose attitude is serving a different function (Himmelfarb & Eagly, 1974). This is corroborated by Eagly and Chaiken (1993) who observed that at the heart of understanding how an attitude can be changed is the concept that people have and express attitudes for different reasons, therefore you need to have knowledge of the motivational basis of an attitude to be able to change it (Eagly & Chaiken, 1993).

Four major functions are served by attitude: the instrumental, adjustive or utilitarian function, the ego-defensive function, the value-expressive function, and the knowledge function (Katz, 1967). The instrumental, adjustive or utilitarian function is that people 'strive to maximise the rewards in their external environment and to minimise the penalties' (Katz, 1967, p. 461). As a result, people develop favourable attitudes towards objects that meet their individual needs and unfavourable attitudes towards those objects that thwart them. This function covers hedonism as it is the 'purpose of increasing satisfaction or pleasure and avoiding punishment or pain' (Pennington, et al., 1999, p. 75). Additionally, an individual will seek friends with a similar attitude to themselves and will develop similar attitudes to the people that they like (Pennington, et al., 1999) which is a behaviour frequently seen in school.

Changing attitudes which serve an instrumental function can be done in three ways. Firstly, by altering the outcomes so that the attitude does not lead to rewards but has punishing consequences, by changing the needs and by learning new, easy paths to achieve satisfaction (Himmelfarb & Eagly, 1974).

The ego-defensive function describes an attitude that can protect an individual from themselves and other people as positive attitudes about ourselves help us to excuse an episode of poor behaviour as not being representative to how we usually behave (Pennington, et al., 2016). To change these attitudes the threat should be removed supportively, without threatening the individual, as they may need help gaining insight into their defence mechanism (Himmelfarb & Eagly, 1974).

Whilst many attitudes prevent people from revealing their true selves, the value-expressive function acknowledges the need to tell others about yourself and to 'be conscious of what we feel, believe and value' (Pennington, et al., 1999, p. 75). These attitudes are fundamentally rewarding as they allow us to make ourselves clear and assert self-concepts (Eagly & Chaiken, 1993). They become apparent in situations which threaten the self-concept and require the individual to reaffirm their self-image (Himmelfarb & Eagly, 1974). Attitude changes may occur when the individual becomes unhappy with themselves or if they change their beliefs.

The knowledge function is how we organise, structure and process information about our social world (Pennington, et al., 2016). This function helps us to see the world as a familiar and predictable place (Pennington, et al., 2016) and although people may not be active in seeking knowledge in terms of education, they do want to understand things that encroach on their lives (Katz, 1967). In trying to change this attitude, care must be taken as new knowledge may not necessarily alter existing attitudes unless the existing knowledge is inadequate, incomplete or inconsistent as it relates to new circumstances (Katz, 1967).

A ‘mismatch between an attitude and the underlying needs that it satisfies elicits attitude change’ (Himmelfarb & Eagly, 1974, p. 44). Therefore, to change an attitude, firstly it must be agreed what attitude is held and secondly, what function it serves, then the method must match the function for change to occur (Pennington, et al., 1999). The functional approach helps to reveal the motivational significance of an individual’s attitudes and beliefs which would not be easily detected (Eagly & Chaiken, 1993).

2.3.4 Thesis definition of attitude

I refer again to the aim of this thesis -

To explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school.

So far in this chapter I have researched numerous theories of motivation and used the tripartite and functional model to define attitude. The tripartite model proposes that attitude is based on three components; affective, cognitive, and behavioural, whilst the functional model focuses on the function of attitude and recognises the influence attitudes have on various psychological functions.

To help orientate the reader Figure 5 shows the parts of the concept map informed by the Literature Review that deals with the ideas I have described in this section.

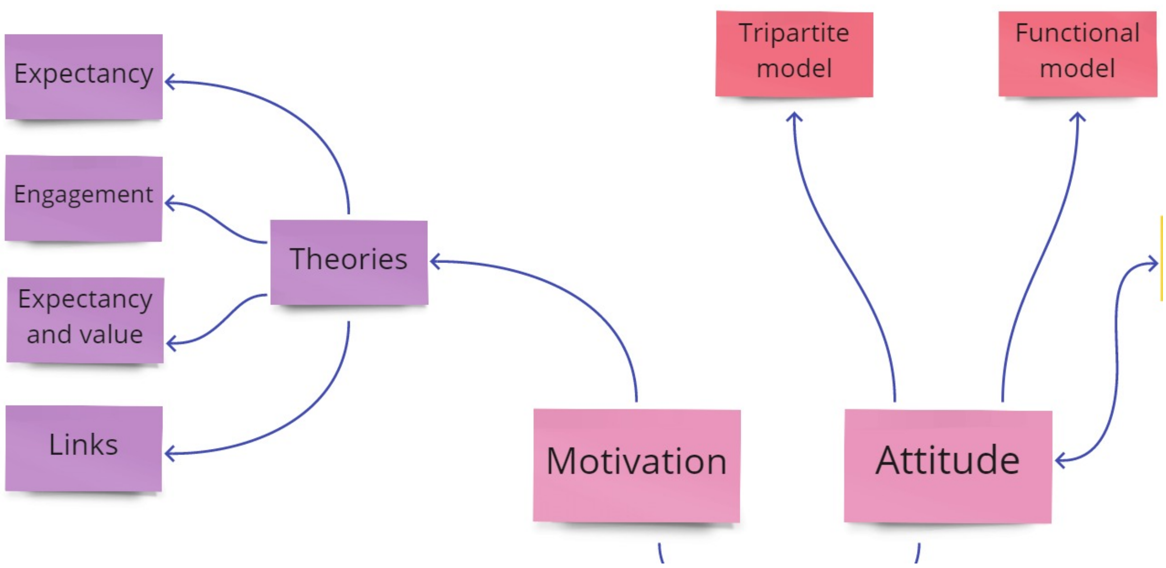


Figure 5 Concept map informed by the literature review

From reading literature around attitude, in this thesis I understand attitude to be the relatively stable (stable across a period of time, rather than fluctuating daily like emotions) thoughts and feelings that pupils have towards mathematics and the reasons behind them.

Whilst researching attitude, it was clear that it formed part of the construct known as affect in mathematics education, along with beliefs and emotions. The following section describes affect in greater detail.

2.4 Affect in mathematics education

Affect is the interaction between cognitive and emotional aspects in mathematics education (Evans, et al., 2006) and is described as 'a wide range of feelings and moods that are generally regarded as something different from pure cognition' (McLeod, 1992, p. 576). The general agreement is that this is divided into three parts: beliefs, attitudes, and emotions (McLeod, 1992). DeBellis and Goldin (2006) also included values, ethics and morals to this field of affect (DeBellis & Goldin, 2006). An example of these components impacting a pupil is if they experience multiple failures, because they may begin to doubt themselves and feel that putting in any effort is pointless, resulting in them feeling helpless. This creates more failures which reinforces their belief that they are not able to achieve in mathematics, creating a negative attitude and hindering future learning (McLeod, 1992). A negative affect has an impact on attainment as it limits and debilitates pupils in the mathematics classroom (Lewis, 2013).

The definitions of the constructs which make up affect are not widely agreed upon, but the following sections describe how they are understood in this thesis.

2.4.1 Beliefs

There are many definitions of beliefs as they are not able to be directly observed and have a large overlap with attitudes (Leder, et al., 2002), however beliefs within mathematics education are concerned with an individual's decision-making process in terms of mathematical problem solving (Schoenfeld, 1985). Beliefs can help an individual meet their emotional needs by providing them with a defence against pain or guilt which can make them very hard to change or give up (Martinez-Sierra & Gonzalez, 2014).

2.4.2 Attitudes

Attitude is the least clearly defined component, as elaborated above, with it being almost indistinguishable from beliefs in early studies (Di Martino & Zan, 2001). Attitude is formed within the context of social psychology and can be thought of as an orientation to behave in a certain way (Di Martino & Zan, 2011) and is therefore more stable than emotions (Lewis, 2013). More recent studies have used a tripartite model to explain attitude, which was explained previously in section 2.3.2.

As described in section 2.3.4, in this thesis I understand attitude to be the relatively stable (stable across a period of time, rather than fluctuating daily like emotions) thoughts and feelings that pupils have towards mathematics and the reasons behind them.

2.4.3 Emotions

Emotions are related closely to the study of a pupil's beliefs and attitudes (Hernandez-Martinez & Pampaka, 2017). Emotions are

> *rapidly-changing states of feeling experienced consciously or occurring preconsciously or unconsciously during mathematical (or other) activity* (DeBellis & Goldin, 2006, p. 135).

They are the least stable component and are thought to involve physiological reactions which affect cognitive processes e.g. attention, memory etc. They are functional and play a key role in how humans cope, adapt and make decisions (Evans, 2000; DeBellis & Goldin, 2006).

Studies have shown that emotional experiences such as enjoyment and anxiety are linked to how well pupils achieve in mathematics and can predict how likely they are to aspire to a career in mathematics or science (Ahmed, et al., 2013; Ashcraft, 2002; Goetz, et al., 2008), with several studies finding a negative association between anxiety in mathematics and achievement (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007). Mathematical resilience can be thought of as what a pupil needs to stay in the 'growth zone' (where pupils experience mistakes, dead-ends, failure and find an activity challenging) for as long as possible. To do this pupils need help to overcome their prior negative mathematical experiences, manage their mathematics anxiety and to be aware of their emotions, attitudes and beliefs (Johnston-Wilder & Lee, 2015)

2.4.4 Values

If performing well in mathematics is valued, an individual may have strong feelings of pride and enjoyment when they achieve, which endorses their self-efficacy with mathematics, however if these individuals do not do so well then it may be more difficult for them to overcome the negative effect of performing poorly, whilst still placing a high value on performing well in mathematics (Hurst & Cordes, 2017). If this is so, then a pupil who regularly performs poorly may have to value mathematics less to protect themselves from the feelings of negative affect. So, a pupil's beliefs about how important mathematics is in their life could be altered by their emotional reaction to their performance. If mathematics is not valued then success or failure in mathematics is less likely to produce a strong affective response (Hurst & Cordes, 2017).

Affect in mathematics therefore plays a large part in how pupils feel towards mathematics, what they believe, why they behave in a certain way, how they react in different situations and the value that they place on mathematics. All these factors will impact upon the motivation and attitude of pupils throughout their years in secondary school.

This chapter so far has covered the theories of motivation, models of attitude and investigated the four components of affect in mathematics. Figure 6 repeats the concept map of this section of the chapter to help orientate the reader.

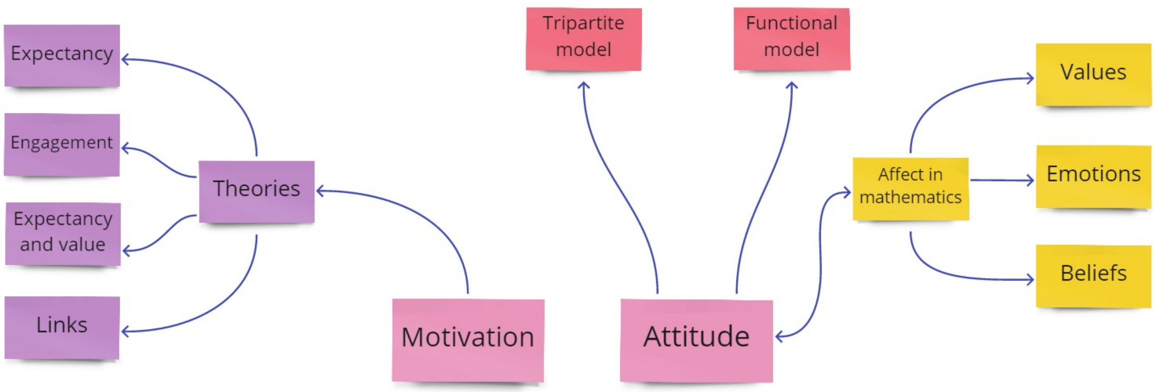


Figure 6 Section of the concept map informed by the literature review

This review of literature has helped me to understand the many facets of both motivation and attitude, but to investigate the question 'what influences pupils' attitudes and motivation in mathematics in the study setting?' I need to explore what factors have been shown to affect motivation and attitude.

The remainder of this chapter covers the research into this area and has been organised under the following headings:

Personal factors	**System factors**	**General factors**
Mindset	Prior attainment Grouping	The Role of Stereotypes in Mathematics
Resilience in Mathematics	Selection	Female Underrepresentation
Mistakes and Mathematics		The Role of Adolescence
The Role of Parents and Teachers		
Students' Experience of Mathematics Lessons		
Mathematics Anxiety		

2.5 Factors that could affect both motivation and attitude

2.5.1 Personal factors

2.5.1.1 Mindset

In our society, it is often believed that some people are born with more talent than others. Research and investigations over more than forty years suggest that people who have experienced an overemphasis on natural intellect and talent are left vulnerable when faced with failure, are fearful when faced with a challenge and are reluctant to remedy their weaknesses (Dweck, 2007).

When faced with a challenge, mastery-oriented children will often respond by increasing their effort and concentration, perhaps showing more mature problem solving skills, in order to increase their performance and probably perform better than they have before, whereas other children respond to difficulties by decreasing their effort and concentration which may result in reduced problem solving strategies and a poorer task performance (Diener & Dweck, 1978; Dweck, 1975; Dweck & Bush, 1976; Dweck & Reppucci, 1973). Children tend to be debilitated by their failures if they attribute them to factors beyond their control, such as insufficient ability i.e. an increase in effort would be pointless, whereas those who attribute their failures to controllable factors such as a lack of effort, tend to perform at their best when faced with difficulty (Licht & Dweck, 1984). Subjects which regularly face pupils with new concepts and skills, such as mathematics, give mastery-orientated pupils the chance to perform at their best, whereas helpless pupils are more likely to reduce their effort and fall behind (Licht & Dweck, 1984).

Selective approaches to education in the UK, such as setting, streaming or school selectivity, can appear to be based upon a belief that we all have a level of intellectual ability which cannot be changed and so is effectively fixed. By contrast, it is possible to believe that everyone has the capability to improve their underlying ability, even if they have different current skill levels (Dweck, 2008). These differing beliefs are known as having a 'fixed' or 'growth' mindset and often students seem to have developed more of a fixed view of their ability in mathematics, than other skills such as reading, and this view is often reinforced by their parents (Boaler, 2013; Marks, 2014).

A recent study by Leslie, Cimpian, Meyer and Freeland (2015) looked at different students (graduates, post-doctoral fellows etc) at university in the USA, in a variety of fields and asked them if they thought that being a top scholar in their field required somebody to have a special ability that could not be taught. They found that philosophy had the highest rating and mathematics was second (Leslie, et al., 2015). This belief that ability in mathematics is a fixed trait, means that people who are good at mathematics do not need to work hard but also that if you have to work hard at mathematics then you are not cut out for it and may never be able to learn it (Hurst & Cordes, 2017).

Rattan et al (2012) suggest that a fixed mindset might affect how people interact with children, as teachers who believe that mathematics ability is fixed might have the tendency to judge a pupil as having a lower ability more quickly than a teacher who believes that ability in mathematics can be changed, but also when these teachers try to help a pupil who is struggling, they are more likely to devalue effort and engagement in mathematics by making statements such as "not everyone is good at math" (Rattan, et al., 2012). These interactions reinforce the beliefs of some pupils, which then reduces the chance that they will put in additional effort to try to help them overcome their struggles (Dweck, et al., 2004).

A fixed mindset can lead to a reduction in pupil self-efficacy and an increase in negative attitudes towards mathematics, which may result in avoidance behaviours (Hurst & Cordes, 2017). These avoidance behaviours may then lead to poor results in mathematics which provides the pupils with further evidence towards their belief that they are not good at mathematics and whilst this downward spiral can be seen in other subjects it seems to be particularly strong in mathematics (Hurst & Cordes, 2017). Teachers often encourage a fixed mindset in the way that they use praise, trying to boost a student's self-esteem by praising them for being 'smart' as opposed to praising effort or resilience (Yeager & Dweck, 2012).

A 'growth mindset' is when a student believes that intelligence and the ability to be smart can be learned and that their brain can grow with exercise. The implications of this are that students are able to learn more effectively as they seek out challenges and are resilient when faced with failure (Boaler, 2013).

Growth mindsets can be developed in schools if teachers use practices that enable students to develop it, such as teaching students about the brain and how it changes when they learn (Robinson, 2017). However, based on her work, Boaler claims that many school practices in England are founded on the idea of fixed ability, which results in the limiting of students' attainment and the increase of inequality (Boaler, 2013).

Three hundred and seventy-three students were followed across the difficult transition into seventh grade in a study by Blackwell, Trzesniewski and Dweck (2007) in the USA. In the UK, a similar transition takes place a year younger. Students in this study started seventh grade with equal prior achievement in mathematics, irrespective of their mindset because typically the impact of mindset does not emerge until a student has faced a setback or a challenge (Dweck, 2008), although I would argue that students will have already met setbacks and challenges prior to this stage in their education. Results showed that the effect of the differing mindsets, as revealed in self-report questionnaires was apparent as early as the end of the autumn term and the students continued to diverge over the next two years. The study showed that the difference was because of several important variables. A student with a growth mindset was more orientated towards learning goals and, even though they cared about their grades, they cared about their learning more. These students held a far stronger belief in the power of effort and believed that effort supported ability, regardless of your present ability level. Contrastingly, students with a fixed mindset believed that effort was only necessary for the students that lacked ability and was therefore not likely to be effective for them. Lastly, when faced with setbacks, those students with a growth mindset showed reactions which were more mastery orientated. They were less likely to degrade their ability and employ negative strategies such as withdrawing effort or cheating, than those with a fixed mindset, but instead were more likely to employ more positive strategies such as increasing their effort and trying a new strategy (Dweck, 2008). This study suggests that students need to view challenges as something that they can overcome with time, effort, help from others, patience, determination, and a variety of strategies. These and similar studies seem to suggest that teachers need to emphasise that students have the potential to change in order to prepare them to face challenges with resilience (Yeager & Dweck, 2012).

Despite these claims, Simms' points to null results in studies such as Rienzo, Wolfe and Wilkinson (2015), which have looked at the impact of growth mindset interventions on achievement in mathematics (Simms, 2016). An explanation for this lack of impact could be that the pupils are already receiving messages of growth mindsets through current teaching or that interventions related to mindset are not necessarily effective but may have had a positive impact on the pupils by decreasing their mathematics anxiety or increasing their self-efficacy (Simms, 2016).

Clearly the mindset of the pupils in the study school will have a large impact on their motivation and attitude towards mathematics. When reading about mindset, it was suggested that pupils need to be resilient in the face of challenges. As resilience could influence attitude and motivation, the following section details resilience in mathematics.

2.5.1.2 Resilience in mathematics

Resilience was defined by Masten (2001) as a "good outcome in spite of serious threats to adaptation or development" (Masten, 2001, p. 228) and can be thought of as a behavioural or emotional response to a challenge, either socially or academically, that is positive and aids development e.g. putting in more effort (Yeager & Dweck, 2012). Put simply, being resilient is responding positively to challenges (Yeager & Dweck, 2012).

Mathematical resilience (Johnston-Wilder & Lee, 2008) is a construct defined by Johnston-Wilder and Lee (2010) as

> *a positive approach to mathematics that allows people to overcome any affective barriers presented when learning mathematics* (Johnston-Wilder & Lee, 2010, p. 1),

which they argue differs from resilience in other areas of learning because of factors such as the nature of mathematics, beliefs that ability in mathematics is 'fixed' and the type of teaching often used in mathematics classrooms (Johnston-Wilder & Lee, 2010).

Students who think that intelligence is fixed may interpret academic challenges as a sign that they are 'dumb' or are seen by others to be 'dumb' which compromises the academic resilience of even high achieving students (Blackwell, et al., 2007). Even if students are taught the skills that they need to be resilient, they may not be able to use them adequately unless their mindset allows them to believe that they have the potential to improve (Blackwell, et al., 2007; Yeager, et al., 2013).

Parents and teachers can unintentionally undermine the resilience of a student as Mueller and Dweck (1998) found that praising a student for being smart led them to have more of a fixed mindset and made them less resilient to academic setbacks (Mueller & Dweck, 1998). Rather than praising students for being smart when they do well, this implies that they should be praised for the process that they used i.e. effort, strategy, focus or persistence, in order to promote resilience (Yeager & Dweck, 2012). The same is true of some student feedback such as 'not being a mathematics person' as this leads students to believe that they cannot improve and gives them lower expectations of their own performance (Rattan, et al., 2012).

As there are so many changes to the curriculum, making it more rigorous and placing so much emphasis on examinations, students need to be more resilient in the face of these challenges, for these changes to be successful (Yeager & Dweck, 2012) and the students to achieve their potential.

How resilient the pupils are will clearly have an impact on the pupils' attitudes and motivation towards mathematics, especially as the study school is in a selective area and pupils have no choice about whether to study mathematics or not. During my reading on pupils' mindset and resilience it became apparent that teachers and other key adults can foster a growth mindset in pupils by praising the process as opposed to ability, and how mistakes are interpreted will also affect the pupils' mindsets. This is discussed further in the following section.

2.5.1.3 Mistakes and mathematics

Boaler (2015) points out that mistakes are an important opportunity for learning and growth, but they are often regarded by students as an indicator of their ability. Mistakes should therefore be valued by teachers and students and viewed as learning opportunities as opposed to learning failures (Boaler, 2015). Applying this to mathematics, Boaler believes that the frequency of fixed mindsets among students has led to them craving the opportunity to produce pages of mathematics work which is correct. If this is the case, she claims that development opportunities are being missed. Students should be faced with challenging work which results in mistakes and these mistakes should be seen as valuable opportunities for learning (Boaler, 2013). The re-evaluation of mistakes provides teachers with an opportunity to make encouraging comments which make links to the mistake, creating an opportunity for learning and giving the student time to think about it, to reassure students, and show students' mistakes to the class so that everyone can learn from them (Boaler, 2013).

This is relevant to my thesis because pupils' experience of mathematics is likely to be affected by the normal expectations in their classrooms. The following section investigates the role of parents and teachers in greater detail.

2.5.1.4 The role of parents and teachers

Many parents feel able to help their children with reading but feel that their abilities in mathematics are not adequate enough to support them (Cockcroft, 1982). It appears to be accepted in our society that mathematics is a difficult subject and that few people are born with real mathematical ability. In 1982 Cockcroft voiced that parents can unknowingly influence their children's attitude towards mathematics in three main ways –

- Parents may unintentionally implant attitudes
- Parents can develop or undermine their child's confidence
- Expectations of parents can result in motivational beliefs and behaviours which are maladaptive (Cockcroft, 1982).

Parents who have a realistic and accurate expectation of their child's attainment in mathematics have a greater impact on their child's learning than those parents who over-estimate the attainment. In fact parents who have a realistic expectation of their child's attainment, have more impact on their attainment than other direct involvement such as helping them with their homework (Askew, et al., 2010).

A report which looked into mathematics education in high-performing countries found that parents who had a more positive attitude towards mathematics often had a higher expectation of their child's interest and capability, and the children scored higher in mathematics tests (Askew, et al., 2010).

Interactions with parents, carers and teachers help children gain a lot of their attitudes and perceptions (Eccles & Jacobs, 1986) and whilst the value and support that parents give to mathematics and science is related to how much their children value and are motivated in these subjects (Bouchey & Harter, 2005; Leaper, et al., 2012), it may still be possible to prevent pupils having negative beliefs about mathematics before they give up on mathematics lessons entirely (Hurst & Cordes, 2017).

In mathematics and science, parents and educators may be more focused on ensuring that students feel good about themselves than in helping them to achieve (Dweck, 2008). This can take many forms such as the praising of intelligence or talent or relieving the pressure to succeed with comments that remove ability e.g. ‘they are not a mathematics person’ (Dweck, 2008). These strategies can encourage a fixed mindset, as praising a student’s intelligence as opposed to their effort or strategy reinforces the idea that their intelligence is fixed. To keep looking intelligent, a student may avoid challenges and lose motivation and confidence when tasks become too difficult and they may even lie about their scores afterwards, whilst in contrast if a student is praised for the process e.g. effort or strategy, then they will seek out challenges and thrive on them (Dweck, 2008).

A report into raising the motivation of pupils in Key Stage 4, found that teachers need to be caring and supportive and make the mathematics enjoyable for the pupils for them to be motivated (Kyriacou & Goulding, 2005).

Teachers regularly, albeit perhaps unintentionally, convey information about how useful, valued and interesting a particular area might be (Eccles & Jacobs, 1986). Midgeley, Feldlauger and Eccles (1989) found that the interest, value, and perceived usefulness of mathematics increased between sixth and seventh grade when students reported that they went from a teacher who offered low support to one with high support. However, the reverse occurred if students went from a high to a low support teacher and these changes had the most impact on lower achieving students, who measured support in terms of how fair, friendly and caring the teacher was, which all relate to a positive affective experience for the students (Midgley, et al., 1989). This means that the level of support that parents and teachers offer in mathematics may alter the perception of whether mathematics ability and knowledge should be valued, as well as encouraging greater mathematical ability (Hurst & Cordes, 2017).

Teachers’ low confidence in their teaching efficacy reinforces feelings of incompetence and disaffection in pupils which can lead to resentment, anger and disengagement (Jackson & Davies, 2000; Lee & Smith, 2001), whilst high quality relationships between pupils and teachers facilitate academic achievements and help pupils’ other psychological variables such as self-esteem and self-confidence (Coleman, 2011).

Research has shown that girls achieve better in mathematics (and science) if the teaching is not sexist or competitive but cooperative and is taught from an applied as opposed to abstract view (Eccles , 2004). This is a good example of the environment meeting the needs of the pupil - 'person-environment fit' and shows how the behaviour of teachers can play a large part in whether pupils thrive at secondary school (Coleman, 2011).

The huge role that parents and teachers play in a child's education is clear, but what should also be noted are the probable effects of more subtle interactions, as throwaway comments such as "well I was never good at maths" or "she is not a maths person" continue to reinforce the generally accepted view that mathematics is something that you were born with the ability to do, so there is little point in working at it.

The research in this area made suggestions for how the environment and interactions in the classroom can encourage a growth mindset in mathematics, however pupils' experiences of mathematics lessons may be very different. This is discussed under the next heading.

2.5.1.5 Students' experiences of mathematics lessons

Another approach to motivation is the social learning approach which acknowledges the impact of the environment and claims that a meaningful environment or a psychological situation is the best predictor of someone's actions (Rotter, 1954; Anderson, et al., 2004). The social environment of a classroom has a significant impact on the motivational behaviour of the pupils with the most important factor being the level of friendship that the pupils have for each other (Anderson, et al., 2004).

For pupils to view themselves as someone who can do mathematics i.e. a mathematician, studies have shown that the classroom climate is important and should be caring and supportive. The activities which pupils are presented with need to be both enjoyable and challenging so the pupils can gain a deeper understanding of the mathematics, whilst providing opportunities for pupils to collaborate, ensuring each pupil feels equally valued (Kyriacou & Goulding, 2005).

The behaviour of undergraduate mathematics students was seen to be similar to secondary school pupils as a study which looked into their experiences found that one of the main factors which influenced their attitude was how successful they were at the subject (Brown, et al., 2005). When the students felt that they were not succeeding at the subject they had little motivation other than trying to maintain their self-esteem and gaining credentials, and by the end of their course, the only students who described themselves as 'mathematicians' were a small number who were considering going into lecturing, the majority of the students did not feel a strong commitment to the subject (Brown, et al., 2005).

This disillusionment may be due to how obvious failure in mathematics is compared to other subjects. Students who struggled to follow their lectures were very aware of their lack of success (Brown, et al., 2005). Many of the students had been successful in mathematics without having to work hard and whilst some adapted to having to work hard at university, many did not, becoming slightly depressed in their second year because they had lost confidence that they were succeeding in their degree (Brown, et al., 2005).

In the questionnaires that the students completed at the start of their course, many of them commented on how useful mathematics would be in their life and for future careers, however, as their course progressed, many of these same students became disappointed that much of the mathematics they were studying had become too pure and lost its relevance and usefulness to them (Brown, et al., 2005). The changes in feelings towards mathematics seen in university students seem to mirror those seen in secondary schools.

For mathematicians it is the journey to work something out and not the final proof that is exciting and this beauty is often missing from schools today, even though amazing mathematics can even be shown with primary school mathematics (Gallagher, 2014), however many pupils are aware of the feeling of being 'taught to the test' and Reay and Wiliam (1999) found that pupils as young as ten or eleven were very aware of the effects of the SATs assessments. Reay and Wiliam also noted the pressure that teachers were under to try to improve the scores which pupils' achieved, irrespective of the impact that this might have on the pupil, concluding that the more schools are driven to meet targets and improve performance, the more likely it is that

> *students will be inscribed into school practices entirely in terms of their ability to contribute to the school's target for the proportion of students achieving specified levels in the national curriculum assessments* (Reay & Wiliam, 1999, p. 353).

Whilst this is describing a situation for primary schools, it can be applied to secondary schools trying to meet GCSE targets.

One of the findings of a study which asked pupils to draw a mathematician at work was an image of small children, powerless against a threatening, authoritarian mathematician, which implies that pupils often feel intimidated by their teachers in lessons (Picker & Berry, 2000). Many pupils projected superpowers on to their mathematician which represented how invisible mathematical processes can be to pupils; appearing as a power as opposed to a skill that can be learnt (Picker & Berry, 2000).

Clearly the experiences that pupils have in their mathematics lessons are going to shape their attitude and motivation towards the subject. These experiences might be cumulative as the pupils move through school and experience new topics, teachers, schools etc. As pupils get older mathematics might lose its relevance.

2.5.1.6 Mathematics anxiety

As mathematics increases in difficulty and the pupils experience failure, many become anxious about mathematics lessons and develop mathematics anxiety. Mathematics anxiety has been discussed since the 1950s and research into the area has shown that it can be separated from general anxiety, as being an emotional reaction to numbers and mathematics, which is not related to lower levels of general intelligence but is linked to lower grades in mathematics (Batchelor, et al., 2017). Definitions include feeling helpless, mentally disorganised and experiencing dread when faced with a mathematical problem which requires manipulating number and shapes (Zakaria & Nordin, 2008). The anxiety does not appear to have a single cause according to Norwood (1994) but is rather the accumulation of factors such as truancy, teacher attitude, learning mathematics without understanding through rote fashion, and low self-image and coping skills (Norwood, 1994). Greenwood (1984) stated that the primary cause of mathematics anxiety was teaching which did not encourage understanding and reasoning and that the problem of anxiety would not reduce until mathematics was taught through problem solving (Greenwood, 1984; Zakaria & Nordin, 2008). This is supported by Butterworth (1999) who attributed mathematics anxiety to a lack of understanding and suggested that teaching methodologies should move away from drill and repetition, towards learning through understanding (Butterworth, 1999), and Stuart (2000) who explains that a lack of confidence in dealing with mathematical situations results in individuals who are not fluent in calculations and are less likely to have discovered strategies to support them when dealing with mathematics (Stuart, 2000; Zakaria & Nordin, 2008).

These emotional feelings are not just limited to the classroom but can arise whilst doing mathematics in everyday activities e.g. personal finance or shopping (Batchelor, et al., 2017). A study by Hembree (1990) found that college students who had a greater level of mathematics anxiety achieved lower in mathematics, took fewer mathematical courses and felt negatively about their mathematics capabilities than those who had a low level of mathematics anxiety (Hembree, 1990).

Research by Zakaria and Nordin (2008) found that there was a significant, weak negative correlation between mathematics anxiety and achievement and a strong negative correlation between mathematics anxiety and motivation. They also found a low positive correlation between motivation and achievement (Zakaria & Nordin, 2008). This means that increased mathematics anxiety could result in lower achievement and reduced motivation, but low motivation also means lower achievement, so mathematics anxiety affects achievement in more than one way. Although a negative relationship between mathematics anxiety and mathematics performance has been found, the direction of this relationship is unclear i.e. does mathematics anxiety cause someone to have a poorer mathematics performance or does poor mathematics performance make a person anxious towards mathematics? (Carey, et al., 2019). The two possible directions of this relationship have been summarised by Carey et al. (2015) in two different theories: The Deficit Theory and the Deleterious Anxiety Model (Carey, et al., 2015).

The Deficit Theory suggests that people who have a poorer performance in mathematics are more likely to become anxious about mathematics, see Figure 7:

Poor mathematics performance → Increased mathematics anxiety

Figure 7 The Deficit Theory model (Carey, et al., 2019, p. 14)

Research has shown that children who have a difficulty learning mathematics, such as dyscalculia, have higher levels of mathematics anxiety than those without such a difficulty (Passolunghi, 2011) and longitudinal studies have found that higher mathematics anxiety may be linked to a decreased mathematics performance in the previous year (Ma & Xu, 2004). It has also been suggested that adults with mathematics anxiety may have difficulties with basic number skills which indicates that their performance was weakened at an early stage, before they had developed mathematics anxiety (Maloney, et al., 2011) (Carey, et al., 2019).

Despite all of this research, not everybody who suffers from mathematics anxiety has poor mathematics performance and not every person who has a poor mathematics performance develops mathematics anxiety (Carey, et al., 2019).

The Deleterious Anxiety Model suggests that mathematics anxiety affects an individual's performance in mathematics, see Figure 8:

Figure 8 The Deleterious Anxiety model (Carey, et al., 2019, p. 15)

These pupils may avoid choosing mathematics when it is optional (Hembree, 1990) and have a tendency to answer a question quickly in order to avoid the situation of increased anxiety but the answer is often inaccurate (Ashcraft & Faust, 1994). This tendency towards mathematics avoidance in people with high mathematics anxiety has a negative impact on learning and test performance (Carey, et al., 2015) and might distract them from what they are trying to learn or recall (Carey, et al., 2019).

Due to the range of arguments in support of these two models, Carey et al. (2015) suggest a third model which is cyclical i.e. mathematics anxiety may cause a decrease in mathematics performance which in turn may produce mathematics anxiety, see Figure 9:

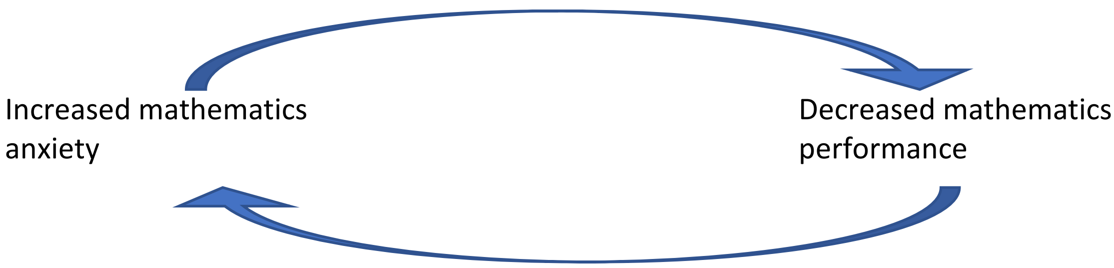


Figure 9 A cyclical model of mathematics anxiety (Carey, et al., 2019, p. 16)

The factors causing mathematics anxiety are not yet fully understood (Eden, et al., 2013), but they can typically be classified into environmental factors such as negative home experiences (Simpkins, et al., 2005) or negative experiences at school (Newstead, 1998), personal factors such as self-efficacy (Jameson, 2014) and cognitive factors (Batchelor, et al., 2017).

Traditionally it was thought that mathematics anxiety came as a result of more complex mathematics, at the end of primary school (Maloney & Beilock, 2012), but recent studies with adults, which have shown that mathematics anxiety is linked to difficulties with low-level mathematics as well as higher-level work, have challenged this view (Lindskog, et al., 2017; Maloney, et al., 2011; Maloney, et al., 2010; Nunez-Pena & Suarez-Pellicioni, 2014). Other studies have shown that mathematics anxiety is present in younger pupils, for example Young et al. (2012) found that children as young as seven can develop mathematics anxiety (Young, et al., 2012). This anxiety then follows the pupils through to secondary school and university with low achievement often going together with mathematics anxiety, and pupils with little or no mathematics anxiety often having higher motivation (Zakaria & Nordin, 2008). Due to developmentally appropriate mathematics anxiety scales, mathematics anxiety has been able to be investigated in younger years, however these have given mixed results so further research is needed in this area (Eden, et al., 2013; Batchelor, et al., 2017).

Although general anxiety does not necessarily change with age, mathematics anxiety has been seen to increase with age and the relationship between mathematics anxiety and mathematics performance becomes more specific with age (Carey, et al., 2019). Pupils in primary school indicated that the transition from primary to secondary school had been a cause of their mathematics anxiety as the work appeared to be harder and they were unable to cope. They also felt under greater pressure from tests, SATs, and more homework (Carey, et al., 2019).

Research by Carey et al. (2019) found that some other triggers of mathematics anxiety were the transition from primary school to secondary school and how the pupils are grouped, especially if it involved work being compared between peers. Pupils who had mathematics anxiety appeared more sensitive to negative experiences such as a poor performance in a test or being teased by their peers and in extreme cases the pupils' overwhelming negative emotions made them dread their mathematics lessons, act poorly in class so that they had to be removed from the classroom or resulted in them becoming tearful. The pupils in the study discussed other triggers such as mathematics being harder than other subjects which resulted in a lack of confidence or being compared to siblings or peers and fearing ridicule (Carey, et al., 2019).

Teachers have an impact on mathematics anxiety as well, with primary school pupils feeling confused by different teaching methods and secondary school pupils struggling with poor teacher explanations or interactions. The transition to secondary school resulted in harder work and greater pressure from tests which left the pupils feeling as if they could not cope and often created anxiety towards mathematics (Carey, et al., 2019).

Research has found that students who choose to study mathematics after secondary school are better protected from negative experiences such as a poor result if they have a positive attitude towards mathematics and no mathematics anxiety. This suggests that if pupils experience a positive affect towards mathematics, this may stop them from giving up when they are faced with future difficulties (Hurst & Cordes, 2017).

Studies which have investigated the influence that parents have over a child's mathematics anxiety have found that parental expectations had a positive effect on children's problem-solving capabilities by reducing their anxiety levels (Vukovic, et al., 2013). Jameson (2014) found that there was no significant relationship between the mathematics anxiety of parents and their children's anxiety or engagement in mathematics activities (Jameson, 2014). However, a study by Maloney et al. (2015) found that the mathematics anxiety of parents predicted their child's achievement and anxiety in mathematics over the school year, but only for those children whose parents were frequently involved and helping them with their homework (Maloney, et al., 2015; Batchelor, et al., 2017).

Gender differences in mathematics anxiety have found that despite there being no difference between girls' and boys' performance in primary schools, girls have a higher level of mathematics anxiety at that age. Mathematics anxiety was also found to have a greater impact on secondary school pupils than primary school which may be as a result of the accumulation of previous mathematics experiences (Carey, et al., 2019).

To reduce mathematics anxiety, it is suggested that teachers should create positive learning environments which are free from tension and situations which may cause embarrassment and humiliation to the pupils. This should increase achievement (Zakaria & Nordin, 2008) because when a pupil does not believe that they can do well in mathematics i.e. has a low self-efficacy, they experience a greater level of anxiety on a high valued task (as opposed to a low valued task), whilst pupils that believe that they can do well, experience less anxiety overall, regardless of the task (Hurst & Cordes, 2017).

It is clear from this section that the presence of mathematics anxiety affects how a pupil feels towards mathematics and will have a big impact on their attitude and motivation in the subject. This anxiety may already be present when the pupils start secondary school or may develop as they get older. Factors which affect mathematics anxiety are numerous and include previous experiences, self-efficacy, teaching styles, tests, perceived rote learning, parental influence, and gender.

2.5.2 System factors

2.5.2.1 Prior attainment grouping

Due to the government's mastery agenda at the time of writing up the thesis, practices have changed since the research cohort were in primary school, when it would have been normal to place children in prior attainment groups. As the research cohort would most likely have been exposed to this grouping at primary school, I have included literature about this area in this chapter.

A conservative estimate is that eighty-eight percent of children that are placed into sets at age four, remain in those groups until they reach school-leaving age, according to an editorial in 2002 (Dixon, 2002) and prior attainment grouping is more common in mathematics and science than any other subject (Kutnick, et al., 2005). A school should provide a stimulating environment for students, where their interest can be fostered and where teachers are able to recognise and develop the potential of students. As children develop at a variety of rates and show different interests during various stages of development, teachers need to help students develop their potential throughout their school years (Boaler, 2005). It is a challenge to support students in this way if they are placed in a low prior attainment set at an early age, as they are told that they are achieving at a level which is lower than their peers, they are given work which is less of a challenge and potentially less interesting, separated from other students who may stimulate their thinking and potentially taught by teachers who are less qualified or less experienced (Boaler, 2005). Wiliam and Bartholomew (2001) found that in terms of mathematics attainment, it mattered more what set a pupil was put into than what school they went to, something parents have no control over (Wiliam & Bartholomew, 2004).

In effect, a child's future might effectively be decided for them by age four, despite what is known about child development and all of the work that goes on in school throughout a child's life (Boaler, 2005). Despite this, and despite the performance of English schools, prior attainment grouping is still common practice (Boaler, 2005). The location of the UK towards the bottom of the PISA's equality measure is in part due to this practice, according to Boaler, and should be a concern, as the government claim to promote social justice and citizenship (Boaler, 2005).

The fact that the UK used prior attainment grouping so widely suggests that there are advantages to this practice, and a study into prior attainment grouping on attainment in

English, mathematics and science in 45 UK secondary schools, at the start of the century found that the number of years that a pupil had been taught in a set as opposed to a mixed prior attainment group improved mathematics performance in key stage three, but had no impact at key stage four (Ireson & Hallam, 2001; Ireson, et al., 2002). However, they did find that which set you were in affected a pupils' achievement at both key stages with a high set achieving a quarter of a GCSE grade more than a middle set and a low set a quarter of a grade below (Ireson & Hallam, 2001; Ireson, et al., 2002) but the fragility of these effects was noted by Wiliam and Bartholomew who suggested that ability grouping cannot be understood on its own but to appreciate the impact on attainment and attitude the detail of how setting is practiced in schools (e.g. criteria for sets) also requires looking at (Wiliam & Bartholomew, 2004).

A different study involving over 3000 schools showed that borderline pupils who were selected for a grammar school gained significantly higher results than their peers who attended a non-selective school and were equally able (Schagen & Schagen, 2002). This complexifies the story because it brings in other factors which affect pupils' achievements such as aspirations and teachers' expectations as well as school factors i.e., a pupil in a high set in one school might not be in a high set in another school which has a different intake.

In the 1970s the disadvantages of mixed prior attainment teaching were thought to be due to the difficulty in providing work at an appropriate level for high and low prior attainment pupils, with critics suggesting that it did not motivate or increase the achievement of higher attaining pupils, whilst the advantages of mixed prior attainment classes were mainly viewed societally (Hallam & Ireson, 2003). Reid et al (1982) found that teachers believed that mixed prior attainment classes were inappropriate for teaching mathematics (Reid, et al., 1982). A more recent study which investigated the attitudes of teachers towards prior attainment groups, found that teachers believed that prior attainment groups protected higher attaining students from negative peer pressure and allowed them to maximise their attainment, but that pupils in lower prior attainment groups were more likely to have lower self-esteem and poorer behaviour due to feelings of alienation (Hallam & Ireson, 2003). The teachers felt that teaching, classroom management and meeting the needs of all pupils was easier with prior attainment grouping (Hallam & Ireson, 2003), however research by Boaler et al. (2000) found that the idea of pupils being at the same prior attainment masks the considerable variation that occurs within a set (Boaler, et al., 2000). In a study of six schools, they found that pupils who were taught in mixed prior attainment groups were given work that was at an appropriate pace and level for them, as 77% of pupils taught in sets felt that the work was at the right level for them but 81% of pupils taught in mixed prior attainment groups felt the work was appropriate for them (Boaler, et al., 2000)

Equity is defined by Gutierrez (2002) as

> *erasure of the ability to predict students' mathematics achievement and participation based solely on characteristics such as race, class, ethnicity, sex, beliefs and creeds, and proficiency in the dominant language* (Gutierrez, 2002, p. 9).

However, the subject areas of mathematics and science are both ones in which there are considerable inequalities in terms of achievement and participation, and an examination of UK performance and participation in these subjects by gender, social class and ethnicity show that there are inequities for all of these groups. Although we would like to think of students as being treated fairly and equally in schools, achievement and participation are predictable if gender, social class and ethnicity characteristics are known (Boaler, et al., 2011).

Prior attainment grouping has been shown to have a detrimental effect on middle and lower attaining students and to have no impact on higher attaining students, whereas mixed prior attainment grouping has a positive effect on middle and low attaining students and does not negatively affect the high attaining students (Boaler, 2013). More experienced teachers are often given the higher attaining sets (Francis, et al., 2019), despite evidence which shows that good quality teaching has a greater benefit on lower attaining pupils (Black & Wiliam, 1998). Working class pupils have been found to be more likely to be put into a lower set even if they have the same prior attainment as a middle class pupil and research has shown that social class was the most important factor when putting pupils into sets (Dunne, et al., 2007).

Whether students are told what prior attainment group they are in or not does not matter, the students who are exposed to prior attainment groups experience a change in their belief about their own potential. The message to the students is clearly that some students are clever and some are not (Marks, 2014; Boaler, 2013). In her case-study research into the effects of setting on low prior attainment pupils, Marks (2014) found that the practice of putting lower attaining pupils in small groups may be a contributory factor to low mathematical gains and actually be widening the gap in attainment (Marks, 2014).

Countries which group students by prior attainment at a younger age tend to have larger social differences, and the results of students in schools which differentiate early depend more on parental status, however when schools differentiate later, the students appear to be able to play a bigger role in the results (Green , 2003). Evidence has shown that the economic status of children is much more strongly connected to the economic status of parents than it was in previous generations (Blanden, et al., 2002). Research which looks at prior attainment grouping has repeatedly shown a high correlation between sets and social class, which results in a disproportionate number of students from working-class backgrounds being put into a low prior attainment set (Boaler, 1997). The achievement of students in these lower prior attainment sets is limited if expectations are low, whilst in high prior attainment sets achievement can be affected by the speed, pressure and anxiety created by being in an environment which can be highly competitive. This can particularly affect the performance of girls (Boaler, 1997).

However, prior attainment grouping has been found to affect higher achieving pupils too as fixed mindsets are found in students across the prior attainment range and some students with the most damaging beliefs about fixed attainment are high-achieving girls, as from an early age these girls have often received damaging praise, which focuses attention on the notion of being smart or clever. Therefore, as soon as these students fail at a task they assume that this is because they are not smart after all (Dweck, 2007). Even when high achieving girls are placed in top sets this causes them to fear challenge and struggle to cope with failure as they feel that they are smart and therefore need to preserve the image of being smart (Boaler, 1997). Although there is not much research into boys at this level, this claim could apply to boys too.

If pupils are set by prior attainment, it is hard for them to remain motivated if they are in a set which denies them access to higher grades at GCSE, and if they are set by gender then the boys' class can sometimes enhance the 'laddish' behaviour that gender grouping was trying to combat (Kyriacou & Goulding, 2005). Boaler et al (2000) conclude with a worrying statement that the British focus on ensuring that some of the most able pupils achieve the highest standards, has created a situation which leaves the majority of pupils achieving far below their potential (Boaler, et al., 2000).

This section has shown the effects that prior attainment grouping can have on pupils of all abilities, and as setting is widespread in UK secondary school mathematics classrooms and in the study school, it is clear that it will be having an impact on the motivation and attitudes of pupils. The notion that pupils receive a message about their own prior attainment, even if they do not know what set they are in led me to research the effect selection has on pupils, as the study school is in a selective area. Selection and its impact on pupils are discussed in the next section of this chapter.

2.5.2.2 Selection

The study school is a comprehensive secondary school in a county which still has the grammar school system and has two single sex grammar schools next door to it. Despite the abolition of the traditional 11+ exam in the 1960s, 163 out of 3113 state-funded schools in England are still selective grammar schools (Smith-Woolley, et al., 2018). Ninety-three percent of children attend state-funded schools with around seven percent being privately educated, and many of these fee paying schools are academically selective (Smith-Woolley, et al., 2018). It is believed that these selective schools set pupils on a different trajectory with research linking these schools to higher academic achievement, greater acceptance at university and the potential for higher earnings compared to non-selective schools (Smith-Woolley, et al., 2018). Despite non-selective schools in selective areas being called comprehensive schools, it can be argued that they are similar to secondary modern schools as they have very few pupils of high ability (Jesson, 2006).

Grammar schools are typically located in more affluent areas and on average attract pupils with a higher socioeconomic status (Smith-Woolley, et al., 2018) and the UK Department for Education has shown that for the academic year 2016-2017, selective schools achieved the highest results, when compared to non-selective schools in highly selective areas and other non-selective schools, with an average Attainment 8 score of 69.3, and Progress 8 score of 0.45, which is a statistically significantly above the national average (Government, 2018). This report found that non-selective schools in highly selective areas (like the study school) had the lowest attainment of the three groups, with an average Attainment 8 score of 42.1, and a Progress 8 score of -0.14, which was statistically significantly below the national average (Government, 2018). The other non-selective schools, which 89% of pupils in state-funded mainstream schools attend, so contribute the most to the national average, have an average Attainment 8 score of 46.5, and Progress 8 score in line with the national average (Government, 2018). Much of the difference in attainment was due to the variety of prior attainment of pupils between each school type which is summarised in Table 1:

	Selective Schools	**Non-selective (selective area)**	**Non-selective**
Prior attainment above the expected level at the end of primary school	93.7%	30.3%	41.0%
Prior attainment below the expected level at the end of primary school	0%	15.9%	13.0%
Average Attainment 8 score for pupils with prior attainment above the expected level	70.2	55.2	59.8

Table 1 Percentage of pupils at the end of KS4 (who data was available for)

It is clear from the table that pupils with prior attainment above the expected level achieved higher results at selective schools than the two other types of school (Government, 2018).

A major concern of the selective system is that being placed in a school with a poor reputation will negatively affect pupils' self-esteem and the perception of their academic capabilities as it has been shown that being placed in a school with a low status affects other people's image of a pupil, which in turn may lower their personal self-worth (Gamoren & Berends, 1987; Oakes, 1985; Ahmavaara & Houston, 2007). A study by Schagen and Schagen (2002) found that borderline pupils who were selected for a grammar school gain significantly higher results than their peers who attend a non-selective school and are equally able, and therefore questioned if it was fair for a pupil's future to be so strongly changed by one test (Ahmavaara & Houston, 2007). Whilst pupils in grammar schools achieve well, Jesson (2006) found that lower prior attainment pupils achieved better in true comprehensive schools than in non-selective schools in a selective area (Ahmavaara & Houston, 2007).

A study by Ahmavaara and Houston (2007) which consisted of 856 English secondary school pupils (years 7 and 10) from two selective and two non-selective schools, found that the aspirations of the pupils were strongly related to the type of school they attended, with those in a selective school having higher aspirations for their achievement (Ahmavaara & Houston, 2007). They found that the pupils in the selective school had a higher perceived confidence in their own intelligence and proposed that this could be consistent with Dweck's findings (1999), as pupils who have a more flexible theory of intelligence are more motivated and persistent and therefore more likely to be selected for grammar school. This motivation leads to higher levels of aspiration (Ahmavaara & Houston, 2007). However this link was not mirrored in the non-selective schools where they found no relationship between theory of intelligence and aspiration, which may be because the pupils feel helpless and that they are bound to achieve poor results no matter how hard they try, so their efforts do not have a big impact on their achievements (Ahmavaara & Houston, 2007). These pupils may also be trying to preserve their self-esteem because if they believe that their intelligence is fixed then they cannot change it so failing to get in to the selective school is not due to their effort or motivation (Ahmavaara & Houston, 2007).

The effects of the study school being a non-selective school in a selective area are likely to impact the pupils from the point in time that they are allocated their secondary school place, or perhaps even before when their peers take the grammar school test and they are deciding whether to (what subconscious message do they take from not being entered for the test), or they are not successful, and this effect on their self-esteem, motivation and effort will have a big impact on how the pupils respond to their secondary mathematics education.

My experience as a teacher in the study school, was that being good at mathematics (or many academic subjects) was not deemed to be 'cool' and the idea of mathematics being 'boring' rippled through many lessons and impacted on the enjoyment for many pupils. The comments that I frequently heard at parents evening such as "I could never do maths" and "she/he isn't a maths person" plus the association of mathematics as 'uncool' led me to research the role of stereotypes in mathematics, which is discussed in the following section.

2.5.3 General factors

2.5.3.1 The role of stereotypes in mathematics

There is a stereotype of mathematicians and scientists as being awkward, isolated and always working out equations with many believing that being seen to be good at mathematics is bad for their popularity (Hurst & Cordes, 2017). Pupils who were labelled as gifted and talented were asked to produce posters based on what it meant to be classed as such and whilst most of the comments were positive because the label helped them to feel special, offered them opportunity and gave them confidence in themselves; many pupils were also concerned that they were called a 'boff' or 'swot' and that their peers may be jealous of them. Many of the pupils had also been victims of bullying and name calling and felt under an added pressure from teachers, parents, and peers to do well. They felt that they had set themselves unrealistically high expectations due to the external pressure put on them (Fox & Pope, 2005) (the role of parents and teachers was discussed in section *2.5.1.4* earlier in this chapter).

Picker and Berry (2000) found that many teachers were unaware of how little knowledge their pupils had about mathematicians and how this knowledge can play a part in changing and shaping pupils' views about mathematicians (Picker & Berry, 2000). How famous mathematicians are presented to pupils can affect their mindsets because if they are portrayed as someone who loved mathematics and devoted themselves to it then this implies a growth mindset as mathematics is something that can be worked on, whereas to say that they were born a genius reinforces the idea of a fixed mindset (Dweck, 2008). The stereotype of a mathematician working alone is very common, but it is not necessarily accurate so pupils should be exposed to the careers that require a good mathematical background, especially those involving helping and working with others, which is often a popular career choice, so that pupils are encouraged to continue with mathematics (Hurst & Cordes, 2017). Henrion (1997) argued that mathematics is more likely to be viewed as irrelevant to pupils if it becomes dehumanised and decontextualized and that this may discourage them from pursuing it further (Henrion, 1997).

Stereotype threat is when people are lead to behave in a way which is consistent with a stereotype because of the activation of a self-relevant stereotype, for example African Americans perform worse on a test of intelligence when race is included as an aspect of the question, or women perform worse on mathematics tests when their gender is highlighted (Dar-Nimrod & Heine, 2006). Dar-Nimrod and Heine (2006) conducted a study to investigate how the mathematics performance of women was affected by the threat of stereotype. In two experiments, college aged women completed two mathematics sections of a test, separated by a verbal section, which contained a comprehension essay to read. The content of the essay varied with some arguing that differences in gender in mathematics, although being of the same magnitude, were due to either genetic or experimental causes. There were also two additional essays to test the threat of stereotypes. One of these essays argued that there were no gender related mathematics differences, whilst the other made the reader aware of gender differences without explicitly addressing the mathematics stereotype. The study was replicated with a different experimental design but in both cases women who were exposed to the essay describing experimental causes or no genetic difference performed significantly better than those women who read about the standard stereotype or of a genetic difference. The conclusions of the study were that the threat of stereotypes can be reduced, or even eliminated if women are shown experimental accounts of where the stereotypes originate so that they are provided with explicit experimental arguments against genetic gender differences (Dar-Nimrod & Heine, 2006). This could be interpreted in relation to mindset with the explanation of the gender difference in mathematics achievement being as a result of genetics (fixed), whilst the other group was told that the difference between genders was as a result of their different prior experiences (growth). In both studies, those women that were given the fixed mindset explanation performed significantly worse (Dweck, 2008).

A second study followed several hundred female students through their calculus course at an elite university in the USA, in order to understand the influence that mindsets had on their sense of belonging in the mathematics class, their desire to pursue mathematics in the future and their grades in mathematics. Again, the students' mindset as well as the mindsets of those around them was an important factor. The students with a growth mindset were less vulnerable to the negative effects of stereotypes, even if they were prevalent in their mathematics environment, they still felt that they belonged in the class, intended to study mathematics in the future and earnt high grades. Contrastingly, students with a fixed mindset were more affected by the negative stereotypes and if these negative stereotypes were widespread in their mathematics environment, the students displayed a degenerating sense that they belonged in the mathematics class which was supplemented by a decrease in their intention to take mathematics in the future and a decrease in their final grades (Dweck, 2008). However, there are several studies referred to in Dweck's work which make claims to unpublished research, therefore these should be approached with caution.

A study into the sense of belonging that women had towards mathematics included nine hundred and ninety-seven participants at a highly selective north-eastern United States university and asked participants to complete a scale to show how much they felt they belonged to mathematics during their calculus course. The second step in the study, which involved one hundred and thirty three participants, was to examine the relationship between the sense of belonging and a student's intention to pursue mathematics in the future (Good, et al., 2012).

The results of this study were that students who felt that their mathematics ability was acquirable were able to maintain a high sense of belonging, which resulted in a reduction in the power of perceived stereotypes to alter a female student's desire to study mathematics or their achievement in mathematics. A female's sense of belonging should therefore be supported by communicating that mathematical intelligence is incremental in an educational environment and may help to reduce the culture of talent that is prevalent in classrooms and which can send out a fixed-ability message. Instead, learning environments should foster a culture in which anyone can develop their skills, which may allow for more females to feel that they belong in a mathematical environment and encourage more women to pursue an education in mathematics and science (Good, et al., 2012).

The terms mathematician and mathematics clearly conjure up many images and emotions for individuals which are developed through their own experience as well as that of society and other influencers such as parents and teachers, and these have the potential to have a large impact on the level of enjoyment, interest, motivation and determination that someone will have towards the subject.

Throughout the reading on stereotypes in mathematics, mindsets and resilience, the differences in gender were noted and it is well known that more women are being encouraged into mathematics and science related careers. The following section looks at the issue of female underrepresentation in mathematics and the possible reasons behind it.

2.5.3.2 Female underrepresentation

Women make up over half of the world's population but only 28% of scientific researchers worldwide are women. The low participation levels of women in STEM subjects can be seen at all levels of education with participation decreasing as the level of education increases. This continues into the workplace with an absence of women in high level managerial or decision-making posts (UNESCO, 2016). There has been an increase in the percentage of degrees going to women in the areas of science, technology, engineering and mathematics but certain disciplines still have a considerable gender gap (Good, et al., 2012). The number of women achieving bachelor's degrees in computer science, mathematics and engineering has declined in the USA, for example, in 2007, 81% of engineering and computer science bachelor's degrees were earned by men and 79% of physics degrees, and women earned 40% of the science and engineering doctoral degrees in 2006 (Foundation, 2010). There is a growing belief that mindsets are playing a large role in the underachievement in mathematics and science of women and minority groups, as well as their tendency to not pursue a career in these areas (Dweck, 2008).

In countries where there is a gender gap in the performance of students in secondary schools, females tend to be underrepresented in STEM subjects in higher education and in the workplace. In Japan women make up 15% of researchers whereas 52% of researchers in Kazakhstan are female and 53% in Thailand (UNESCO, 2016). In contrast, in more mathematical based subjects, in Kazakhstan only 32% of workers in engineering, construction and manufacturing are female and 24% in Thailand (UNESCO, 2016). This higher concentration of females in science as opposed to mathematical based STEM subjects is a pattern which is seen among other Asia-Pacific countries (UNESCO, 2016).

It is thought that gender differences when mathematics becomes optional may be in part due to differences in attitudes and beliefs about mathematics (Hyde, et al., 1990), perhaps because it is still thought that women perform worse than men in mathematics and science, even though this is not true (Spelke & Ellison, 2009).

There is a long history of gender inequities in mathematics and science in the UK, with girls characteristically achieving less than boys at GCSE level. Due to research in this area, the achievement level is now equal, however mathematics and science are the only subjects in which girls have not pulled far ahead of boys and the results in 2009 showed that for the first time since 1997, in mathematics, boys slightly outperformed girls, which may have been due to the removal of coursework at that time (Boaler, et al., 2011). In a report which looked at the participation in mathematics and science in 2007, 80% of male students who achieved an A* grade at GCSE chose to take it for A-level as opposed to only 64% of female students (Boaler, et al., 2011). Noyes (2009) showed that after GCSE attainment, being female had the greatest negative effect on the likelihood of taking mathematics A-level, so like for like fewer female students took mathematics A-level (Noyes, 2009).

There is often confusion when students learn new skills in mathematics and science as they are faced with new concepts, but a study by Dweck found that bright girls did not cope well with this confusion (Licht & Dweck, 1984). In the study, students were classified as helpless (they were more likely to attribute failure to uncontrollable factors and decrease their effort and concentration when faced with difficulties) or mastery-orientated (students who confront obstacles and do not dwell on difficulties but focus on strategies to solve problems). Within these groups the students were then randomly assigned to one of two learning situations. One group had some confusing material near the beginning of the task, and half did not. The confusing material was not relevant to the topic so any differences in the two groups could not be attributed to the quantity of relevant information that the groups were shown, but instead on motivational consequences as a result of being shown the confusing material (Licht & Dweck, 1984).

When students in the helpless group were faced with confusing material, they showed considerably poorer mastery of the overall target material than the mastery-orientated style students (Licht & Dweck, 1984). These differences were not due to their intellectual ability to understand the target material because both groups performed as well when they were not presented with the confusing material. Instead, the results suggest that their motivation may be affected when students with a helpless characteristic are faced with confusing material, which leaves them less able to cope with difficult intellectual situations (Licht & Dweck, 1984).

In subjects where confusion and failure can be easily avoided then students who had a helpless[2] mindset would not perform any differently to mastery-orientated students but in subjects where students encounter more difficulties, such as mathematics then it could be expected that students with a helpless mindset will be hampered. A further finding was that in boys, the less able students were more hampered, but among girls, the more able students appeared to have been the most debilitated by the confusion material (Licht & Dweck, 1984).

The students were also asked to rate their ability in comparison to other students on a scale from 1-25. Boys who were confronted with the confusing material excelled if they viewed themselves as intelligent but the difference between the opinions had no impact if there was no confusing material. For girls however, the ones that viewed themselves as intelligent, were most likely to be debilitated by the confusion in the task (Licht & Dweck, 1984). The higher a girl's IQ was, the worse they performed, with many girls unable to

[2] The use of the word 'helpless' does not assume 'learned helplessness' (Dweck & Reppucci, 1973; Seligman & Maier, 1967) but is used for its everyday meaning i.e., the pupils feel helpless.

learn the material once they had experienced the confusion. The confusion did not hinder the performance of boys. In fact they were energised by it, with the boys with a higher IQ learning better than those with a lower IQ (Licht & Dweck, 1984). These students were in fifth grade with girls still achieving better grades than boys in almost every subject. The task did not involve mathematics, so gender stereotype was not present and there was no stigma attached to the girls' achievements yet. Therefore the conclusion to the study is that there is a difference in how students cope when they are faced with a situation which questions their ability; whether this has the effect of challenging them, or demoralising them (Licht , et al., 1984).

There is a link between gender and mindset beliefs because findings have shown that although there is a sizeable gap between the mathematics grades of males and females by the 8^{th} grade, the gap is only present in students who believe that their intellectual ability is innate (Dweck, 2007). If students believed that their ability could change, the gap was almost non-existent. Despite male and female students having the same starting ability, the study showed that male students with a growth mindset achieved slightly better than their fixed mindset peers but female students with a growth mindset did a lot better than their fixed mindset peers (Dweck, 2007). In short, girls who believed that their ability in mathematics was a quality which could be developed fared well, whilst those who believed that their ability was fixed did not (Dweck, 2007). When a girl with a fixed mindset faces a challenge then they are led to question their ability because if they are struggling then they feel that they are not gifted and if their initial grades are poor then they feel that they must lack ability (Mueller & Dweck, 1998).

If a female student believes that mathematics ability is a gift, then they may also be vulnerable to stereotypes so that if they are in an environment that degrades their gift then they may lose the aspiration to continue in that field and so may not continue with mathematics education, or follow a career in mathematics or science (Dweck, 2007).

To give female students longer lasting confidence, their ability should not be praised because this reinforces the notion that ability is a gift and makes them reluctant to take on a challenge (Dweck, 2007). Instead, an intervention in a junior high school showed that if you teach students that their intellectual skills can be developed, as opposed to being gifted to them, then important gains can be made in the achievement of female mathematics students. This message can be conveyed through an intervention or in the portrayal of mathematical ability as being something that can be developed (Blackwell, et al., 2007).

Although the possibility of a gift that makes males better at mathematics and science than females, cannot be completely ruled out, females do have all the ability they need to be just as able in mathematics related careers, their abilities just need to be fostered in a way which allows them to meet their potential (Dweck, 2007).

Gender may therefore have a big impact in the motivation and achievement of pupils in the study school. With girls in higher attaining sets being affected by potential failure if they have a fixed mindset. The cumulative effect of failing to get into grammar school, being set for mathematics and being a girl may be affecting their motivation and attitude towards mathematics.

The final factor which impacts all areas of school life especially the motivation and attitude of pupils, is the role of adolescence, and this is discussed in further detail in the next section.

2.5.3.3 The role of adolescence

Adolescence is a period of transition between childhood and adulthood which brings with it feelings of anxiety, as adolescents think about their future and the complexities of being an adult. They may struggle to find the balance on things in their lives such as effort at school, either compulsively overworking or not putting in enough effort. The transitional period has a great impact on their lives, and as adolescents spend more time in school than anywhere else other than their bed (Eccles & Roeser, 2011) it could have a large impact on their motivation and attitude in mathematics.

Research suggests that for some, early adolescence is the start of a downward spiral that can lead to academic failure and dropping out of school (Eccles, et al., 1993). Simmons and Blyth (1987) found a decline in the school grades of some early adolescents as they moved into junior high and that the magnitude of the decline gave a prediction for subsequent failure or school dropout (Eccles, et al., 1993). A gradual decline in academic motivation can be seen in adolescents such as attention in class, attendance and perception of self (Eccles, et al., 1993).

The 'stage-environment fit' was suggested by Eccles (2004) and argues that in order to keep pupils motivated to learn at secondary school, the school (environment) should be constructed to meet the needs of the stage of the pupils (early to middle adolescence) (Eccles , 2004). Adolescents should have more opportunities to control their development and with time be allowed more space to extend their cognitive skills and to be shown greater evidence of the purposes of their education (Coleman, 2011). If schools do not meet the changing developmental needs of the pupils, then they will become progressively more dissatisfied with the education system (Zimmer-Gembeck, et al., 2006).

The central issue surrounding adolescence is forming an identity that sets a foundation for adulthood, and school is one of the important contexts where this formation evolves (Abbassi, 2016). The large amount of time that adolescents spend in school is one of the reasons why schools are so important in identity formation but also the activities and programs that the adolescents are involved in can help them to discover and develop their interests and abilities (Abbassi, 2016). Adolescents also have to make decisions and choose pathways for things such as career, gender, life values and attitudes for their futures (Abbassi, 2016). The decisions that are made in school are part of the adolescent's identity and can lead to commitments, which is the first sign of achieving an identity (Lannegrand-Willems & Bosma, 2006). Kroger (2007) argues that other factors such as the school structure and interactions with peers and teachers provide adolescents with the social and emotional experiences which may have long-term effects on identity (Kroger, 2007).

Therefore, it is important that relationships are built in school to promote the formation of identity, so teachers and other key adults in schools should foster caring and compassionate relationships with their students (Nakkula, 2003). The importance of the relationship between teachers and adolescents was also highlighted by Dreyer (1994), and Cotterell (2007) viewed the building of relationships and relational connectedness as one of the essential elements of the support system in a school that contributes to the formation of identity (Abbassi, 2016). However a lot of research has found that there is a decline in the perception that adolescents have of the emotional support from their teacher and their sense of belonging in the classroom as they transition from elementary to secondary schools (Burchinal, et al., 2008; Wigfield, et al., 2006; Zimmer-Gembeck, et al., 2006).

Research has found that in order to promote motivation and help adolescents' bond with their school, academic work should be meaningful to the developmental interests and social realities of their lives (Burchinal, et al., 2008; Roeser, et al., 2000). If pupils feel bored in school, have a lack of interest and perceive the curriculum to be irrelevant to them, then this is a predictor for reduced engagement and learning, and a withdrawal from school (Finn, 2006; Eccles & Roeser, 2011). Teachers can promote interest and engagement in learning in a number of ways, such as providing lessons which are at an appropriate level of challenge, build systematically as well as teaching pupils strategies to assist them in learning (Eccles & Roeser, 2011). Tasks which are interesting, increase the intrinsic motivation to do well (Deci & Ryan, 2002) and increase the chance that the pupil will develop a strong personal identity as a committed pupil (Eccles, 2009).

There is evidence that both the design and content of academic work does not change over time in a way that reflects the changes in adolescents as they move into secondary school i.e. increase in cognitive abilities, varied life experiences and motivational needs which are linked to identity (Eccles, 2009; Roeser, et al., 2006; Wigfield, et al., 2006) and as a result Larson (2000) found that children in middle school reported the highest rates of boredom when doing their schoolwork , especially when it was passive e.g. listening to a lecture, but also in particular subjects which included mathematics (Larson, 2000). This discrepency between the needs of the adolescent, and academic work that lacks challenge and meaning, may be reflected in the decline in motivation seen in adolescents as they transfer to secondary school (Eccles & Roeser, 2011).

It is argued that in order for motivation, learning, engagement and well-being to be as high as possible, the climate of schools and classrooms must stress the importance of, and provide opportunitites for their pupils to feel independent, competent and supported emotionally (Eccles & Roeser, 2011). The pupils would be provided with the opportunity to have a voice in how the classroom runs and what assignments they are asked to do, be successful at the academic and social tasks and supported emotionally (Niemiec & Ryan, 2009; Zimmer-Gembeck, et al., 2006).

Adolescence clearly plays a large part in the changes seen in attitude and motivation over time. If the school environment, classroom atmosphere, teacher relationships and tasks in class are not in line with the needs of the pupils, then they are likely to lose interest and motivation and have lower achievement in mathematics.

2.6 Summary

This chapter covered the theories of motivation, models of attitude, investigated the four components of affect in mathematics and discussed the various factors which affect the motivation and attitude of pupils. Figure 10 shows the full concept map of this chapter to help orientate the reader.

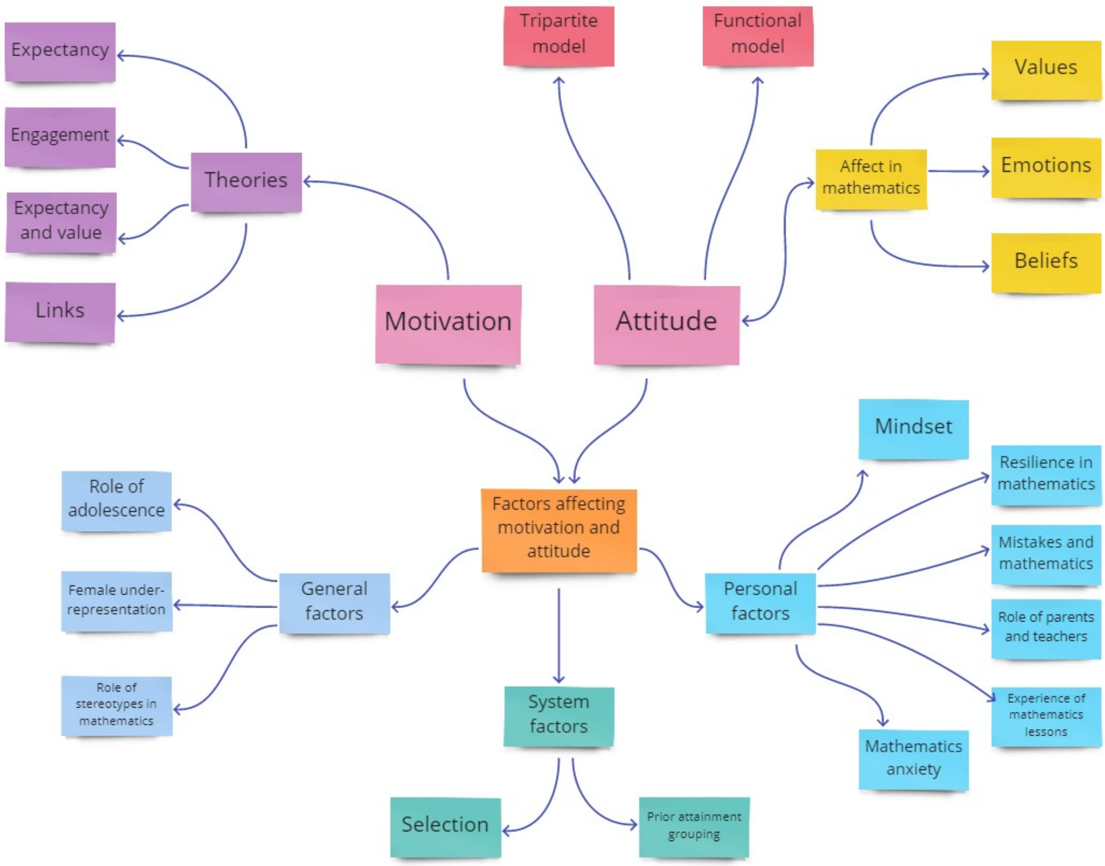


Figure 10 Concept map informed by the literature review

The mathematics crisis seen in the UK and across the world has been discussed, where not enough people are choosing to continue to study mathematics beyond the compulsory level, despite evidence showing that it can lead to a higher salary. There is a view amongst many in society that mathematics is a difficult subject which must be endured and that some people are born with the ability to succeed in mathematics and some are not. Many believe that mathematics is something that should be 'survived' in school and that it lacks relevance and use in adult life. Pupils often describe not liking mathematics as it is hard and boring, and mathematicians have a stereotype of being isolated workers with few people skills.

In this thesis, motivation is understood to be the reasons behind the level of effort that a pupil puts into learning mathematics. This includes –

- expectations of their achievement
- pupil self-efficacy
- pupil incentives for succeeding (achievement value)
- what pupil's attribute their success to
- not wanting others to think badly of them
- pupil goals.

Attitude is understood to be the relatively stable thoughts and feelings that pupils have towards mathematics and the reasons behind them.

There are many factors which are contributing to the feelings and experiences of pupils in the study school, from adolescence to parental and teacher influence and mathematics anxiety to pupil mindset. The selective school system as well as the school environment, ethos of mathematics lessons, teacher relationships and the pupils' self-efficacy may all contribute to the pupils' experiences of mathematics in the study school. To improve the perception of mathematics, so that it is seen as an exciting, challenging, and enjoyable subject which pupils will increasingly enjoy throughout secondary school and want to study beyond compulsory education, I need to establish which factors from the literature review, or other factors, are affecting the attitude and motivation of pupils and the nature and progress of these effects. Therefore, I refer again to the research questions embedded within this aim:

- Within the study setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study setting?

Chapter 3 Methodology

This chapter establishes the methodological approach of the research. First the research questions are presented followed by an introduction to the theory behind the design of the study and a justification for this design. Next the research tool design is explained, and the research tools described. The research process is then explained in detail, including ethics, reflexivity, and the issues of power balance in the research design. The final section explains the methods used for analysing the data and includes the approach to coding and the identification of themes.

I refer back to the research aim for this study:

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

3.1 Design

3.1.1 Mixed methods approach

In this section I argue that a pragmatic, mixed method research design in which I adopted three research tools is the most appropriate for my research aim and explain how I came to that decision. Rather than deciding on one specific paradigm, I felt that it was necessary to choose approaches which were most suitable to meeting the research aim, which requires significant insight into the perceptions and emotions of adolescents who are in a situation in which they have already been 'not selected' for a type of schooling seen, by society, to be of higher value. My views on the choice of paradigm have been influenced by researchers such as Clough and Nutbrown (2012) who consider that research should be an act which is 'creative', as methods are blended and mixed in order to provide a fit which best suits the research aims (Clough & Nutbrown, 2012). I realised that using a purely quantitative or qualitative design would not be suitable due to the nature of my research aims, since, while I need to know something about the proportion of pupils who hold certain clusters of views, I also need to probe those views and learn more about them in some depth and maybe uncover aspects as yet unknown. I have therefore adopted a pragmatic approach to use both quantitative and qualitative designs.

Pragmatism aims to find a middle ground between quantitative and qualitative designs and allows methods to be mixed successfully so that they offer the best opportunity for answering the research aims (Onwuegbuzie & Leech, 2005), in my case combining an understanding of pupils' perceptions with the proportions holding those perceptions. Using a pragmatic approach offers a range of advantages such as allowing researchers to be flexible in their investigative techniques and making them more likely to collaborate with other researchers, regardless of their philosophical orientation because they tend to view research as a holistic venture which requires a prolonged period of engagement, observation and triangulation (Onwuegbuzie & Leech, 2005). Although I did not collaborate with other researchers, I was able to use the insight of my peers on PhD research days and the research design includes the beliefs of colleagues within the mathematics department in the study school.

Due to the positive attitude that pragmatic researchers have towards both techniques they are well positioned to use qualitative research to inform the quantitative section of their study and vice versa. To be able to use both qualitative and quantitative methods, the research question should not be able to be answered by drawing on only one method but both of them should be equally useful (Cohen, et al., 2011). There is a dialogue between the construction of the question and the choice of method: what methods would enable me to answer my question and is my question appropriate for those methods? Since my question arises from my own practice and my commitment to my pupils, it comes first in this dialogue but consideration of methods available to me led to modifications of the question as well. Results arising from qualitative data cannot usually be generalised beyond the field in which it is collected, but offer conjectures for the field; quantitative data can suggest proportions to augment any conjectures, and also to generalise within the field, whilst the use of qualitative data can help to explain any relationships which may be discovered in the quantitative data (Onwuegbuzie & Leech, 2005). Quantitative results can be validated by referring to qualitative data and ideas from qualitative data can be used to analyse quantitative data (Onwuegbuzie & Leech, 2005). Pragmatists opt for a method or theory which is more useful in a specific context, for example to answer a practical problem as opposed to one which would reveal a general underlying truth (Giacobbi Jr, et al., 2005).

Using a mixed methods approach can increase the accuracy of the data and provide a more complete picture of the research topic than a single approach would provide, as it enables the researcher to develop the study and build on the original data and can aid sampling, for example a questionnaire may be used to screen participants who may be interviewed at a later date (Denscombe, 2008). This is useful in my study as I intend to select from participants providing interesting responses in the questionnaires to participate in the focus groups.

In summary this study adopted a mixed methods approach which leans towards the qualitative and interpretive paradigm, but also includes the gathering of quantitative data. I focused on a pragmatic philosophy to justify the mixed methods approach to investigate the research aims. Despite Johnson and Onwuegbuzie (2004) warning that a weakness of mixed methods approach is that it can be difficult for one researcher to carry out, especially if two or more approaches run concurrently as it may require a research team, they argue that a strength of mixed methods approaches is that they provide stronger evidence to reach a conclusion. This is due to the corroboration and merging of findings when qualitative and quantitative research is used together, as well as constructing knowledge which is more complete to inform theory and practice (Johnson & Onwuegbuzie, 2004). As I am only focusing on one school and, due to the number of factors which will affect the pupils' motivation and attitudes, I am not expecting to find a conclusion to my research but will instead explore these factors to see which ones have the greatest influence and how they interact with each other, I believe that this is the best approach for my research.

3.1.2 Interpretivist approach

In this study, the interpretivist paradigm was adopted to meet the research aims because I wanted to explore the pupils' attitudes and motivation towards mathematics at two transition points in secondary school. I used qualitative data collection methods, through questionnaires, focus groups and interviews in school to explore pupils' and teachers' opinions. The quantitative elements of the study enable me to establish the scene that the qualitative data is set in and allows for a greater understanding of the context of the pupils' attitudes. Most of the research was in the form of exploratory analysis of attitudes towards mathematics, which provided both qualitative and quantitative data.

Two key research tools were used to investigate the research aims. The first research tool was questionnaires to collect quantitative and some qualitative data and the second was focus groups with pupils and interviews with staff, that allowed for qualitative data to be gathered. As a pragmatic researcher I was able to see small details whilst appreciating the broader picture, and as a result can combine macro and micro levels of the issue I am researching, thus being able to say something general about motivation and to see this through the eyes of individuals and their experiences (Onwuegbuzie & Leech, 2005). The desire to capture the voice of a participant is often what drives qualitative research whilst quantitative data is driven by the concerns of the researcher, pragmatic researchers have the advantage of merging these two desires into a single investigation (Onwuegbuzie & Leech, 2005).

3.2 Single-site study

As a teacher, my motivation for this research was born out of an interest in the pupils in my school and my direct experience of the apparent decline in motivation and attitude which I witnessed in my lessons. As I was interested in these specific pupils, in this context and in this school, this is a single-site study with features of a case study as defined by Stake (1978), Yazan (2015) and Yin (2004) (Stake, 1978; Yazan, 2015; Yin, 2004). This kind of study allows generalisations about a specific instance and gives attention to the subtleties and complexities of a case in its own right (Stake, 1978). It provides a tool for researchers to study phenomena, which is often complex, within their contexts, and should be considered if the focus of research is to answer "how" and "why" questions, if the research is intended to uncover conditions which are relevant to the context of the study and if there are not clear boundaries between the context and what is being explored (Baxter & Jack, 2008). This type of study can note features which are unique to that situation, and which may be the key to understanding certain situations. There are many examples in social science of single-site in-depth studies such as this being used for professional development or policy information for example Muir and Geiger (2016) used a survey and student and teacher interviews to investigate a teacher's and the students' perceptions of the benefit of a flipped classroom in their study school (Muir & Geiger, 2016) and Hernandez-Martinez and

Vos (2018) interviewed students after a course which they designed to gain an insight into the students' experiences of the relevance of the activities (Hernandez-Martinez & Vos, 2018). This kind of study can be undertaken by one researcher and their insights may be interpreted directly and used for staff development or educational policy making. Possible weaknesses are that the results may not be able to be generalised to other settings and are not easily cross-checked, as they may be biased, subjective or personal. They are also susceptible to observer bias (Cohen, et al., 2011). Therefore researchers need to gather their data from a range of sources in order to capture the complexity and entirety of the single-site study (Yazan, 2015).

The research was conducted with a population of pupils who were at or going to one school and so was an in-depth study of a situation in a particular period. The ability to examine the situation in depth, in its real-life context is the strength of the method of study (Yin, 2004).

Cohen et al (2011) reports that this kind of study can provide a vivid, chronological description of events, relevant to the case which are then analysed, and specific events highlighted, and can focus on individual perceptions to gain an understanding of their insights of an event, with the researcher playing an integral role and attempting to portray the case in a written report (Cohen, et al., 2011). Such studies recognise that there are many variables which can affect a case and therefore usually require more than one tool in order to collect the necessary data (Stake, 1978). They also report the 'real-life' of a context which is unique and ever-changing (Cohen, et al., 2011), which is useful in a changeable educational setting.

3.3 Research tools

This section describes the research tools used in this study along with the reasons behind these decisions. It is split into my reading around previous studies, justification of the research tools and a description of the final research tools. Details of the research process, including sections such as ethics, reflexivity and power balance complete this chapter.

3.3.1 Previous studies

3.3.1.1 Questionnaires

This section describes my reading about other studies which guided the selection of research tools used in this project, starting with examples of where a questionnaire has been used in a qualitative manner to access and report on pupils' attitudes and motivations. Putwain and Remedios (2014) researched the effect persuasive messages regarding failure have on pupils prior to important exams. Some examples of these 'fear appeals' are

> *If you fail GCSE maths, you will never be able to get a good job or go to college. You need to work hard in order to avoid failure*

and

> *GCSE maths is really important as most jobs that pay well require GCSE maths, and if you want to go to college you will also need a pass in GCSE maths. It's really important to try your hardest* (Putwain & Remedios, 2014, p. 504).

This study involved 347 pupils in Year 11 and data was collected through questionnaires, in three waves; approximately three months prior to the GCSE mathematics examination, approximately one month before and the final strand of data collection was the GCSE mathematics results. The data was collected by form teachers during registration so that the mathematics teachers were not present. A questionnaire consisting of 28 items was used to measure motivation using a scale to see if pupils had higher or lower motivation when their teachers made more frequent fearful messages. The results from this study found that pupils reported having lower self-determined motivation if their teachers made more frequent fear appeals, which were perceived to be threatening. On analysis of the GCSE mathematics results, pupils performed better if they had reported a higher self-determined motivation and felt that their teacher made less frequent fear appeals or ones which were less threatening. Conversely, lower GCSE mathematics results followed more frequent fear messages which were interpreted as threatening and seemed to lower self-determined motivation (Putwain & Remedios, 2014).

The implication of this study is that fear appeals used by teachers in the run up to important exams may not be having the desired motivational effect. Before an exam, teachers obviously want to motivate their pupils in a variety of ways and may not be aware of the type of messages they are giving or how they may be interpreted. The study makes suggestions that psychologists who work with schools could help teachers to consider the type of message they are presenting to pupils and how they are interpreted, as well as helping them to plan their messages so that they are more effective in motivating the pupils (Putwain & Remedios, 2014).

The use of questionnaires was a powerful research tool in Putwain and Remedios' (2014) study as they allowed researchers to have an insight into the feelings and thoughts of the pupils regarding the type of messages they were hearing in lessons and how they interpreted them. The researchers were able to link the results of the questionnaires to the GCSE examination results to make suggestions for improved practice in schools.

As the aim of my research is to get an insight into the thoughts and feelings of pupils regarding their attitude and motivation towards mathematics, I developed a similar research tool to enable this exploration. The use of a questionnaire offered the potential for an insight into factors which may influence pupils' motivation and attitude towards mathematics and the use of prior attainment groups as a grouping mechanism allowed for insights into the changes in motivation and attitude over time.

The results of Putwain & Remedios' (2014) study are based on pupil perceptions of fear appeals from questionnaire results and not from observational data or information direct from teachers which is similar to my study as most of the data which I have collected regarding attitude and motivation in mathematics is through pupil questionnaires. However, my data has been enriched by focus group discussions and short interviews with teachers to get their opinions throughout the academic year.

A study in 2010 by Guay et al. involved 425 French-Canadian pupils in elementary schools who were all given a questionnaire in their classrooms by a team of three trained research assistants. This study aimed to examine school motivation by looking at motivation towards specific school subjects but also examining school motivation as a multidimensional concept which varies in intensity and quality between school subjects (Guay, et al., 2010). The results of this large study were that in lower years in elementary school, pupils self-reported different levels of intrinsic, identified, and controlled motivation for any given subject. The levels of motivation differed across school subjects. The results also showed that the differences in motivation between subjects increase as the pupils moved through elementary school. The implications of this research is that there is a necessity to investigate motivation within school subjects as opposed to across the curriculum as a whole and that the effect of these motivation types may develop as pupils have an increased exposure to learning experiences. Analysis of these motivations may allow more targeted interventions within specific subjects (Guay, et al., 2010).

The use of questionnaires in Guay et al.'s work was instrumental in unpacking the nuanced findings reported. Since my study explores similar constructs to Guay et al., I decided to develop a questionnaire that included self-report items to identify and access the factors which may affect pupils' motivation in mathematics.

Stroet et al. (2016) compared the level of pupils' motivation in social constructivist schools (where schools have adapted their learning environments to include modern views on learning which have seen a shift from having knowledge to being equipped for life-long learning), traditional schools and schools which combined aspects of both. The data in this study was collected at five occasions during one school year. Initially, within the first few weeks of school, with the other four dates spread evenly over the rest of the academic year. 489 pupils from 10 schools were given questionnaires and had some of their lessons recorded. Teachers within the schools were contacted by the research team and had the opportunity to participate in the study (Stroet, et al., 2016).

Here questionnaires were used as a research tool to explore pupil motivation and the inclusion of teachers gave greater scope and detail to the results of the study. As my research explores pupil motivation, I chose to include the voice of the mathematics department at regular intervals throughout the research period to add depth and a greater insight into possible reasons for the changes in pupil motivation and attitude witnessed in the study school.

Another study investigated the effects of interactive whiteboards on 773 elementary pupils' self-reported motivation in mathematics in 2010, by giving all the pupils and teachers a survey. The teachers' survey involved a four-part Likert scale in which they had to rate the extent to which they used interactive whiteboards and the pupils' survey was designed to cover a range of attitude responses which were relevant to their motivation in mathematics lessons (Torff & Tirotta, 2010). The use of the Likert scale in these questionnaires was helpful in uncovering a range of attitude responses and since my study is exploring pupils' attitude towards mathematics, I decided to include a Likert scale in my questionnaire, combined with open questions to identify the factors which may affect pupils' attitudes in mathematics.

3.3.1.2 Interviews

This section describes the studies where an interview has been used in a qualitative manner to access and report on pupils' attitudes and motivations, and how these guided my research decisions.

A qualitative, longitudinal study by Hannula (2006) was conducted over three years and involved the researcher interacting with pupils as their mathematics teacher and allowed for a lot of varied data such as classroom observations, interviews with parents and individual and group interviews. 68 interviews were analysed in two ways; focusing on one pupil at a time and trying to interpret and reconstruct their ideas through a narrative. The purpose of the study was to increase the understanding of pupil behaviour in classrooms by increasing our understanding of what motivation is and how it is regulated (Hannula, 2006).

The use of interviews in this study was key to increasing the understanding of pupil behaviour and motivation. Similarities such as the longitudinal design and the range of data types, between Hannula's research and mine helped me to decide that interviews would help me to explore the motivation of the pupils in my setting.

The following study shows how focus group and interviews can be used successfully to gain qualitative data. A study which looked at pupils who had not achieved five GCSEs at A*-C including English and mathematics and so had to retake them in Further Education, used focus group discussions as well as individual interviews. The research found that the school experience of the pupils such as discipline, application of sanctions and lack of academic support all contributed to pupils being demotivated. However, the pupils' experiences at Further Education varied significantly with their secondary school experiences as they felt supported by teachers and experienced a greater ownership and autonomy which led to them successfully re-siting their exams (Anderson & Peart, 2016). The use of focus groups to establish possible reasons for the pupils not to have achieved their five GCSEs allowed the pupils to voice their opinions in a safe and open environment and gives the interviewer the flexibility to adjust their questions in response to the pupils' answers, whilst individual interviews were held after the focus group discussions to offset any effects of group conformity.

The use of focus group discussions was clearly a powerful tool for getting pupils to voice their feelings in an unintimidating environment. As pupil voice is crucial in my study, this helped me to decide to include interviews and focus groups (after my pilot study which is described below) in my research to elicit conversation regarding the pupils' attitudes and motivation towards mathematics.

3.3.2 Pilot study

This reading of previous studies led me to choose questionnaires and pupil interviews as my research tools for the pilot study. Although the main study is described in detail in *3.4* '*Research process'*, as the pilot study shaped my final research tool decisions, I have discussed it here to give a chronological account of these decisions. For clarity, Figure 11 summarises the research in a flow diagram.

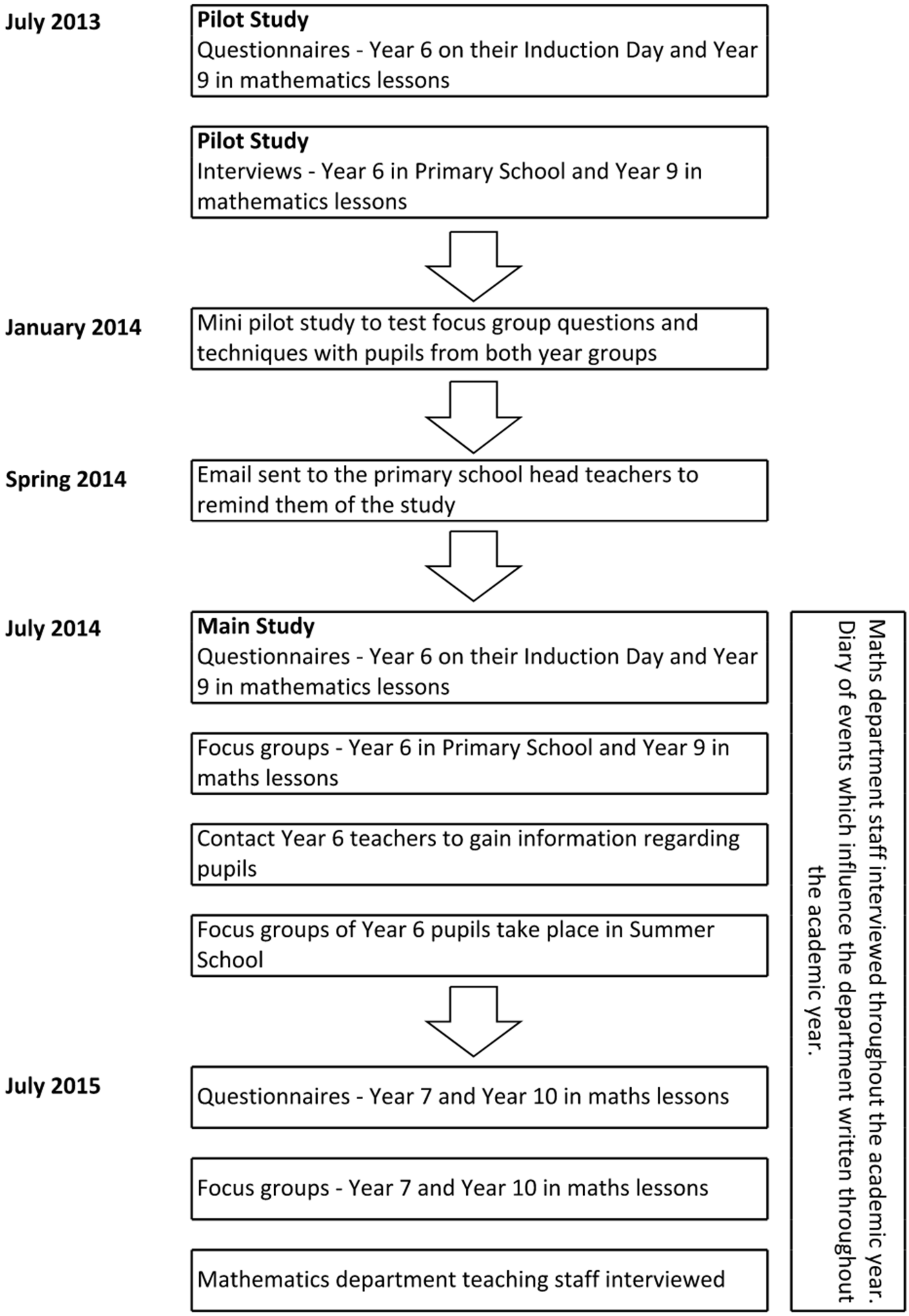


Figure 11 Flow diagram of the study

The research took place over two years with the first year consisting of a pilot study of between thirty and forty pupils in both years 6 and 9. A pilot study was used to test the research tools in advance so that any areas for improvement could be identified and solved before the real research started (Denscombe, 2014). In the pilot study, the pupils in both year groups completed a questionnaire. The year 9 pupils completed the questionnaire in their mathematics lessons and the year 6 pupils completed it when they came to secondary school for their induction day in July. A convenience sample was used to select which pupils would take part in the interviews. These pupils were all the ones who completed the permission slips. Pupils were interviewed in groups of three to investigate their opinions more deeply. Whilst the year 9 pupils were involved in interviews in their mathematics lessons; with the permission of both the primary school head teacher and my head teacher, I travelled to the primary school to conduct the interviews for the year 6 pupils in their own surroundings. As only one primary school head teacher agreed to me visiting their school, I could only interview the twelve pupils from that school who had returned their consent forms.

The second pilot phase was used because, after analysing the results of the pilot study, I realised that I needed to adapt the questionnaires and interviews to get the information which I required. The number of questions in the questionnaire was reduced and how I planned the research was changed due to some of the problems that I had encountered. As only one of the three primary schools had allowed me to interview in their school, I changed the time that I contacted the head teachers so that they had time to add it into their school calendar as many of them said that they did not have time for me to visit because they were rehearsing for their school play. I also changed the information sheet which I provided the new year 7 form tutors with so that they could allow time during the year six induction day to fill out the questionnaires in tutor groups. Some teachers struggled to find time to complete the questionnaire or did not realise the significance of it, whilst others did not follow the instructions regarding the removal of name tags from the questionnaires before the pupils received them.

In the January after the pilot study I conducted this mini pilot study to check that my interviewing skills had improved and to practise running a focus group, as I found that I was having to lead the pupils during the pilot study and the pupils were not able to express themselves sufficiently. In Spring I contacted the primary schools to remind them that I still wanted to visit their schools during the summer term to conduct the focus group discussions with their pupils, just in case it was not in their calendar.

Despite three primary schools agreeing for me to visit them for the main study focus groups, I struggled to get the reply slips in from parents. I do not think that it helped that they were from a school that their children were not yet attending so they must have felt quite removed from it. Eventually I managed to get enough reply slips to go to three different primary schools to conduct focus group discussions with year 6 pupils. I also struggled to get enough reply slips from the year 9 pupils and found myself going into mathematics lessons to re-explain the research and spark an interest in supporting my project.

To gain a perspective from the year 6 teachers I asked the head teachers to pass their contact details on to me or to forward my email to them as I had hoped to gauge the level of mathematics taught in primary schools and to see how motivated the year 6 pupils were in primary school. Unfortunately, only one teacher had the time to answer some of my questions, so this was another frustrating angle of the research, which again relied on help from others.

There were some year 6 pupils who had returned their reply slips to be interviewed in focus groups, but I did not have permission from the head teacher to go into their school and run the focus groups. The study school runs a Summer School in the first week of the summer holidays during which year 6 pupils can make new friends, meet teachers, and familiarise themselves with the school. This is run by the head of the mathematics department who granted me permission to come in to school during this week and conduct the focus groups for those pupils who I had permission from but whose primary schools did not have time to facilitate my needs.

The pilot study was used to test the research tools which involved the pupils. I did not pilot the interviews with staff (although I did have informal discussions with them all regarding my research) because I did not want to take up their time and because I wanted to concentrate on practising tools needed for the main focus of the study - the thoughts of the pupils.

As a result of the pilot study and the previous reading into possible research tools, the final tools which would be used in this study were a combination of questionnaires, focus groups and interviews with staff in the department.

3.3.3 Justification for research tool design

This section describes how I combined my reading on similar previous studies and the experiences of my pilot study to design the final research tools. Under each subheading is a justification for the research tool design decisions and a description of the research tool.

3.3.3.1 Questionnaires

A questionnaire was selected as a research tool because they are useful for collecting information and providing structured, often numerical, data. They can be given without a researcher having to be present and are relatively straightforward to analyse. However, some limitations of questionnaires are that they are time consuming to develop, pilot and improve. The resulting data can be limited and simple as the recipients of the questionnaires are not able to be flexible with their responses (Cohen, et al., 2011).

The design of a research questionnaire should ensure that it is not used to change people's attitudes or to give them information but should be created so that it collects data which can then be analysed (Denscombe, 2014). The questionnaire should consist of a list of written questions and each person who reads the questionnaire should read an identical set of questions, it should be written accurately so data can be processed easily (Denscombe, 2014). Lastly, questionnaires should gather information by going directly to the person and asking them (Denscombe, 2014). The reliability and validity of data from questionnaires can be affected by poorly worded questions, confusing layouts, or inadequate response options. In these cases it would be difficult to draw any conclusions from the data (Artino Jr, et al., 2014).

A copy of the questionnaire that I used to explore the changes in pupil motivation and attitude can be seen in Appendix A and consisted of 35 questions in 2014 and 36 in 2015. The first 20 questions were laid out as in Figure 12 with two options on opposite ends of the scale and the numbers 1-5 between them, in a Likert scale design. The pupils then had to circle the position which described where they sat on the scale.

I usually enjoy school	1	2	3	4	5	I do not usually enjoy school

Figure 12 An example of the Likert scale used in the questionnaire

A Likert scale was chosen because it creates numbers which would allow me to use statistical analysis, it also allows for a level of sensitivity and differentiation in pupil responses (Cohen, et al., 2011). A semantic differential, which involves putting opposite statements at the end of a scale was used because it gave me the ability to combine a tool of measurement with pupil opinion and frequency (Cohen, et al., 2011). The categories of the scale needed to be discrete and exhaustive and only measure one thing at a time (Oppenheim, 1992).

There are disadvantages to this layout such as assuming equal intervals, respondents interpreting the numbers differently and respondent bias. Although the numbers imply that a response of 4 may be twice as powerful as a 2, this cannot be inferred from the Likert scale, nor can the gap between 5 and 4 be assumed to be the same size as 4 to 3 etc (Cohen, et al., 2011). If I wanted to assume that the intervals between the numbers were equal, then Friedman and Amoo (1999) suggest that category descriptors (e.g. strongly agree, agree) actually have equal intervals (Friedman & Amoo, 1999). I chose not to label the intervals in between the statements but gave numbers which the pupils could interpret and was careful not to infer equal intervals or greater information from the data than was reliable.

Similarly, respondents can interpret a scale differently i.e. a 4 for one person may not be a 4 for another (Cohen, et al., 2011), so the researcher should be aware of this during analysis. Research has shown that respondents are biased towards the left-hand scale (Friedman & Amoo, 1999) so to overcome this I organised the questions so that some positive responses were on the left and some were on the right. These avoided respondents circling all the left-hand responses automatically.

Human nature means that we often do not like to be seen as extreme so many respondents will not choose the values at the end of the continuum so in a five-point scale, respondents may only consider the middle three values (Cohen, et al., 2011). To overcome this, you can use a larger point scale; Friedman and Amoo (1999) suggest using a five to eleven-point scale, whilst Schwartz et al (1991) suggest that a seven-point scale is the most reliable (Schwartz, et al., 1991). I chose to use a 5-point Likert scale due to the age of my respondents, I thought that a seven-point or larger scale may be more unreliable as it is expecting respondents to identify very subtle differences between a 2 and a 3 etc. To avoid using terminology which may add to the fear of choosing an extreme response, I did not label the numbers 1 to 5, but left them as numbers so the pupils did not see words such as 'strongly disagree' etc unless it was appropriate to the question.

The final decision was whether to have an even or odd number of options, as many respondents will choose to sit in the middle (Cohen, et al., 2011), however I believe that having 'no opinion' is an opinion so I chose to have an odd numbered scale so that pupils were able to select the middle if that was their response.

Although there are more disadvantages to a Likert scale, I have listed the main considerations above and the decisions I made to overcome them. To increase the reliability of the scale data and to add depth to the pupil responses the questionnaire contained 9 open questions which invited the pupils to write a response to the question. I positioned the open-ended questions at the end of the questionnaire so that the pupils were not put off by the perceived effort of completing it. I hoped that if they saw a page of questions where they simply had to circle a response they would engage in the task and then complete the free writing questions as well. My intention was then to select pupils who gave interesting responses to take part in the focus groups so that further details could be gleaned.

The remainder of this section describes the contents of the questionnaire. Table 2 links the individual questions and the review of literature. Although I have presented these questions under headings from my reading around the literature, their purpose is to explore different factors. There is no underlying design that these questions should be grouped together or analysed together under one value, for example I have not designed the questionnaire so that questions 9, 26, 28 and 21 ask similar things and their responses can be grouped together to give a 'Mindset' value. As the questionnaire was designed for children, each question focused on a different strand that I wanted to explore and did not ask the children the same thing in multiple ways, enabling me to keep the questionnaire as short and manageable for the pupils as possible.

Literature Review Section	Question number	Question Detail
Mindset	9	I think that being clever is more important in maths than working hard
	26	What does it take to be successful at maths?
	28	If your teacher ordered the pupils in your maths class by ability where would you be?
	(21)	Being entered for GCSE in Yr 10 is unrealistic for me (asked to Yr 10 only)
Resilience	22	I will probably continue with maths after GCSE
	23	If maths was an option now, I would probably choose it
Mistakes in mathematics	10	Work in maths is too easy for me
	18	I enjoy doing maths puzzles
	21a	I really enjoy maths when…. the problems make me think really hard
	21b	… I am the only one who can answer the question
	21d	….I am the first one to get the answer right
The role of parents	11	My parents/guardians think that it is important to work hard in school
	12	Pleasing my parents/guardians is the main reason that I work hard in maths
	14	My parents/guardians think it is important to pass maths exams
	15	My parents/guardians are pleased with my progress in maths
	16	One/both of my parents/guardians are good at maths
	17	My parents/guardians often help me with my maths homework
The role of teachers	13	Pleasing my teacher is the main reason that I work hard in maths
	24	Circle the one thing your teacher thinks is most important in maths lessons
	30	How many maths teachers have you had this year?
Student Experience	1	I usually enjoy school
	2	I usually enjoy maths lessons
	3	I am very good at maths
	4	I struggle to understand in maths
	5	I think that I will use maths a lot when I am an adult
	6	I need maths to get on in life
	7	I need maths to get into college
	21c	I really enjoy maths when we work together in groups
	25	Maths lessons would improve if….
	27	Describe your favourite ever maths lesson
	29	How would you make the class enthusiastic about maths if you could be the teacher for a week?
	34	How has this year been for you in maths?
	35	Compare how you felt about maths now with how you felt in year 9

Mathematics anxiety	8	I feel anxious about the work in maths
Prior attainment Groups	31	Have you moved sets this year?
	32	If you moved sets, did you move up or down?
	33	How do you feel about changing maths set?
Stereotypes in mathematics	19	I wouldn't want to be thought of as a 'maths nerd'
	20	People with maths qualifications get paid more

Table 2 Questionnaire questions organised by literature review section

The topic of the question was guided by the literature review and how the questions were worded guided by reading around the design of questionnaires, but the pilot study helped me to see which questions were successful and which ones needed to be altered. After the pilot study I analysed some of the data from the questionnaires to check the reliability of the responses and reworded some questions, as necessary. The responses from the 2014 questionnaires showed that the pupils did not understand one of the questions due to a double negative, so this question was removed from the 2015 questionnaire.

3.3.3.2 Interviews

The main reason for deciding to use interviews and focus groups is that interactions between the researcher and participants in person, offer a balance to the limitations of questionnaires as they allow for conversations between humans to generate information (Cohen, et al., 2011). Interviews allow participants to discuss their interpretations of issues and to express things from their point of view, as opposed to simple data collection, as well as other visual cues such as non-verbal hand gestures, and allow the interviewer the opportunity to encourage interviewees for complete answers (Vaughn, et al., 1996). Although these benefits need to be weighed up against negative points such as how time-consuming interviews can be as well as interviewer bias (Hannan, 2007). Ethically, they do not allow an interviewee to be anonymous, it may not be convenient for them to take part and there is a potential power imbalance between the interviewee and interviewer (Brenner, 2006). The ethical issues surrounding interviews and interview bias will be discussed further, in '*Ethics' 3.4.1.*

Following the pilot study, I chose to use focus groups for the pupils, which are discussed in more detail in '*Focus groups' 3.3.3.3*, but used interviews as a research tool for gaining the point of view of the department. This was because I hoped that interviews would give the staff the opportunity to speak openly about how motivated their classes were and if there was anything that had helped to motivate, or de-motivate the pupils.

The staff were interviewed privately, on their own, in their classrooms, once consent was sought, and the audio from the interview was recorded using a Dictaphone so that I could transcribe it later. I asked the staff the following 3 questions each term throughout the academic year:

1. How motivated are your year 7 class?
    - ❖ Why do you think that is? Is there anything that you or the school have done to cause this?

2. How motivated are your year 10 class?
    - ❖ Why do you think that is? Is there anything that you or the school have done to cause this?

3. Are there any tasks that the pupils have been really motivated by or that the pupils have found intrinsically interesting?

There are clear ethical issues when carrying out interviews, especially as I was interviewing staff which I worked with as teacher researcher and these are discussed in more detail in section *3.4.3 'Power balance and positionality'*. However, the staff were promised that the transcriptions would be confidential and although quotations might be used, they would remain anonymous. The staff were informed that they could see the transcriptions following the interviews, however none chose to take this up, and were reminded that they could opt out of the research at any stage in the process.

3.3.3.3 Focus groups

Focus groups were adopted as a mechanism to find out more information from pupils regarding their motivation and attitude towards mathematics. This method was chosen because in the pilot study interviews were not successful, since I found that pupils, especially younger ones, were often shy and reserved during interviews but felt slightly more comfortable in a group setting. When I listened to the interviews, I was shocked at how many of the responses were my voice answering for the pupils, to overcome the awkwardness that they felt and monopolising the conversation. During focus group discussions the interviewer can act as more of an observer as opposed to leading and directing the conversation with one pupil so I could respond to the pupils' answers and direct the conversation according to their responses so that the focus group would allow me to follow up on any interesting comments from the questionnaires.

Whilst focus groups are a form of group interviews, they do not have the traditional dialogue between the interviewer and responder. Instead, the group discuss a topic which is supplied by the researcher, with the reliance being on the interaction of the group, to provide an overall view as opposed to an individual's view (Cohen, et al., 2011). The participants therefore interact with each other as opposed to the interviewer and in this way the views of the participants can materialise, and the agenda of the interviewer does not dominate the interview. In a focus group setting, the data arises from the interaction of the group in an artificial setting, which brings together people who do not previously know each other to discuss a topic. Due to the unnatural setting, focus groups often produce insights which may not have otherwise come out in a traditional interview situation (Cohen, et al., 2011). Therefore, I used focus groups to try to overcome the issue of power between myself being the teacher and researcher, and the associated issue of pupils feeling that they could not give honest responses.

Focus groups can generate data on attitudes and opinions quickly, whilst empowering participants to articulate their feelings in their own words, and as the participants are in a group the researcher can gain feedback from the group as opposed to individually (Cohen, et al., 2011). Despite these benefits, there are challenges such as deciding on a suitable number of participants in the group, because if it is too large then the group may become difficult to manage and can fragment or lose focus, but the group dynamics may be affected if it is too small leaving the children feeling pressured (Cohen, et al., 2011). The recommendation by Lewis (1992) is around six or seven for optimum size but it may be smaller for younger children (Lewis, 1992). Morgan (1996) suggests between four and twelve participants in a group (Morgan, 1996, p. 43), whereas Fowler (2009) suggests between six and eight (Fowler, 2009, p. 117). Despite this research, in this study, the composition of the focus groups was heavily influenced by the number of reply slips which I received as opposed to me being able to decide on what sized group would be best. As the researcher has to create an environment in which the participants feel comfortable enough to contribute (Cohen, et al., 2011), I wanted to keep pupils of similar prior attainment together so that they felt secure and able to contribute, but also to see if prior attainment had any influence on their responses. The focus groups were therefore constructed of three to four pupils from either the same or consecutive sets, once I had written agreement from the parents and verbal agreement from the pupils, which is especially important for young adolescents, given my position of power (this is described in further detail in '*Power balance and positionality' 3.4.3*).

Although focus groups were chosen as a research tool to gain insight into the pupils' feelings towards mathematics, there are certain things to note when undertaking research with children as opposed to adults. The cognitive and linguistic development, attention span, experience of life and what they consider important are all things which differ between children and adults (Arksey & Knight, 1999). It is therefore important to establish a feeling of trust with child participants and to quickly put them at ease, ensuring that the situation is enjoyable and not threatening by using straightforward language and asking questions which are appropriate for the child's age. It is also recommended that children are given time to think and that a range of methods are used to interview them, such as drawing, playing a game, using pictures, toys or photographs (Arksey & Knight, 1999).

Therefore, using focus groups can be useful with children as interaction within the group can be encouraged, as opposed to children simply responding to the researcher's questions (Cohen, et al., 2011). A focus group may be less intimidating for a child than a one-on-one interview and may enable them to challenge each other or participate in the discussion in a way that an adult to child interview does not allow (Cohen, et al., 2011). The focus group should mimic normal routine and not be too formal by using a game or props and asking open-ended questions so that interviewees are more likely to offer accurate answers, as opposed to single words (Cohen, et al., 2011).

To encourage a conversation or discussion around motivation and attitude I used a series of cartoon images to encourage the pupils to have a discussion. I gave each pupil a laminated sheet with four cartoons and asked a series of questions which could not be answered with a simple yes or no to spark a deeper response from the pupils. An example of one of these cartoons can be seen in Figure 13, whilst the other images are in Appendix B.

Please contact author for image

Talk about the picture – how does it make you feel?

How would you feel if you were there?

How would you feel if you can't immediately find the answer to a question?

Figure 13 An example of a cartoon and questions from the focus group discussions

I designed the focus group in this way to avoid a situation of a direct question and a biased response, where an interviewee looks for cues as to how to respond to a question. This can be avoided with child participants by using a projection technique where the interviewer can show a group of children a picture and ask them for their responses as opposed to asking a direct question (Greig & Taylor, 1999).

When researching with children, the researcher should avoid being seen as an authority figure and the focus group being viewed as a test, which is difficult in my research because I was a teacher researching pupils in the same school. It is important to get children to say what they really think as opposed to what they think the researcher wants them to say, as well as encouraging them to contradict an adult or assert themselves, which they can often be reluctant to do. Whilst using focus groups can avoid some of these difficulties, it poses its own issues such as some children dominating the conversation, children not feeling able to express their true feelings in front of their friends or if they are not grouped with their friends they may feel uncomfortable or even threatened in that environment and not talk honestly (Cohen, et al., 2011).

To try to overcome this, I organised the focus groups so that the pupils were asked to discuss the question amongst themselves as if I was not there. The group discussion was recorded using an audio-recorder placed on the table. One pupil was asked to report the discussions of the group back to me so that I would be able to hear it clearly on the recording because I anticipated that during the discussion the pupils may talk over each other and interrupt each other, as in natural speech, so it would have been difficult to pick up the key points. However, as I could not leave the pupils unattended, this request may not have been as realistic as if I could have left the room.

3.4 Research process

In this section I will detail the remainder of the study as well as discussing ethical considerations, reflexivity, power balance and positionality, approaches taken to data analysis and saturation.

The study was carried out in an 11-18 comprehensive school of approximately 1200 pupils. As previously described, although the school is not selective, it is located geographically next to two grammar schools and consequently its intake does not have as many pupils who may be described as higher attaining as a comprehensive school in a county without selective schools. As staff we often wonder if the feeling of having 'failed' a grammar school test might contribute to the decline in motivation that we witness in the school and this was a large part of the motivation behind this study.

To investigate changes in pupil motivation I selected two year groups to focus on and two transition points, as including all the pupils in the school would have made the study too large and produced an unmanageable amount of data. The year groups in focus were year 6 into year 7 and year 9 into year 10. I focused on these two transition points as these are key years in a pupil's school life. Starting secondary school is a huge change for pupils, their lessons are often very different to primary school and they can be exposed to more subject areas, perhaps better equipment and resources and specialist subject teachers which may change their opinions of certain subjects. Year 9 to 10 sees the end of a key stage and the start of a big examination period which may add stress, excitement, motivation and perhaps worry to the pupils' school experiences.

At the end of year 6 and year 9 all pupils in these year groups completed a questionnaire (please see Appendix A) to explore their motivation and attitude towards mathematics. After these questionnaires, focus groups were used, as described above, with pupils from both years to investigate their opinions further. This provided both quantitative and qualitative data.

Figure 11 in section *3.3.2* summarises the research in a flow diagram to aid understanding as well as to illustrate the pilot study which led into the main study.

Each term throughout the academic year between the two capture points, I interviewed the staff in the department (including the long-term supply teacher) to record their views on the motivation of the pupils. This was a particularly difficult year for staffing because the department was a member of staff short all year. This meant a stream of supply teachers and class changes to ensure that pupils were not adversely affected for too long.

At the end of the academic year, the year 7 and year 10 pupils were asked to complete the questionnaire again and focus groups were used with the same questions as the previous year, to see if their feelings had changed. All the teachers (excluding the long-term supply teacher as they had left by this point) and the mathematics teaching assistant were interviewed for a final time to discuss their thoughts on motivation and to reflect on the school year.

3.4.1 Ethics

Ethically, the biggest challenge when researching with children is the inequalities which exist between the power and status of adults and children. There are issues during the collection of data, as some children may not be used to giving their opinion to adults, whilst others may have experience from PSHE, drama, or at home (Morrow & Richards, 1996).

In educational research the ethical issues can be considered as a square-based pyramid with four layers (Stutchbury & Fox, 2009) which can be seen in Figure 14. External considerations are at the base which covers issues such as the law, codes of practice and what resources the researcher may have available to them. The researcher should also reflect on the implications of the context in which they intend to work.

The second layer is the consequential layer which considers the possible consequences for an individual, group or society and is followed by the deontological layer which involves the way in which things are done as opposed to the consequences of the actions. This layer concerns issues of honesty and minimising any harm to participants. The top of the pyramid is the core rationale which considers issues of respect and autonomy for the individual (Stutchbury & Fox, 2009).

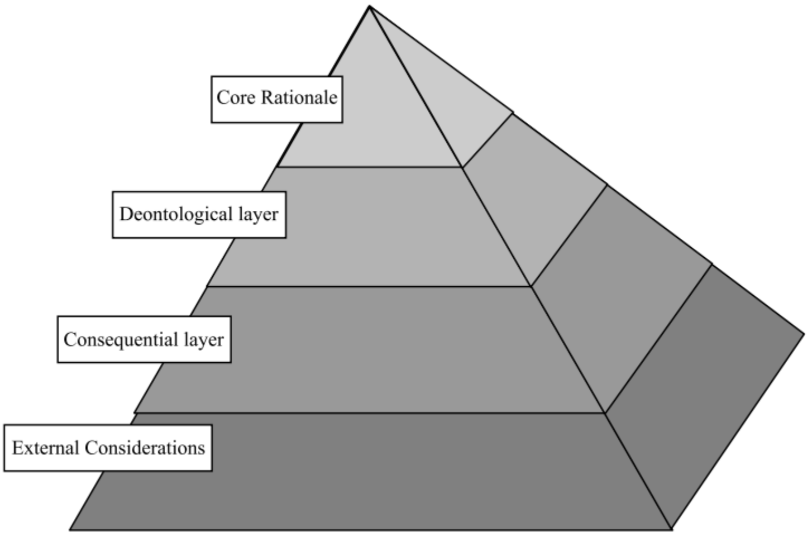


Figure 2. An alternative representation of the ethical grid.

Figure 14 A square based pyramid representation of ethics in educational research (Stutchbury & Fox, 2009, p. 492)

To get informed consent from an individual (the first layer in the pyramid), they need to be free to agree to take part in or refuse to participate in a study once they have a fully comprehensive explanation of the purpose and nature of the research, so the researcher should give clear details regarding what is expected of the participants, what information they need to provide and what procedures are in place to ensure that their information remains anonymous and confidential (Connolly, 2003). At the start of the research, I provided the pupils and parents with information about the study, explaining to them that it was voluntary and that they had the right to withdraw at any point. A copy of this letter can be seen in Appendix C.

I ensured that I used clear, simple language, avoiding jargon but giving appropriate detail in my communication, because when researching with children there may be less detail than adults (Connolly, 2003). To gain consent and minimise harm from vulnerable groups it is possible to get others who know them well to guard their interests and give permission on their behalf (Hammersley & Traianou, 2012), so as well as getting pupils to tick a box on the questionnaire to demonstrate that they were happy to participate, the parents and pupils had to agree to participate in the focus groups by completing a reply slip, a copy of which can be seen in Appendix C.

Before the start of the study, I had full ethical approval from the university (a copy of this approval can be seen in Appendix D) as well as permission from the school in which the study was going to be carried out. To get permission from the department, each member of the mathematics department was given a permission slip to complete before I conducted their interviews, and I reaffirmed their consent before each interview. This can be seen in Appendix E. I had complete support from the school to carry out the study. They have always been very supportive of educational research and the head teacher was happy to get involved and offer backing if necessary. In this study, following the small number of primary schools which allowed me to conduct interviews in their school during the pilot study, the head teacher wrote to the primary head teachers on my behalf, to see if more of them would be willing to allow me into their schools to conduct the focus group discussions. A copy of this letter can be seen in Appendix F.

Completing a questionnaire will always be an intrusion for the participants in terms of the time taken to complete it and how sensitive the questions are, as well as the potential invasion of privacy. As a result, although respondents can be encouraged to participate, they cannot be coerced into completing a questionnaire and the decision whether to be involved in the research and when to withdraw from it must be theirs. Therefore the respondents need to give their informed consent, be aware that they can withdraw at any time, have the potential for the research to improve their current situation explained to them, and should be guaranteed that the research will not harm them but will remain confidential, anonymous and non-traceable (Cohen, et al., 2011).

I explained the study clearly to the pupils in both year groups. The pupils had an opt-in box to tick on their questionnaire and then physically opted in by placing their questionnaire in a box. If they did not wish to participate then they did not have to give in their questionnaire. The pupils were also aware that they could withdraw from the study at any stage and that they would never be identified in the study, but would be tracked through their unique pupil number (UPN) and would be written up as pupil A, B, C.

There are many ethical issues surrounding interviews and focus groups, mostly around the interpersonal interaction and the production of information about a person. The initial decision is who should give their informed consent, should it be the participants or someone above them and should it be given orally or in writing. The possible consequences of the research should be explained to the participants and care must be taken to prevent any harmful effects of the research on the participant. The researcher must ensure that the interviews are conducted in an appropriate manner and that the environment is not threatening or stressful. They should be careful not to let their agenda dominate and be aware that they may interpret something differently to the participant (Cohen, et al., 2011).

To get informed consent, the parents of all the pupils were sent a letter which explained the study and an email address which they could use to contact me if they had any concerns. The letter also contained a detachable permission slip to consent to their child being involved in a focus group. The pupils' permission was sought again before each focus group, which was recorded on a Dictaphone.

There were some areas of influence which I decided not to research because they would have presented insurmountable ethical difficulties, such as issues personal to the pupils e.g. mental health, home life, health etc. Although these will have an influence on an individual's motivation and attitude towards mathematics, the aim of this research is to establish factors which affect large numbers of pupils, as opposed to individual pupil's stories.

3.4.2 Reflexivity

Two of the features of quality research are that the researcher should be able to demonstrate that they are open to developing issues, and that they should be clear and reflexive about "conduct, theoretical perspective and values" (Seale, et al., 2007, p. 9). This is echoed by Watt (2007) who argues that reflexivity is essential because the researcher is the primary tool in the collection and analysis of data (Watt, 2007). This means that the researcher must think deeply about what they are studying and how their own behaviour and assumptions may impact the study (Watt, 2007). Reflexivity involves turning the focus of the research back onto yourself as the researcher in order to acknowledge and take account for your own situation within the research and the effect that you may have on all parts of the research, such as the setting, data set, questions asked, how the data is collected and how it is interpreted (Berger, 2015). As a result of reflexivity, the production of knowledge is not independent of yourself as the researcher, nor is it objective (Berger, 2015).

There are many qualities regarding the researcher's position which will influence the research process. These are

> *personal characteristics, such as gender, race, affiliation, age, sexual orientation, immigration status, personal experiences, linguistic tradition, beliefs, biases,*

> *preferences, theoretical, political and ideological stances, and emotional responses to* (Berger, 2015, p. 220).

The position of the researcher impacts the research in three main ways. Firstly it can affect the researcher's access to the population being studied because respondents may feel more open to sharing their feelings with a researcher who they perceive is sympathetic to their situation and one who may be able to direct the respondent towards help if relevant (Berger, 2015). The second way is that it may affect the relationship between the researcher and the respondent e.g. women may feel more comfortable discussing certain issues with another woman as opposed to a man and thirdly, the background and beliefs of a researcher effects the way that they construct the questions that they ask, how they analyse the information that they get back and shapes any conclusions which they make (Berger, 2015).

Reflexivity is described as

> *the researcher's scrutiny of the research experience, decisions, and interpretations in ways that bring him or her into the process and includes examining how the researcher's interests, positions, and assumptions influenced his or her inquiry* (Charmaz, 2014, p. 344).

There is an obligation therefore that researchers are reflexive about what they bring to their research, what is seen and how they see it (Charmaz, 2014). Reflexivity aims to monitor the effects of the researcher's position and therefore improve the accuracy and credibility of any findings from the study (Berger, 2015). I have offered insights into my reflexivity throughout this thesis but the detailed sections are *3.4.3 'Power balance and positionality*' and *7.5 'Limitations of the study*'.

3.4.3 Power balance and positionality

Research in an educational setting raises many ethical considerations which may not be apparent when researching older groups. When carrying out research with vulnerable people it is important not to disempower groups which are already disempowered. Instead, the researcher should try to promote the empowerment of the group or leave them in the condition in which they were at the start (Munro, et al., 2004). A group which is powerless may not feel able to reveal their true opinions or feelings as they may fear that it will bring more negativity to their situation (Cohen, et al., 2011). This issue can be addressed by thinking carefully about the research findings and by the researcher being sensitive and honest during the interview; if they guarantee confidentiality then the interviewees may be more likely to open up and give honest answers (Munro, et al., 2004).

Children could well feel powerless or insecure in front of a researcher, especially one who is their teacher and as a result may say what they feel the researcher or school wants to hear or in fact give an answer which is socially acceptable. Children may also feel too shy or embarrassed to be truthful, so the researcher must be sensitive to this and recognise the limitations of carrying out research on vulnerable groups. A way of minimising this is to possibly involve a trained professional to carry out interviews and by choosing an interview setting which is not threatening to the child but is familiar and puts them at ease (Greig & Taylor, 1999).

To heed these points as a teacher researcher, I had to ensure that I did not disempower the pupils but instead be sensitive to allow them to speak openly. For both the pilot and main study I went to the primary schools to speak to the year 6 pupils. This was to ensure that they were in familiar surroundings so that even though I was a stranger to them, they would feel comfortable in their school, with their peers. For the year 7-10 focus groups I tried to construct the groups with pupils in the same set so that they were with peers they were familiar with. At the start of the focus groups I stressed to the pupils that they could speak openly and confidentially to me and the focus groups were carried out in a quiet, comfortable location to put the pupils at ease.

When conducting research with children, Hart (1992) set out a ‘ladder of participation’ which is split into non-participation at the bottom and starts with ‘manipulation’ (when children do what adults say, without understanding why) and moves up through ‘decoration’ and ‘tokenism’, which is described as children appearing to be given a voice but they have no choice about the subject or the style of communication and are given little opportunity to form their own opinions. The upper part of the ladder is split into degrees of participation from ‘assigned but informed’ up to ‘child initiated and directed’ to ‘child initiated’ which is a shared decision with adults at the top. This is often a rare situation due to the lack of caring adults who are attuned to the interests of young people (Hart, 1992).

When dealing with children, researchers should try to position their research towards the upper rungs of the ladder so that the child is sufficiently involved and included in the research (Hart, 1992). This is confirmed by Howe and Moses (1999) who suggest that participants need to take on a more active role than they do in traditional research so that they challenge and shape research methods and findings as they progress (Howe & Moses, 1999). This was very apparent in my pilot study when during the interviews the pupils were led by me and I kept summarising their thoughts. This would be low down on the ladder of participation whereas by using focus groups and allowing the pupils to discuss amongst themselves and feedback the pupils have a greater involvement which puts the groups up a rung on the ladder, but not towards the top because the pupils were not co-constructing the research question and activities, as I maintained the overall direction for the study as the researcher.

Unfortunately, as suggested earlier, because I did not involve a third party researcher there is a very strong possibility that the pupils were telling me what they thought that I wanted to hear because I was a mathematics teacher in their school. I did not want to involve another researcher due to the ethical considerations of working with children so to try to minimise the impact of this I encouraged the pupils to discuss amongst themselves, seating them in a circle facing each other whilst I sat and looked away, and then asked one of them to report back on what their group discussed. I hoped that in reporting back what the group said the pupils would not feel that they were necessarily speaking their own views so may feel more confident in the anonymity of the information.

Researchers need to avoid being patronising or overly powerful by thinking about non-verbal behaviours such as how they dress and their choice of language so that they are being inclusive as opposed to coming across as artificial or contrived. The researcher must conduct their research with respect and show dignity towards the participants. The researcher also has an obligation to be inclusive so that all participants feel valued and to abide by the ethical principles such as informed consent, confidentiality, keeping participants informed and ensuring the well-being of their participants. In an educational setting, the pupils should not have the feeling of being used because they have helped to advance the career of the researcher by providing the data, leaving themselves disempowered (Cohen, et al., 2011).

With these issues in mind, I tried to be as friendly and non-teacher like as I could be with the focus groups, which was made easier by being in an informal setting (i.e., not in a classroom). I reminded pupils of the purpose of the research, what it would be used for, how it would remain anonymous and confidential and how it would benefit me. I reminded them that they did not have to take part if they did not want to and that they could withdraw at any point if they felt uncomfortable. I set the focus groups up so that each pupil was involved by reporting back to me and none were ignored. I directed the discussion points at different pupils so that they all had an opportunity to speak.

When interviewing children, researchers often fear receiving inaccurate information as they believe that children's memories are poor and that they have a strong desire to please the interviewer by trying to say the 'right' thing. Hart (1992) argues that, whilst children do not have the same competence in communicating as adults, it does not make their information invalid. Instead, researchers need to be sensitive to the development of children and find ways to maximise their ability to discuss issues which concern them in a manner in which they feel comfortable (Hart, 1992). To encourage pupils of all abilities to be able to contribute to the focus groups I used the cartoons as a discussion point as well as traditional questions. Each pupil had a laminated copy of the cartoons which I hoped would be more accessible to them than traditional questions.

However, most research involving children involves questionnaires and interviews which only scrape the surface of what children can express. Hart (1992) argues that even getting permission from parents and children is a legal safeguard as opposed to an opportunity to truly empower the child in the decision-making process (Hart, 1992). He notes that whilst most psychological investigations would have a difficult time obtaining child volunteers if they asked around in streets or playgrounds; in a school setting, we simply make statements regarding the child's ability to say 'no' because the expectation from the teacher is that the child will participate and gives them little freedom of choice (Hart, 1992). There is therefore, always an issue of power in educational research because there is a chance that the participants will feel coerced into taking part and may give an answer that they feel the researcher wants, even if their behaviour does not display this.

This was not quite the case in my study because I found myself going into mathematics lessons to remind the pupils to return their reply slips if they were interested in participating in my study, despite the ethical tension. Even with these reminders, I found the total number of replies disappointing as I had intended to select pupils to attend the focus groups based on their replies to their questionnaires, however as the numbers were so low, I interviewed all the pupils who returned a consent form. From my visits into the classrooms, I felt that the response rate was so low because the system of getting a written letter to the parents and a reply slip back relied on the pupils passing the letter and reply slip on. An improvement to this would perhaps be to use an online system e.g. Parent mail where the parents are sent an electronic letter informing them of my research. The pupils appeared reluctant to take part in the focus groups because it was the end of term and they seemed like they did not want to miss out on any end of term activities or wanted to avoid doing anything out of the ordinary. Many of the pupils expressed thoughts of "what's in it for me?" and did not feel that my explanation of how changes may be made to their mathematics lessons and other department decisions, was a big enough draw.

To try to reduce the power balance involving myself, the questionnaires were given out by the form tutors of the year 6 pupils and the mathematics teachers of the years 7, 9 and 10 pupils. Although this may have reduced the influence that I have over the results, it does not avoid the affect that the class teacher may have on the responses of the pupils and the feelings of pleasing their teacher that they may have felt, even though they were reminded on the questionnaire that it would remain anonymous and that their teacher would not be reading them.

There were also ethical issues surrounding interviews with staff, primarily ensuring that I had informed consent and that the confidentiality and consequences of the interviews were discussed with the participants (Cohen, et al., 2011). Although the interviewees were not children, many of the same considerations applied; I obtained consent from the head teacher to conduct the interviews and written consent from the staff (a copy of this can be seen in Appendix E) before they were interviewed the first time and verbal consent for subsequent interviews. The structure, consequences, benefits, confidentiality, and anonymity of the research was explained to the staff members and the interviews were carried out in their classroom so that they were in a comfortable environment.

When interviewing peers there are additional issues which need to be considered. As the interviewees were my colleagues, I was not an anonymous researcher but had a history with the department which may be (and was) relevant to the research topic (Platt, 1981). There may also be a temptation for me as the interviewer to contribute more than in a usual interview situation, either by giving stories about oneself, getting to the point quickly without listening for explicit statements and effectively treating the situation as a regular, informal chat (Platt, 1981). Being mindful of these pitfalls helped me to try to navigate around them during the interview, and the presence of the Dictaphone recording the interview made the situation feel more formal.

Due to the familiarity between me as the interviewer and members of the department they may feel embarrassed to reveal things about themselves to me, or I may feel embarrassed to probe in too much detail and after the interview there is the difficulty of how both parties behave as the research relationship passes and I return to being their colleague (Platt, 1981). In this study I was not asking the staff anything that was incriminating or personal, but instead was asking for their views about aspects of the academic year which may have motivated the pupils. Although the staff may not have felt comfortable criticising the department, I emphasised that their views would remain anonymous and would only be used in this thesis. As there is a commonality between myself and the department there may have been times when they did not give full explanations because they would assume that I would understand what they were describing and for me to ask for more detail may imply that I am not part of their group and may affect a personal relationship (Platt, 1981). Therefore, there are inevitable biases as I draw on my background knowledge when transcribing the interviews as I attempt to fill in the gaps in explanation (Platt, 1981). Whilst it is hard to avoid all these scenarios when interviewing the department, being mindful of them when conducting the interviews meant that I could encourage staff to give as full explanations as possible and to not assume anything during transcription. Throughout this process I am grateful for the strong relationships that the department have and how supportive they were of my research because I feel that this helped to overcome many of these issues as they strived to support me in any way possible.

3.4.4 Approaches taken to data analysis

This final section of the chapter describes the steps taken to analyse the data. It covers the order of data analysis, how the data was coded and categorised and how the data was analysed to saturation.

3.4.4.1 Reasons for the order of data analysis

This section describes the order that the data was analysed and the reasons for these decisions. Figure 15 shows the order that the data was analysed but as this study is based on mixed methods research, the qualitative and quantitative components should be "mutually illuminating" (Bryman, 2007, p. 8) so one was not more important than the other.

Therefore, the reasons behind this order started as a personal decision to start the large task of transcribing the focus groups and staff interviews as soon as possible. This led me to start analysing this data set first because I had been working on it for such a long time already, listening to and transcribing the recorded discussions.

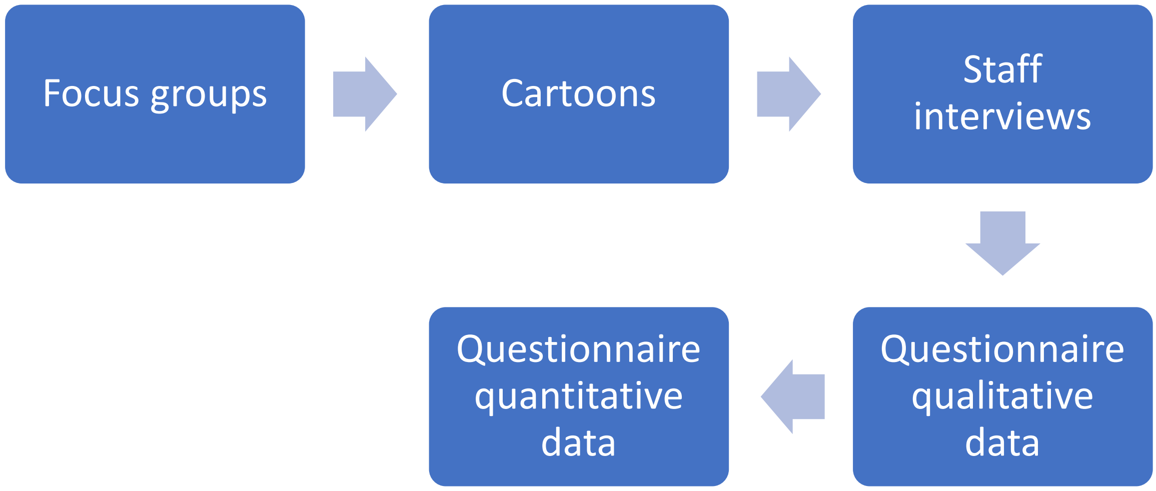


Figure 15 Order of data analysis

Once all the focus group and interview data had been analysed, I moved on to the questionnaire data where I chose to continue with the qualitative data and analyse the open questions first. This seemed a natural progression because I had been analysing qualitative data until this point and then left the quantitative data to analyse last, using SPSS.

3.4.4.2 Approach to coding

In this section, I outline ways in which qualitative data can be analysed, concentrating on the decisions I made to analyse the qualitative questions in the questionnaire and the focus group transcripts. There are two central approaches to analysing qualitative data: an inductive or deductive approach. An inductive approach is when the structure of analysis originates from the data itself (bottom-up) (Braun & Clarke, 2012) as opposed to a deductive approach which uses a framework or structure to analyse the data (Burnard, et al., 2008). When analysing and coding data a combination of inductive and deductive approaches are often used because it is difficult to be purely inductive because we naturally bring something to the data when we analyse it (Braun & Clarke, 2012).

Although there are many inductive approaches, a common one is thematic analysis which involves the analysis of transcripts, the identification of themes within the data and then putting examples of the themes from the text together (Burnard, et al., 2008).

In order to meet the aims of this study I chose to use an inductive approach to my analysis and focussed on using the coding approach described above to identify themes and categories within the data because it is one of the more systematic and clear approaches to analysing qualitative data, concentrating on themes without losing depth of analysis (Joffe, 2012). Thematic analysis is best suited to explaining the thoughts of a given group towards the issue being researched, where the data can be from focus groups, diaries, video material, open-ended questionnaire responses etc (Joffe, 2012).

The first stage in the process of thematic analysis is to use open coding to analyse the transcripts. Open coding has the aim of giving each element in the transcript a name to define it, analyse it and share it with others (Khandkar, 2009). Coding involves me as the researcher in at least two main phases; an initial phase of naming a word or section of data, and a second phase which is more focussed and uses the most popular initial codes to sort and organise the data (Charmaz, 2014). During initial coding, I need to remain as open to new ideas from the data as possible, however due to my prior experiences there are some themes which I am expecting to see. Therefore, there is an obligation for me to be reflexive about what I am bringing to the research, what I see and how I see it (Charmaz, 2014).

From my experience as a mathematics teacher, I have frequently heard mathematics described by pupils as boring and lacking relevance to real life. The familiar question “when am I ever going to use this in real life?” has often been heard in my and colleagues’ classrooms. Mathematics has frequently been described by pupils as being too hard and too much work. An opinion which is often reiterated by parents during parents’ evenings, with phrases such as “well I could never do maths either” or “I failed maths at school and I’m doing OK”. I have felt that some parents feel that they have ‘survived’ secondary school mathematics and that it was not a happy experience for them. This is compounded by people I meet who say that they “could never do maths” when they find out what I teach.

Anecdotally, in the study school, in general discussion amongst the pupils, mathematics is often described as boring, especially in comparison with a more practical subject such as PE with many pupils quoting one of the reasons for not enjoying mathematics being that they are not very good at it.

As well as from my experiences as a teacher and speaking to colleagues, my expectations are influenced by reading around the area of motivation, my own experiences of school as well as external influences such as the media. Although I was aware of these experiences, I did not use these to influence the coding but instead tried to avoid this altering my view of the data.

The codes themselves should be short, clear, and simple and remain close to the data (Charmaz, 2014). If a response has discussed something which is not relevant to the discussion, these cases can be uncoded (Burnard, et al., 2008), however Braun and Clarke (2012) recommend that "inclusivity should be your motto" (Braun & Clarke, 2012, p. 62) advising to code all of the data, even if you are concerned by its relevance because it is easier to discard a code than to go back to the dataset and recode data (Braun & Clarke, 2012). To avoid analytical bias, I chose not to ignore any response and deem it uncodable but created an 'other' category which enabled me to return to those responses to ensure that I had not misunderstood their meaning.

The next stage of the analysis is working through all the words or phrases, removing any duplicates and looking for any similar or overlapping phrases (Burnard, et al., 2008) and to group them around themes which are discovered in the data and are particularly relevant to the research question (Flick, 2002). The aim is to produce categories which are descriptive and multi-dimensional and form an initial framework to analyse the data (Hoepfl, 1997). The data should be read and re-read to identify any themes and to search for the meaning of the data; a process of 'constant comparison' (Burnard, et al., 2008). Although the terms concept, category and theme seem to be used interchangeably in the literature (Bazeley, 2009), within this thesis, 'codes' will mean the description given to an idea in the pupil responses and 'category' will be used to describe a group of codes which are related in some way. The 'themes' used in Chapter 4 are a synthesis of related categories which I used once the data had been coded and categorised.

3.4.4.3 Analysing the focus group data

In this section I describe the analytical approach taken to analyse the focus group data. There were forty-three focus groups across the two years. Table 3 details the number of focus groups in each year group.

2014	Number of Focus Groups	2015	Number of Focus Groups
Year 6	11	**Year 7**	12
Year 9	13	**Year 10**	7

Table 3 Numbers of focus groups

The focus groups were ideally three pupils but a minimum of two and maximum of four, with a mixture of genders but of a similar prior attainment so that the pupils felt able to discuss their opinions. The pupils in a focus group were all from the same class or from adjacent sets. The pupils were asked the following four questions in the discussion and a separate group of questions for the cartoons (see Appendix B):

2014 questions –

1. **How do you feel about maths, what's good about it, what's bad about it, what should it be like? Talk about it together.**
2. **What kind of person is a good mathematician? Describe them to me.**
3. **What would your friends say if you came top in a maths test? How would you feel?**
4. **What I want to do now is find out what you think maths will be like in secondary school. Do you think that you will enjoy it more or less? Why?**

2015 Questions (text in *italic* is different from the 2014 questions) –

a) *Before you joined XXXX School how did you feel about coming to XXXX School? How do you feel now?*

1. **How do you feel about maths, what's good about it, what's bad about it, what should it be like? *Has maths changed from last year? If so, in what way?* Talk about it together**
2. **What kind of person is a good mathematician? Describe them to me.**
3. **What would your friends say if you came top in a maths test? How would you feel? *Would you have felt differently last year?***
4. **What I want to do now is find out *if your feelings towards maths have changed. How do you feel this year towards maths? Why?***

The focus groups were recorded using a Dictaphone and so needed to be transcribed to analyse their content. Transcription is the process of reproducing words which are spoken e.g. in a recorded interview, into written words (Halcomb & Davidson, 2006). As well as transcribing the spoken words, there is also a debate about whether nonverbal cues such as body language and pauses and other functions such as coughing or crying should be included in the transcriptions (Halcomb & Davidson, 2006).

The transcription process can be thought of as a continuum from naturalism through to denaturalism. Naturalism is when every noise, word, sound etc is transcribed in as much detail as possible and denaturalism is when elements of speech such as pauses, stutters etc are removed (Oliver, et al., 2005). In conversation there are lots of verbal and non-verbal signals which can alter the direction of a conversation, some examples of this are laughing, stuttering, and talking at the same time. These can be difficult for a transcriber to interpret because they can set the tone of a conversation or perhaps have no bearing on it at all (Oliver, et al., 2005) e.g. if somebody sniffs throughout an interview it may be that they are upset by what they are discussing or unwell, which is difficult to decide when transcribing. As both methods have arguments for and against them, the decision of how to transcribe my data came down to which method would best suit my research aims.

In reality, it is impossible to record all of the different features and interaction within the focus group discussions, so all transcriptions have an element of selectivity (Davidson, 2009). As I will be interested in the meanings contained within the transcriptions as opposed to the idiosyncratic detail, and too much information may make the transcripts difficult to read and may mean that the content of the discussion is missed, I chose to use denaturalist transcription for my study. This was also the most practical method to use given the number of focus groups I had to transcribe. Although this does not highlight the non-verbal aspects of the recording, nor the context of the statements, it does provide important details and gives an accurate account of the conversation (Cohen, et al., 2011).

The recorded conversations were transcribed by giving each speaker a pseudonym so that confidentiality was retained. Each transcript followed the same template and has an identical structure and appearance (McLellan, et al., 2003). As I was using denaturalist transcription, I chose not to note tones or inflections in the voices of the pupils, nor to include other conversational items such as short pauses, audible breaths and non-verbal behaviours but instead to focus on the specific words that the pupils were saying. Although short pauses were ignored, longer pauses (over 5 seconds) were noted with '…..' as this may show possible thinking time.

When more than one person was speaking, and it was possible to differentiate between them these were listed separately, otherwise if the recording was undecipherable it was ignored and marked with an XXX. The focus groups were designed so that each discussion would be summarised clearly by one pupil at the end of the question, so that vital information would not be missed if they spoke at the same time. If it was possible to identify who interrupted a pupil, then this was noted as 'interrupted by ???'.

To break the transcriptions down into referenced points I have made a note of timings in a sensible place as close to 1 minute, 2 minutes etc as I can. If it was possible to decipher which pupil was talking this has been colour coded, otherwise it has been left as black type. I have used the following key during the transcriptions –

Text / Symbol	Description
……	Lengthy pause (thinking time), over 5 seconds
X	1 missed word
XXX	A section is missing
(end)	The conversation petered out – the pupil did not finish what they were saying.

As I was using denaturalist transcription, I have not tidied up the grammar but have typed as close to the original recording as possible.

Once the data was transcribed it was printed and cut up into each question. All of the focus group responses were then put together for each question; 2014 Q1,2,3,4 and 2015 Qa,1,2,3,4 and within each question, organised by year e.g. the year 6 focus groups were grouped together.

Figure 16 shows the process I followed to analyse the qualitative data from the focus groups.

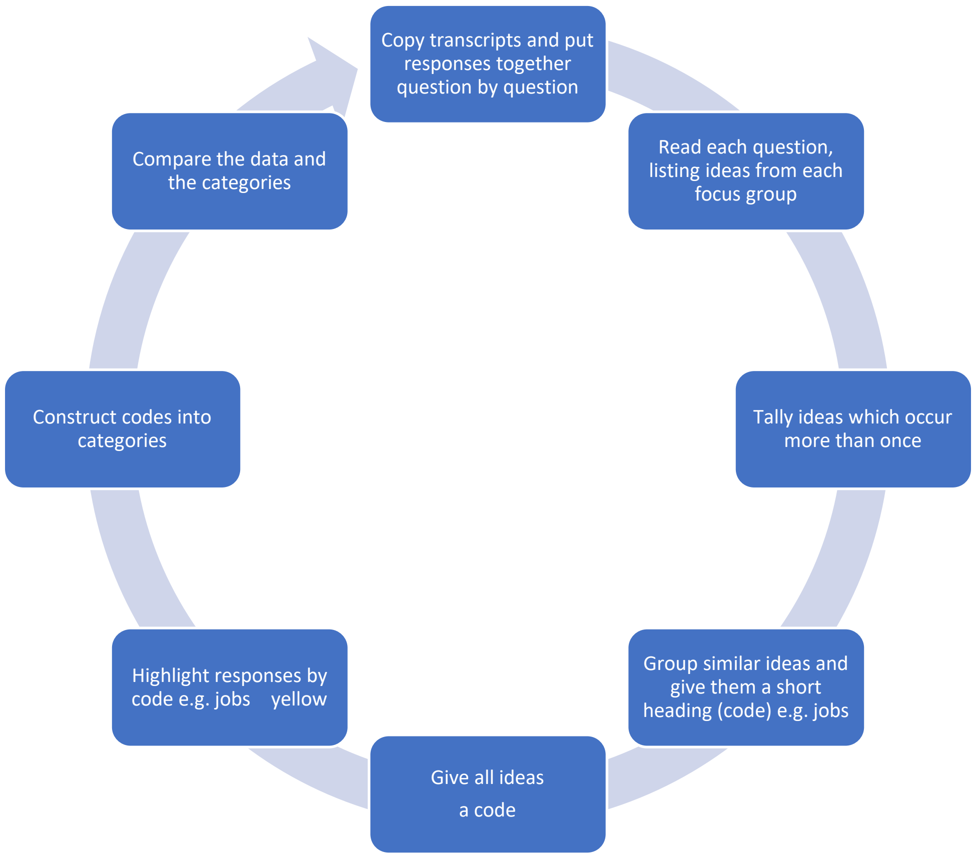


Figure 16 The process of analysing the focus groups

This data was then read and re-read. I listed a key idea from each statement, for example in the statement from 2015 Qa,

> *I felt really nervous at the start, I thought that we were going to get loads and loads of really hard work and loads of hard homework but we didn't actually get that much homework or hard work*

I listed the words 'nervous', 'hard work', 'homework' and 'didn't actually get that much homework or hard work'. These then built into ideas as can be seen in the following list -

Listed word	**Idea**
Nervous	Nervous at the start of the year
Hard work	Expected school to be hard work
Homework	Worried about homework
Didn't get that much homework or hard work	School was not as demanding as expected

As further responses would be read within a question, I tallied if an idea was repeated so that I was able to see which responses were popular between groups. I also placed key ideas into rough groups as the data was being read, for example if the words from a response was a negative opinion about learning mathematics, I grouped that with other negative responses about learning mathematics.

At the end of the question these key ideas were re-visited to see if there were any responses which were similar and could be further grouped together e.g. being scared, frightened or nervous about starting school could all be classified as '*nervous*'.

From the list of ideas, I created codes. I am using the word 'code' to mean a word or a short heading to describe the idea in a pupil response e.g. *nervous and hard work*. As suggested by Charmaz, I coded early in the hope that these codes would quickly help me to identify more focused codes (Charmaz, 2014). Once these codes were identified I re-read the responses to each question and highlighted any statements which fell under the codes e.g. *nervous* was highlighted yellow.

Once all the responses were highlighted, I read through the codes for each question, to see if there were any codes which formed part of a category. The aim here was to reduce the number of codes by putting similar codes into broader categories (Burnard, 1991). For example, continuing with the responses to the 2015 Qa which asked the pupils how they felt before joining the secondary school this is the list of key ideas which was made after the first read through. These were immediately sorted into feelings before (expectations) and current feelings as they were written down.

Feelings Before (Expectations)

Scared

Nervous

Bullying

Excited

Confident

Sets

Hard work

Homework

Not first choice

Feelings Now

Settled

Love it
Freedom
Mathematics is full on/fast paced
Not as bad as imagined
Improved in mathematics

Key ideas were then joined, and along with responses which occurred more than once, a list of codes was created. The breaks show the end of a group of similar responses.

Feelings Before
Scared/nervous
Bullying
Excited
Confident
Hard work/Homework

Not first choice

Feelings Now
Settled/love it

Mathematics is full on/fast paced

Not as bad as imagined

Improved in mathematics

Reading through the codes there were ones which referenced negative personal feelings such as feeling scared, or the secondary school not being the pupils' first choice. Some of the codes made a reference about positive feelings e.g. feeling excited or confident; and some referred to environmental aspects such as homework. These similarities allowed me to construct three categories from the codes; Personal Feelings: Negative, Personal Feelings: Positive, and Environmental Aspects. Table 4 shows which codes were in which category –

	Personal Feelings Negative	Personal Feelings Positive	Environmental Aspects
Before	Scared/nervous	Excited	Bullying
	Not first choice	Confident	Hard work/homework
After		Settled/love it	Mathematics is full on
		Not as bad as imagined	
		Improved in mathematics	

Table 4 The construction of categories from the codes

My decision to place the code of bullying as an environmental aspect was because I felt that the pupils described it as an environmental norm (as opposed to significant bullying). The pupils seemed to accept and expect low level bullying as part of the atmosphere when they moved up to secondary school. They did not describe the personal feelings that they may have felt if this happened (which would have been categorised as feelings), but described it as an expectation, like lots of homework and hard work. If a pupil had said that they were scared that they would have been bullied, then I would have coded this in two places – personal feelings negative (scared) and environmental aspects (bullying).

Once these categories were constructed, I went back to the transcripts and compared the categories to the transcriptions, to ensure that the categories which were forming fitted them completely. Charmaz (2014) describes moving from initial coding to focused coding as not necessarily a linear process but that a response may make you go back to your previous data to explore areas which may have been glossed over first time around (Charmaz, 2014). Where appropriate, categories were then constructed for the other questions.

3.4.4.4 Challenges faced when analysing the focus group data

The following section describes the challenges which I faced whilst coding the focus group data and how I overcame them. The focus groups were designed with the intention that pupils would feel more confident to speak and describe their opinion, so that each pupil had the opportunity to speak and to minimise the impact that I as a teacher had on their ability to speak openly. The focus group could draw out any common feelings between the pupils, perhaps with pupils nodding in agreement or if they disagreed, there would be a safe opportunity for them to debate or discuss their feelings (Ennis & Chen, 2012).

What I have noticed during the transcription process is that in some groups a pupil will speak and a theme for that question is created as the others either just agree or follow that train of thought. This may be due to the size of the focus groups that I used because smaller groups can be more sensitive to dynamics within the groups such as friendship groups, pupils appearing as experts or participants who are acting uncooperatively. Smaller groups work best when the participants are respectful of each other and interested in the topic that they are discussing (Morgan, 1997).

Of course, it may be that the pupils did feel the same, but it also may be that they agreed with the pupil who was most dominant and did not feel confident enough to raise their point of view, e.g.,

How do you feel towards maths this year and why?

Pupil 1 – I find it a lot more better, a lot more fun

Pupil 2 – yeah same

Pupil 3 – yeah same

Pupil 1 – challenging but fun at the same time.

When asked to summarise:

Pupil 3 – uhh, well we find it like fun and that.

I designed the focus group with the hope that each pupil would feel confident to give their opinion so if each pupil in the focus group did have this opinion, or if this is a co-constructed description of all of their feelings then it is an accurate representation, but if they have just agreed with a more dominant peer or the first pupil to answer, then it will distort the findings from the focus groups. To deal with this scenario fairly I have counted an idea the first time it is raised in a focus group as opposed to each time it is agreed upon by a pupil. The figures quoted throughout the analysis of the focus groups will be the number of focus groups which raised an idea, as opposed to the number of pupils.

Question 2 asked the pupils to describe a mathematician and many of them described them as being smart. This term could be used to describe either their appearance or their intelligence and it was not always clear which one the pupils intended e.g. “I see a smart person, wearing glasses”, “just somebody that’s quite smart altogether” or “a sort of stereotype of a smart person wearing a lab coat and glasses”. Unless it was obvious which context the description was intended, I have assumed that it describes a person's appearance. I made this decision for two reasons; firstly because most of the descriptions were related to physical characteristics of the mathematician e.g. glasses, beard, accessories, and also because often the groups who used smart went on to articulate a separate reference to intelligence e.g. "is good at maths", "concentrating", "always working", "quick at solving out stuff".

Questions 1 and 4 asked the pupils to describe how they felt about mathematics and how they thought it would be the following year. In the responses to these questions, how relevant mathematics is to real life, as a positive description would be: "it's good because you use maths quite a lot in life" and a negative description:

> *I think we should do stuff that you are going to need outside of school….like algebra and stuff you don't really need unless you're going to become a mathematician.*

It was also used as a way for mathematics to improve:

> *and with a reason because sometimes when I do maths and people are like 'why are we doing this, what are we going to do with it in life'. But if we actually have got a real situation that we've got to work out then it's better to do*.

In this case I counted the statement in all three sections i.e. as a good feature of mathematics, a bad feature of mathematics and as a way of improving mathematics. This just highlights either how different pupils view mathematics, or perhaps how there are parts of mathematics which the pupils feel are relevant to life and parts which are not, and how each personal experience shapes their opinion.

Some responses appeared to be able to go into more than category. Using question 4 again, three categories were constructed from the data (personal experiences, classroom experiences, rationale). A year 9 pupil felt that mathematics was "hard to remember because there is quite a lot to remember" and suggested that different methods of teaching may make topics more memorable. Rationale for mathematics was used to describe any reference to the reasons why the pupils have to study mathematics e.g. it is useful in real life or it will be useful in certain jobs. Personal experience of mathematics covered any personal feelings that the pupils felt towards mathematics e.g. if they enjoyed it, if they found it stressful, if they found it hard etc. The final category: classroom experience was used to describe any response which the teacher could control e.g. sets, how serious the lessons were, how much homework was set, how varied lessons were etc. Using these criteria, the statement could be split up into the first part "hard to remember" which is a personal experience and the suggestion for how teachers can help would come under the third category of classroom environment.

Another example of a response which appeared to be able to go into two categories is when the pupils discussed how they did not like to be picked on. Although the teacher has an element of control over who they ask in the classroom, being picked to answer a question is an almost inevitable part of being in the classroom so I focussed on how this made some of the pupils feel i.e. the worry and pressure that they felt when they were picked on in class.

3.4.4.5 Cartoons

The process for analysing the cartoon data followed the same route as for the focus group data. The data was transcribed, put into question groups and key ideas were identified before being highlighted and eventually categories were constructed.

Although I already had the categories from the focus group data, I took an open coding approach to the cartoon data and was open minded to the generation of new categories and new ideas in the data, however the outcome was the construction of a similar set of categories.

3.4.4.6 Analysing the data from the staff interviews

The staff interviews were transcribed using the same approach as for the focus groups (see '*Analysing the focus group data' 3.4.4.3*), using denaturalist transcription. By now I had analysed the data from the focus groups, so I was already aware of the codes and categories that had arisen from this data, however I took an open coding approach to the staff data and was receptive to new ideas coming from this important teacher voice.

As I had a small number of transcriptions compared to the focus group data, I did not group the responses by question but analysed each transcription in its entirety before highlighting key ideas across all the transcriptions. This allowed me to see if there was a narrative coming from each staff member, as well as deepening this narrative with connections to background information such as how they were affected by the class rotation (please see Table 7, section *4.5*) and specialism, so that I could tell their story as accurately as possible.

Perhaps due to the small number of staff interviews compared to pupil data, the questions I asked the department, or because the staff have had similar experiences in the study school, there were a limited number of key ideas repeated across the transcriptions. These key ideas were grouped together to form categories e.g. any discussion on motivation in year 10 was coded as year 10 motivation:

> *Year 10 not so much, they started off well, very motivated, very hardworking, the fact that they're doing their GCSEs sort of motivates them but throughout the year that's changed and the majority of them became less inclined to work and less serious about getting their exam at the end of the year*
>
> *I don't find this particular year 10 group a highly motivated year 10 group. I think that's because a significant number, boys and girls, who are not interested in doing well and don't want to work at it.*

Once all the qualitative data was analysed, the categories from the staff data were synthesised with the categories from the pupil data, where appropriate, and prevalent themes arose which are discussed in Chapter 4. The formation of these themes are explained in more detail in the following section.

3.4.4.7 Analysing the qualitative data from the questionnaires

This section describes the open coding approach I took to analyse the qualitative questions in the questionnaire. The questionnaire was completed by all the pupils in year 6,7,9 and 10 who consented. From this population, a 10% sample was taken, stratified by gender and year group. The size of the sample for thematic analysis should be large enough so that there are enough pupils in each year group and gender to make valid comparisons between the groups and to reveal ideas within a group rather than on an individual basis (Joffe, 2012).

A 10% sample was selected because it provided a manageable sample of data. The sample was stratified by gender because of the differences in gender, suggested by the literature and by year because the study is based on changes in motivation and attitude as the pupils move through secondary school, so the sample needed to reflect the population. 'Set' was not included in the stratification because the year 6 pupils were not in sets in primary school and I wanted the method of sample selection to be the same across the study. Table 5 shows the number of questionnaires in the population and sample. The population number is the number of consenting pupils (and therefore parents) who were offered the opportunity to take part. As the aim of the study was to track these students from one year to the next, the same students were asked in 2014 as 2015.

2014 - 2015	Number of Questionnaires in Population	Sample Size
Y6 – Y7 Boys	107	11
Y6 – Y7 Girls	110	11
Y9 – Y10 Boys	99	10
Y9 – Y10 Girls	93	9

Table 5 Number of pupils who participated in the study

To choose those pupils who were going to be in the sample I numbered the students from 1 to 107 (in the case of year 6 boys) and used a random number generator to select 11 numbers from 1-107. A random number generator was used because I wanted a random selection from each stratification, and I had no criteria for picking a purposive sample at this stage. I then selected these questionnaires, photocopied them, and cut the responses up into each question. The questionnaires were photocopied so that I could keep the complete questionnaire to look back through if necessary. The responses were then put together for each question by year and gender (Y6 boys, Y6 girls etc) so that I could systematically read all the responses to a question together. This process was repeated for each of the 8 groups. The responses for one question were considered before I moved on to the next question so that I could work systematically through the data, coding each response appropriately (Vaismoradi, et al., 2013)

Figure 17 shows the process I followed to analyse the qualitative data from the questionnaires.

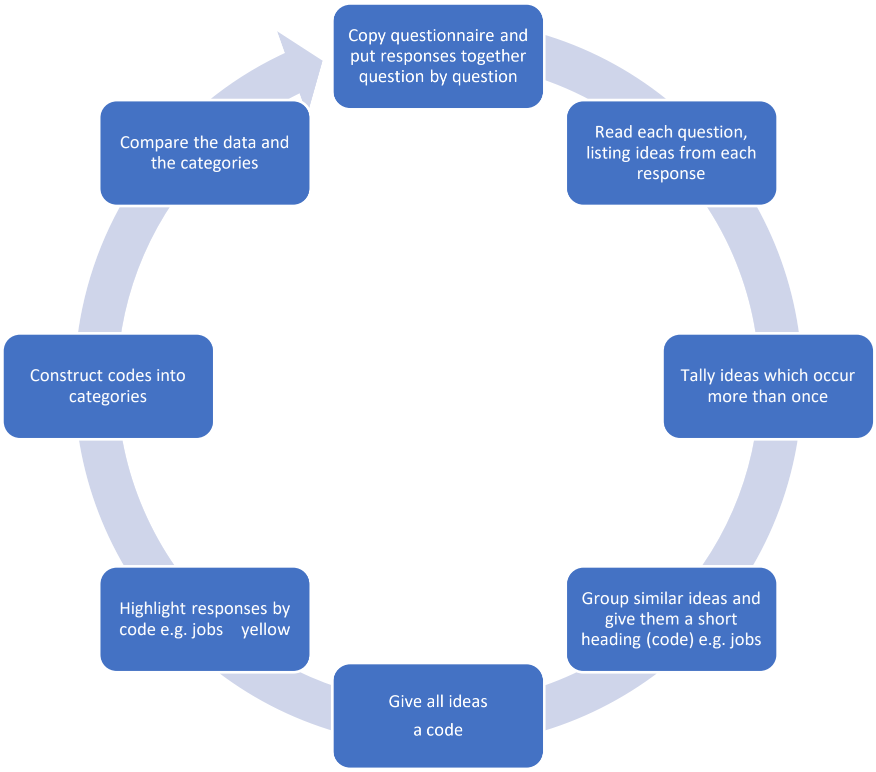


Figure 17 The process of analysing the questionnaire responses

The responses to each question were then read and re-read (Braun & Clarke, 2012). I listed words or phrases which explained the pupils' point of view in response to the question (Braun & Clarke, 2012). For example, in response to the question

I will probably continue with maths after GCSE

a year 9 girl wrote 'I'm not sure, because I don't feel confident in maths and I don't really enjoy it'. I listed the words *I'm not sure*, *I don't feel confident* and *don't really enjoy it* because this captured the three parts of her response which had meaning. These ideas were listed as *unsure, confidence* and *don't enjoy.*

As I read further responses for a question, if ideas occurred more than once they were tallied e.g. the first time a pupil mentioned that they were unsure about whether they would continue with mathematics I wrote down *unsure*. The next time this was mentioned I put a dot next to the word *unsure* and if it came up again, another dot etc. This allowed me to see if there were any repetitions in the ideas.

When appropriate, I placed key ideas into rough groups as the data for each question was being read, for example if pupils discussed that they would take mathematics because it is important to help you get a job or you need mathematics for a lot of jobs then I would group these together under the idea that mathematics was *useful for a job.*

Once I had read all the responses for all the questions, I re-visited the ideas that I had listed to see if any of them could be grouped together e.g. describing mathematics as important, the main subject and essential to have, were grouped together under the idea of the *importance of mathematics*.

From the list of ideas, I created codes. I am using the word 'code' to mean a word or a short heading to describe the idea in a pupil response e.g. *important, I don't enjoy it* and *useful for job*. I then went back through each question and highlighted where these codes were present in the responses. Referring to the previous example 'I'm not sure, because I don't feel confident in maths and I don't really enjoy it' I highlighted 'not sure' in yellow for the code *don't know*, 'don't feel confident' in pink for the code *confidence* and 'I don't really enjoy it' in red for the code *don't enjoy it.*

Once all the responses were highlighted, I read through the codes for each question, to see if there were any codes which formed part of a category. For example, in response to the question of whether the pupils would continue with mathematics after GCSE, the following list shows the codes from the pupils in year 6 and 9 -

Enjoy mathematics
Know enough
Not useful for job
Useful for job
Don't know
Confidence
Don't enjoy mathematics/hard
Important subject
Useful in life

Reading through the codes there were ones which referenced personal feelings such as enjoyment, confidence or finding mathematics hard. Some of the codes made a reference about the pupils' futures e.g. mathematics is useful in a job or it is not useful in a job; and some referred to the value that the pupils placed on mathematics e.g. I know enough or it is an important subject. These similarities allowed me to construct three categories from the codes: *Personal Feelings, Future Uncertainty* and *Subject Value.* The following list shows which codes were in which category –

Personal Feelings	Future Uncertainty	Subject Value
Enjoy mathematics	Not useful for job	Know enough
Confidence	Useful for job	Important subject
Don’t enjoy mathematics/hard	Don’t know	Useful in life

Once these categories were constructed, I went back to the data and compared the categories to the data, to ensure that the categories which were forming fitted the data completely. Where appropriate, categories were then constructed for the other questions.

The difficulties with analysing qualitative data are that the researcher can be influenced by the first reading of data so some things may seem more important than they turn out to be. This can steer the data and lead to bias but is human nature (Male, 2016). Therefore, at the end of the process I went back through the data and repeated the process to see if I had jumped to any conclusions when looking at the data the first time around as analysing qualitative data is not generally a linear process but is often repeated (Khandkar, 2009).

With the literature review in mind, the initial steps of coding and categorising the data allowed me to get to grips with the large amount of qualitative data from the questionnaires, focus groups (see Appendix G) and interviews. However once the raw data had been organised, collated, and compared in the ways described above, pervasive, unexpected groups of ideas from my data set became clear to me, which I have called themes. These themes represent the analysing, thinking, synthesising, reflecting and recurring messages within the data.

These themes cover virtually all of the data and although some of the small comments made by pupils are missing from these descriptions, the aim of the research was to tell the overall story of the pupils. These themes cropped up throughout the data and captured the stories which were emerging. Some of these themes refer to the particular situation of the study school and some of them are factors which provide the levers which are discussed in the concluding chapters of this thesis. I have used these themes as the layout for the findings described in Chapter 4.

3.4.4.8 Saturation

This section describes saturation and explains the approach that I took to ensure that I had saturated the qualitative data from the questionnaires.

Theoretical saturation is achieved when no new ideas are present in the sample and when the categories are clearly described and fully dimensional (Morgan & Boychuk Duchsher, 2004; Timonen, et al., 2018). When similar responses are repeated, the researcher becomes confident that the data is saturated (Nelson, 2015).

Bowen (2008) states that it is not enough to claim that the data is saturated but advises researchers to make the steps that they have taken to reach saturation explicit (Bowen, 2008). In order to explain when saturation point is reached Francis et al (2010) suggest specifying a minimum sample size for the first round of analysis and then specifying how many more interviews (this was relevant to their article but for my data it will be questionnaire responses) need to be conducted, without any new ideas being seen, for a researcher to conclude that they have achieved saturation (Francis, et al., 2010).

My initial sample size was 10% of the data, stratified by gender and year group. Once this 10% sample was analysed, I took a further 10% sample to see if there were any different responses in this sample. This further sample was stratified by gender and year again because of the differences in gender, suggested by the literature and because the study is based on changes in motivation and attitude as the pupils move through secondary school, so the sample needed to reflect the population. Set was not included in the stratification because the year 6 pupils were not in sets in primary school and I wanted the method of sample selection to be the same across the study.

This second sample (10%) provided ideas which were not present in the initial sample (10%) so I could not stop analysing the data. However, the new information was not present in all the 8 year groups (year 6, 7, 9 and 10 girls and boys) but only in year 10 so a third sample was collected. The new ideas found in the second sample were mostly surrounding the variety of teachers that some classes had experienced that year so for the third sample 10% of year 10 students were selected, stratified by gender and set to ensure that the feelings of all classes in the year group were analysed.

When the analysis of additional data fails to show anything new, but existing codes are being repeated, the sampling can stop (Bowen, 2008; Khandkar, 2009). The details of these saturation samples are presented in Appendix H and the findings from the sample as a whole (including these saturation samples) are discussed in Chapters 4 and 5.

3.4.4.9 Challenges faced when analysing the qualitative data from the questionnaires

The following section describes the difficulties I faced whilst coding the questionnaire data and how I overcame them. Due to the one-sided nature of questionnaires, there were a few instances when it would have been beneficial to be able to speak to the pupil either to explain the question or to ask them to explain their response more. An example of this was a year 9 girl who responded to the question

What does it take to be successful at maths?

with 'I don't understand the question?'. It would have been useful to explain to her what the question meant so that I could have an insight into her thoughts but as this was not possible, I put the response into the 'other' category.

Another example of this was in response to the question

How has this year been for you in maths?

where one year 10 boy wrote 'long story short, about 7/10' and a year 10 girl 'really bad'. In these cases, it would have been insightful to be able to ask the pupils to explain their comments, however this is obviously not possible with a questionnaire. In these cases, where the statement was relevant but did not give me any content, I put them into a separate category *lack of content.*

The responses to the question

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

were particularly difficult to analyse because the descriptions were very specific, due to the nature of the question. The pupils often listed a topic e.g. column addition, fractions etc as opposed to the reasons why this lesson was the best. To analyse this question, I had lots of codes to try to cover all the responses and used a s*pecific topic* code to cover the responses which listed a mathematics topic. The codes are summarised in the following list –

Specific topic

Challenging

Choice

Group work

Problem solving/puzzle

Games

Easy

Never had one

Positioning

Fun

Behaviour

Competition

Again, as there were similarities in the codes, three categories were constructed: *classroom environment, personal experience,* and *activity type*. The following list shows what codes the categories consisted of -

Classroom Environment	**Personal Experience**	**Activity Type**
Choice	Challenging	Specific topic
Group work	Easy	Problem solving/puzzle
Positioning	Fun	Games
Behaviour	Never had one	Competition
	Too many to choose one	

There was a range of responses to this question which could be interpreted as never having had a favourite lesson. Some responses were clearly saying that they had never had a favourite mathematics lesson, whilst others were more vague e.g. 'I can't remember' does not say that it has not happened, simply that the pupil cannot recall it and 'don't have one' may be a similar response to the year 7 girl who felt that she could not pick just one lesson because she has had so many fun ones. The following list shows the responses which fell under the code 'never had one' as well as the year 7 girls' response as a comparison for detail –

Year 10 boys	I can't remember No favourite Don't have one
Year 10 girls	I don't have a favourite I never had one I haven't got one
Year 9 boys	I have never had a favourite maths lesson ever I don't have a favourite
Year 7 girl	I can't pick we have had lots of fun lessons

As the question focused on what made that lesson their favourite, and as these responses did not include any detail to explain their thoughts, I coded all the above responses (except the year 7 girl whose response was coded as *too many to choose one*) as *never had one*. This code explained a personal experience that the pupils have of their mathematics lessons so went in the *personal experience* category.

Some of the responses to the questions showed what was personal to that pupil at the time, for example in response to the question

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

a year 9 boy wrote

> *allow us to listen to headphones, but if there are any arguments they have to take them out.*

The study school does not allow headphones to be used in lessons and had been tightening up on pupils who had headphones visible (hanging around their tie, poking out of their shirt etc) and this appeared to be bothering this pupil. In case this suggestion would help some of the pupils concentrate in the class, to analyse this, I coded this as *behaviour* which came under the category *classroom environment*.

Despite trying to code the data as thoroughly as possible, there may be cases where responses may fall into two separate categories if they contain separate elements, or perhaps are better placed in an *other* category. An example of this was in response to the question

If maths was an option, I would choose it now a year 7 boy wrote

> *it depense [sic] really how hot it is because like now I get iratated [sic]and wish to be outside (running).*

I struggled to categorise this response and initially felt that it was not a relevant response so was going to place it in the *other* category, assuming the boy had misunderstood the question. However, after offering it as an example to my research community I re-considered the statement as I felt that it explained the boy's feelings towards mathematics and perhaps what he may prefer to be doing instead of being in a mathematics lesson, which meant that it sat in the *personal experience* category.

Another example which I offered to my research community was in response to the question

What does it take to be successful at maths?

to which a year 7 boy suggested to 'listen for the hints in the question & read'. Initially I interpreted this question as advising you to read the questions thoroughly and try to spot any hints in them. However, on re-reading I realised that the hints for the question came after the word 'listen' which is a behaviour attribute which the pupils need, so I coded the first part of the response as 'listen' which came under the category of *behaviours*.

Some responses to the questions did not appear immediately relevant. For example, in response to the question

I will probably continue with maths after GCSE

a year 9 boy wrote 'I'd like to travel before I go to university etc so I'm not entirely sure yet but probably'. The discussion of travel initially made me question the relevance of the response but as he goes on to say that he is not sure, I focused on this part of his response and noted it as *unsure of the future* and ignored the reference to traveling.

Two other responses seemed to lack relevance, so I ended up coding them as 'other' and did not include them in the analysis. An example of this was a year 9 girl who responded to the question

If maths was an option now, I would choose it

with

> *I'm happy with how many lessons I have a week of maths and wouldn't want more time spent based on a topic I find boring.*

In this case I have assumed that she has mis-read or did not fully understand the question, or that the pupil could not communicate her response back to me because I am unsure how to interpret it as I do not know what she meant by the word 'topic'.

The other response which was coded as *other* was in response to the question

What does it take to be successful at maths?

To which a year 10 boy wrote 'be able to count to 1 2 3 4 5 6 A b C D'. He may have intended his response to mean that one must be able to be good with numbers and read but I do not want to infer a meaning from this, so have chosen to code it as *other*.

There were many responses with more than one key idea in them, so in these cases I split the responses into sections. For example, in response to the question

If maths was an option now, I would choose it

a year 9 boy wrote

> *because I want to have essential maths knowledge, but I don't want to learn everything to do with maths.*

This covered two key points; the *importance* of mathematics but pupils feeling that they *know enough*. In these cases, for greater accuracy, I split the response into its key ideas and reported them separately.

Another example of a response containing more than one idea was in response to the question

If maths was an option now, I would choose it

a year 9 girl wrote

> *I know that it is important so I would probably take it for the benefit of my qualifications but if it didn't count for anything then I wouldn't choose it.*

She is discussing that she is aware of the value of mathematics but implies that she does not enjoy it enough to choose it if it was not deemed important in societal terms. In this case I only took the point that she felt that mathematics was important because I felt that I was inferring that she did not enjoy mathematics but that was not explicitly written, and as mathematics is deemed important by society then she would choose it.

In conclusion a thematic approach, using open coding was used to analyse the qualitative data from the questionnaires. Any responses which were interpreted as not relevant were put into an *other* category so that they could be revisited, and more tricky responses were offered to the research community to help me analyse them. Responses which contained more than one idea were broken into their key parts and coded appropriately. A 10% sample was used as it provided a manageable set of data and the final sample contained this 10% plus the saturation samples as described above.

3.4.4.10 Creating an attitude scale

The questionnaires were completed by year 6 and year 9 pupils in 2014 and year 7 and year 10 in 2015 with the hope of tracking two year groups as they crossed key transition points; starting secondary school and starting key stage four respectively. The data collected from the questionnaires allows for comparisons to be made within subjects (year 6-7 and year 9-10) and between subjects (e.g. 6-9).

One of the aims of the questionnaire data was to see if the motivation and attitude for an individual change as they move across a transition point, so the first section of the questionnaire contained questions regarding attitude and motivation which had Likert scale responses. The responses in a Likert scale have a rank order and although some researchers often assume that the differences between the values is equal, this is not necessarily the case. For example, the strength of feeling from strongly disagree to disagree, may not be the same as from disagree to no opinion (Jamieson, 2004). In this analysis, I have assumed that the data from my Likert scale is ordinal, which means that it can be ordered and ranked but it is not possible to measure the distance between the values (Allen & Seaman, 2007). Therefore, the data should be analysed using median, mode, frequencies or percentages in each category (Jamieson, 2004).

To investigate whether motivation and attitude change as the pupils move across a transition point, I needed to try to quantify the attitude feelings of the pupils. When looking at similar studies, researchers had created a variable to allow them to carry out further analysis. For example, in a study which looked at trying to measure mathematics confidence, computer confidence and attitudes to the use of technology in learning mathematics, eleven questions were chosen from 37 in a questionnaire which was given to 289 students, to create a measure of mathematics confidence. This measure was then checked for validity using Cronbach's alpha and for normality by looking at means and midpoints (Fogarty, et al., 2001).

In another study, 1500 students in 17 schools were given a questionnaire to discover their reasons for not continuing with mathematics. To see if there was a relationship between the participation rates and the attitude words pupils used in their questionnaire, the words were placed onto a scale e.g. like was +1, dislike -1, excited +2 etc. This allowed the researchers to calculate a score in each school and to then make comparisons across schools (Brown, et al., 2008).

A third study which was looking into mathematics anxiety and resilience among apprentices summed the scores from a 5-point Likert scale to create a variable which allowed the researchers to assess the level of mathematics anxiety in each group. This enabled them to compare their findings with other studies around the world (Johnston-Wilder, et al., 2014).

As a result of these studies, I took the decision to create a value for attitude for years 6 and 9 which was called 'pre attitude value' and years 7 and 10 called 'post attitude value'. The creation of this value involved tests to check for validity and normality which are discussed in section *5.1 'Checking the attitude scale'.*

This chapter has described the design of the research from pilot study to the main body of research, including detailed descriptions of the research tools and the reasons behind these designs. The ethical considerations behind the study have been described as well as the issues of teacher researcher, the imbalance of power this creates and how I sought to overcome these. Finally, the approaches taken to data analysis have been explained as well as the reasons behind these decisions.

The next chapter discusses the responses from the focus groups, questionnaires, and staff interviews.

Chapter 4 Findings: qualitative data

I refer back to the research aim for this study:

To explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

This chapter details the findings of the qualitative data from the questionnaires, focus groups and staff interviews. The process of coding, categorising, and analysing the qualitative data was discussed in section *3.4.4, 'Approaches taken to data analysis*'. A detailed account of the data from the questionnaires and focus groups can be read in Appendix G but in this section, I report the integrated summary of the qualitative data.

The findings are reported in themes, which have been synthesised from the detailed analysis of the qualitative data; each theme is the title of a section and is split into student view and staff view where appropriate, ending with a concluding summary. Themes are discussed in more detail in '*Analysing the qualitative data from the questionnaires' 3.4.4.7.*

The following list shows the themes that have been constructed from the data:

Expressions of greater negative feelings in year 10

The importance of Primary Schools

Achievement breeds success

Effects of disruptive pupils

The importance of stability of teachers

Students' experiences of mathematics lessons and suggestions for improvements

Changes in pupil mindsets

The perceived relevance of mathematics

Table 6 shows the relevant details about the staff members reported in this section, such as role in the school or length of time spent working in the school.

Staff Member	Role
Z	Class teacher (specialised in teaching lower prior attainment sets)
Y	Second in department
X	Head of department
W	Supply teacher (for the final term of the year)
V	Class teacher
U	Mathematics teaching assistant
T	Class teacher

Table 6 Staff member role and code

4.1 "Because I'm bad", "Because I'm not that bright", "Because I'm not very smart" Expressions of greater negative feelings in year 10

4.1.1 Student views

From the qualitative responses to the question of whether the pupils would continue with maths after GCSE, the response of 'not being good at it' was more prevalent in year 10. It was not mentioned at all in year 6 and only by two pupils in year 7, although one rationalised that although she found it hard, she would still choose maths because it would help with her future. Only one year 9 girl stated not being good at maths but then 3 girls and 3 boys in year 10 mentioned not choosing maths because they were not good at it.

In the same question no girls mentioned that they were good at maths, but two year 7 boys did, although this positive feeling was not mentioned in any other years. This is similar to how much the pupils enjoyed maths; two year 6 girls responded that they enjoyed maths, but this was not mentioned again in the responses from the girls. One year 6 boy and two year 9 boys wrote that they enjoyed maths, but this was not mentioned in year 10.

In the responses to whether the pupils would choose maths now if it was an option, one year 6 girl and one year 10 girl would choose maths because they enjoy it, but this differs from the boys where three year 6, four year 7, two year 9 and no year 10 pupils wrote that they enjoy maths. This indicates a greater negative feeling of year 10 pupils towards maths as there is a general tailing off in terms of finding maths enjoyable. One girl in years 6, 7 and 9 wrote that they did not enjoy maths, but three year 10 girls felt that way. However, this is not mirrored in the responses of the boys. There were two boys in year 6 and three in year 7 who did not enjoy maths and only one response in year 10. This particular result does not follow the previous ones where the pupils seemed to be more negative about maths in year 10.

This data seems to show an increase in negative feeling which was present in the focus group responses too. When the pupils were asked what maths should be like there were more groups in year 9 which felt that maths should be more fun than in year 6. In contrast to this feeling, the number of suggestions that the lessons should be more varied decreased dramatically from year 6 to year 9 but the pupils expressed more stress regarding their seating arrangements in later years, with nearly a third of the year 9 focus groups mentioning who they sat by in lessons as being a cause of stress for them.

The reaction their friends would have if the pupils came top in a maths test changes as the pupils get older with 9% in year 6 saying that their friends would be jealous but 77% in year 9. The use of the word boffin also doubled from year 7 to 9.

When the focus groups were asked what they thought maths would be like in the following year there was a large decrease in the number of pupils who thought it would be more fun with over half the groups in year 7 and only 14% of the groups in year 10 using the word fun. The expectation of maths becoming more fun appears to have decreased as the pupils have got older. This is supported by the number of pupils who feel that they will enjoy maths less the following year doubling from year 6 to year 9 and the number of pupils who feel that maths will be harder in the following year generally increasing from year 6 to 10. As would be expected as they face their upcoming GCSE exams, more pupils in year 9 than year 6 felt that maths would be more stressful in the following year. The data shows that the dislike of repetition trebled in year 9, possibly due to pupils realising that the maths curriculum is cyclical in nature, with topics being revisited and built on each year.

When the questionnaires were given to years 7 and 10, they had an extra question to answer, which was

How has this year in maths been for you?

The data appears to suggest a difference in the responses between the two years as there were no negative comments towards maths expressed by the year 7 pupils, only the year

10 pupils. Word such as ‘really bad’, ‘not learnt anything’ and ‘stressful’ were used, as well as three pupils commenting on how much hard work it had been and how difficult maths was.

In summary the data seems to suggest a decrease in the enjoyment of maths as the pupils get older, as they appear to find it more stressful, less fun, more repetitive and more difficult in years 9 and 10 than in years 6 and 7.

4.1.2 Staff views

In the staff interview data, it appears that staff felt that the year 10 pupils were not as motivated as in year 7. One explanation of this from staff member Z was that:

> *because it is so exam motivated this year and it’s got to a stage where, especially with the lower abilities, because we were doing the papers in the lesson rather than in homework, they were never learning anything new. They were learning how to do the exam papers rather than actually learning*.

It is worth noting some background to this comment, as the study school had recently come out of the OFSTED inspection category of ‘Special Measures’, senior management had been very heavily focussed upon exam results for many years previously. This links to the following idea of motivation coming from the staff, as staff member X also felt that the year 10 group was not particularly motivated:

> *I think that because a significant number, boys, and girls, who are not interested in doing well and don’t want to work at it and I think that all the motivation comes from the teacher for many kids. There is no real reason for it, because you know the year 10s, we have had better and worse groups of kids who are just generally keener to work hard, just this group is a funny mix of them.*

The intense focus on exam results may be one explanation for the feelings of staff member T who also noted a decrease in motivation from the year 10s as they appeared to tire of the focus on their exam:

> *they started off well, very motivated, very hardworking, the fact that they're doing their GCSEs sort of motivates them but throughout the year that's changed and the majority of them became less inclined to work and less serious about getting their exam at the end of the year*.

One staff member felt that the school’s decision to put the year 10 pupils in for early entry mathematics had contributed to their decrease in motivation;

> *I think that we have lowered the motivation by having the year 10s doing the exams, I think that has had a negative effect on the lower groups.*

In summary, the teachers appear to recognise the impact of exams on pupils, with three of the staff members identifying that pupils in year 10 were not as motivated as in year 7 and have listed exams as a possible reason for that. The staff seem to have conflicting views about whether the introduction of exam papers as lesson materials have motivated the pupils or not, possibly based on which set they teach, but this may be due to the teachers' decisions about how to prepare their pupils for the exams; a different teaching method might have incorporated new learning by using exam questions as starting places for new ideas. Although they did not appear to take any responsibility for it, the staff all noticed a lack of enthusiasm from the pupils by the end of the year.

4.1.3 Summary of the theme: Expressions of greater negative feelings in year 10

The data seems to show some agreement between the staff and pupils about the reasons for the decline in enthusiasm towards mathematics as the year progresses. Staff member Z acknowledged that focusing so much on the exam, especially with sets of lower prior attainment, may be de-motivating them because they are not learning anything new. This links to a discussion further in this chapter that as mathematics teachers we assume that pupils want to achieve in mathematics, but this is not always the case. Some pupils may not feel that they need mathematics for their future or are so despondent from the grades which they have previously received in mathematics that they are not motivated to achieve in their exam.

This is supported by the feelings of the pupils who appeared to enjoy mathematics less as they got older, finding it stressful and more repetitive in year 9 and 10 than year 7. Although the staff recognise this decline and seem to understand what is causing it, they do not appear to question or challenge these causes. However further data, presented in the rest of this chapter and discussed in chapter 6, suggests that the teachers feel constrained and unable to do anything to increase the enjoyment of mathematics for their pupils. This apparent lack of agency on the part of the teachers is explored further in section *6.5.2 'A lack of agency and autonomy'*.

4.2 "Because my primary school teachers said I could be whatever I wanted to be when I'm older"
The importance of primary schools

4.2.1 Staff views

Whilst the aim of this study is to explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school, the next few paragraphs detail what may contribute to the motivation levels that pupils start with in year 7.

Staff member X credits the enthusiasm towards mathematics of year 7 pupils, to the efforts put in by their primary schools:

> *junior schools are pushing them a bit more, they are keen to do well in maths, they value maths as a more important subject. I think that carries them through the transition.*

They also attribute the year 7 motivation to the primary schools:

> *and the fact that they have been pushing them and pushing them and they've been trying to expose them to more difficult maths and trying to get more kids ready for level 6 at the top end and also trying to encourage those weaker ones to be better mathematicians.*

This member of staff also admits that the priority in the secondary school has been with the older examination year groups (10,11,12 and 13, see section *4.1.2*) so year 7 have not been their focus and they have not had any interventions or changes during the year. There appears to be an acceptance by the teacher that as the school has had to focus on exam classes (due to their previous OFSTED inspection category), that there has not been any effort or resource put in to sustain or increase interest in mathematics during year 7, instead the department has been 'coasting' on past enthusiasm and support. Although the constraints teachers report is discussed in more detail in chapter 6, the implication of this situation is that any motivation towards mathematics that the year 7s may have, is due to what has been instilled in them from primary school, as opposed to any interventions at secondary level.

4.2.2 Summary of the theme: the importance of primary schools

Staff member X, as head of department acknowledged that a lot of the motivation and enthusiasm that the year 7 pupils had was due to the pushing and stretching that they have received in their mathematics lessons at primary school. As a result of the school focus being on examination groups, they admit that the year 7s have been broadly left throughout the year and have not had any interventions such as revision in tutor time; that may have been running in other year groups. It appears that the teachers are aware of the pupil experiences being surfaced in this study, however they appear to lack control and agency over responding to them. There is a sense that the teachers feel at the mercy of the inspection process; this is explored further in section *6.5.2 'A lack of agency and autonomy'*.

4.3 "Because I struggle in maths to the point I feel like crying, that's why" Achievement breeds success

4.3.1 Student views

In the focus group discussions, a third of the year 7 and one year 10 group felt more confident towards mathematics that year

> *I think the better you do in maths the more confident you become so then that'll probably put you away from the thought of giving it up because if you're good at it you don't really want to give it up as long as you enjoy it.*

From the focus groups, when the students were discussing the cartoons, around half of the focus groups felt that if you achieved in mathematics, you enjoyed it more; "when I get a good grade in maths I feel happy and it motivates me a bit",

> *if they do good and they're in a higher group I reckon they get more confident and they're doing well and they carry on working hard*

and

> *some people believe they're good at it and some people believe that they can get places in life by just trying their best but others if they can't do it they believe they're rubbish if they're in bottom group or they don't try as well and they say they're not going to take it when they're older.*

The final example summed up the next group of responses which appears to suggest that students do not enjoy mathematics if they do not achieve in it,

> *if you barely get a C or maybe a D you're probably going to think I've got no chance, there's no point carrying on if I can barely pass GCSE*

and "if you're doing badly in it and you're struggling then you tend to not enjoy it". This was given by 2 focus groups in both year groups. A year 7 student felt that *people say stuff about maths like oh it's so boring and stuff but it's only because they can't be bothered to try but when you do try, I think people find it more fun.*

Feelings of stress were mentioned by between a third and half of all year groups during the focus groups; "it can be frustrating when you don't get a good grade", "I just push my papers away so I don't see it", "if I really don't know something I feel kind of anxious" and again, as in the first cartoon, the feelings of anxiety happen "when the teacher asks me a question or if there's a really hard sum on the paper".

4.3.2 Staff views

Staff member Z (who specialised in teaching sets of lower prior attainment) described the work in year 7 as being so fast paced that even if a pupil did not understand one topic, the class moved on to the next topic so quickly that the pupils would not feel left behind for long. There seems to be a conflict between an imposed 'speed' in the Scheme of Learning (set by the department to cover the National Curriculum). The teacher does not appear to feel that they had the autonomy to vary the pace to ensure robust learning, suggesting an acceptance that the class moved on to keep up with the Scheme of Learning, even if not everyone understood a topic. There again appears to be a lack of teacher agency over in-class decisions; why do the teachers feel that they cannot push back? This issue is explored further in section *6.5.2 'A lack of agency and autonomy'*.

Staff members described pupils in both years 7 and 10, who were motivated by the prospect of achieving the next grade or of moving up to the next set, however staff member Z acknowledged that there were students who feel that they do not make any progress; "I'm going to work really hard and still be this grade, so why bother".

Staff member Y (who taught a middle set) also agreed with this idea, feeling that the year 10s had increased their focus as the exams were approaching (which conflicts with some of the previous comments regarding pupils feeling demotivated by working on past papers) because they would get low grades when they started to complete past papers, but this increased as time went on:

> *I can think of one young lady in particular who was getting like 15% on average and towards the end 60s, 70s, 80s – with help probably but it didn't matter, it was an opportunity to say "you really are, you know, you've come on leaps and bounds, I reckon you'll do it this year" type thing. You know, which is a much more positive, rather than "oooh you're going to be scraping a G if you're lucky".*

This idea was also seen in a description of the choice between the higher and foundation papers, with staff member Y describing

> *I think they preferred…to at least be able to have a good crack at a lot of the paper, rather than being able to do just a little bit of it.*

Staff member V explained how they saw the motivation of a pupil drop when they got a bad mock exam result:

> *XXX has been very motivated but then had a really bad mock and following a really bad mock, switched off, stopped handing his papers in, the papers he handed in they weren't very good, so I think that for him was a really bad experience of the mock because all of his other papers were like 85 and above and in his mock he got like 35-40 so something has switched him off after the mock.*

Staff member U describes what they feel is:

> *a generation of students who are very aware of their place in the hierarchy and how they relate to other people not only who are in that group but within the year group and you do get mentions of bottom sets and that's why I try and change it and say you're in a set according to your current ability.*

This again appears to reiterate the idea of a self-fulfilling prophecy, that a pupil may cap their belief in what they can achieve according to what set they are in. The staff member goes on to explain how they try to counteract this effect:

> *what I try to do is get over the stigma of "oh it's maths" and just boost their confidence, I don't know what's happened in their past school life that they've switched off to maths, they might have had a bad experience in years 1-6 which has knocked their confidence. I'm not saying that we can keep on going around and saying you're going to be brilliant in maths but I just want them to have a go, just that encouragement to say you might not get it right this time but you can have a go another time and what's happened has happened, fresh starts.*

This data makes me wonder if teachers get into certain habits that they believe to be motivational, but which may, or may not align with an exam and grade focus, as teachers are immersed in a results focused school environment.

4.3.3 Summary of the theme: achievement breeds success

The staff and pupils appeared to agree that success breeds success so that if a pupil feels that they are achieving in mathematics they are more likely to enjoy it and continue with it when offered the choice. The students mentioned the feelings of stress which occurred when they did not achieve a good grade or if they were asked a question that they could not answer, either in class or on an exam paper.

The staff views echoed the pupils with the year 10s seeming to be focused by completing past exam papers and motivated by being able to complete most of the papers and by the prospect of achieving the next grade. However, another staff member noted the drop in motivation when a pupil gets a poor grade in their exam and described it as if the pupil had been "switched off" by their grade.

One member of staff appeared to accept that the fast-paced scheme of learning in year 7 meant that the pupils did not spend long enough on a topic, so even if they did not understand it, they quickly moved on to another one which they may have been able to do. Some members of staff seemed to feel that the pupils capped their perception of their own attainment depending on which set they were in. Although this was dealt with positively by one member of staff who believed that it was important to try to boost the confidence of the pupils and encourage them to keep trying and have a go, despite any previous failures that they may have experienced, the data appears to show that the staff do not question the efficacy of setting despite their observations, they seem to be accepting that this is 'the way things are' and not critically engaging in what might be good, or otherwise, for their pupils. The lack of teacher agency implied by this data is discussed further in section *6.5.2 'A lack of agency and autonomy'*.

4.4 "Behaviour it is terrible and it's hard to work" Effects of disruptive pupils

4.4.1 Student views

When asked how their mathematics lessons could be improved in the questionnaire, girls and boys in year 6 and girls in year 7 felt that their mathematics lessons would improve if there was better behaviour in their lessons. This was not mentioned in years 9 or 10.

4.4.2 Staff views

Staff member V explains how one de-motivated pupil can try to influence a class:

> *XXX who is the most unmotivated person in the world, adamantly doesn't need any qualifications because he's going into the army. Not interested, really disruptive, ummmh, actively encouraging others not to work almost, he's been really negative ummmh, but bright enough that he should be in that group.*

Staff member U also notes how the motivation and behaviour of some pupils can affect the group:

it does surprise me how some students, even though there can be madness around them, are still focused to achieve and they want to achieve and I do find the ones who are causing the madness seem to get the attention whether it's good or bad to keep on track whereas the ones who want to learn are kind of left behind they're not ignored but because they're quiet and they're doing something you don't really go across, and that's probably my problem as well, you don't go across to reinforce the learning and establish what they've learnt, what they should, that's how I think about it.

4.4.3 Summary of the theme: effects of disruptive pupils

The issue of the behaviour of some pupils affecting the learning in the class was mirrored by both students and staff. Although there is a whole school behaviour policy that is used to deal with serious cases of misbehaviour, the staff comments here highlight a typical tension for teachers in the department and possibly other departments, where they must try to juggle the needs of everyone in their class. This means perhaps inevitably giving more attention to the louder pupils or those displaying low-level disruptive behaviour, whilst running out of time to help those that may be quietly struggling. Here, staff member U appears to be reflecting on their practice and realising that they are choosing who they speak to in class and perhaps are not finding the time to get to the quiet pupils, whereas other members of staff seem to be accepting the disruption that certain pupils cause and not questioning how the situation can be improved. The teachers do not appear to feel that anything can be done about the low/mid-level disruption and do not call into question the senior management role or mention the behaviour policy. This again seems to suggest that the teachers do not feel able to control or have any agency in these matters. This is discussed further in section *6.5.2 'A lack of agency and autonomy'*.

4.5 "I feel very emotionally unstable with the constant movement and don't know where my ability stands" The importance of stability of teachers

In this particular year, the mathematics department was understaffed and so had rotated some classes on a fortnightly basis so that they did not have a supply teacher for too long. Table 7 details the changes that the pupils experienced throughout the year. Please note that greyed out boxes means that those sets were not affected by any staffing changes (at that point).

Year 7 - Half year (b)

7 set 1			
7 set 2	After October half term Supply teacher for 2 weeks	Second supply teacher until Christmas	HOD Christmas until the end of the year
7 set 3	Changed teacher for 1 week		
7 set 4			Taken over by a supply teacher from Christmas until the end of the year

Year 7 - Half year (r)

7 set 1	
7 set 2	
7 set 3	October half term until the end of the year in a split class – 2 lessons with a mathematics teacher and 2 lessons with a music/mathematics teacher

Year 10

10 set 1			
10 set 2	Supply teacher for a few weeks then had 2 mathematics teachers for 2 lessons a week each	4 weeks before Christmas until early March the sets were mixed up and were on a 2-week rotation of 2 supply teachers and 2 mathematics teachers	Early March – groups were re-set based on their homework scores and all three were given a mathematics teacher
10 set 3			
10 set 4			
10 set 5			
10 set 6			Supply teacher from March until the end of the year
10 set 7			
10 set 8			
10 set 9			

Table 7 Changes in staffing by set

4.5.1 Student views

As a result of these staff changes, many pupils wrote about how they were affected by the lack of a regular teacher which showed how having a stable teacher is important to them.

When the pupils were asked in the questionnaire if they had changed sets that year and how it made them feel, two year 7 pupils had moved twice and felt that more thought was needed before pupils were moved. A year 10 pupil described themselves as emotionally unstable because of being moved twice.

When asked to describe how the year had been for them, some pupils did speak positively about their experiences in year 10, however an overwhelming amount of year 10 pupils who had been affected by the rotating classes, discussed the effect of this on them. Although this was done by the department to manage a difficult situation, it seems that the pupils did not like the instability of not having a regular teacher.

4.5.2 Staff views

Despite noting that the rotation of staff was good for the three members of staff involved because they had less planning (they had to plan a two week topic and then got to deliver it three times), staff member Y discussed the impact of the staff rotation on the pupils in year 10:

> *I'm not sure how the kids liked it. I'm thinking of three or four girls in particular who seem to be quite unfocused, very negative, "I can't do it", "I'm going to fail", "I'm not going to get good results", etc etc, but once we got them, once they came back to their regular group and stuck with one person maybe it was easier then to motivate them by working on their confidence rather than the maths really, trying to instil that "you can do it", "repeat after me, you can do it.*

This ties in with the expressions of greater negative feelings seen in the year 10 data, but it is worth noting that the rotation of staff only affected certain groups, not the whole year group (see Table 7 above).

This member of staff also acknowledges the impact of the rotation on their teaching and motivation, commenting that

> *my motivation improved when I had one group twice, rather than just two groups once because then I felt I could work on not treating the lessons as just a one-off.*

They felt that they put more thought into the lesson planning and perhaps taught it better and were able to

> *work on a relationship more when you put more thought into it because you are thinking about those individuals.*

Staff member X felt that setting helped to motivate pupils to do well in year 7. They also acknowledged the impact of the staffing changes on the motivation of year 10 explaining that there had been more issues and complaints from parents about the staffing structure and that parents did not know who to contact about their child's mathematics. The difficulties extended to parents evening and reports:

> *it makes it more difficult come parents' evening for teachers to talk about the kids throughout the year and are only able to comment on so many weeks. Reporting has been difficult, and I think that constant change gets in the way of the bigger picture from the teacher's point of view of seeing the children. And I think that must in some ways demotivate the kids, whether they think it does or not and they might even enjoy the change.*

Staff member X acknowledges the effect of changing set on the pupils, saying that if they move across a half year group and end up in a lower set, this can affect their motivation but that pupils who move up a set are more motivated. They summarised the changes in motivation as:

> *it just depends on what happens, and what happens to a particular child in terms of their mathematics and their kind of growth, or they just keep it going and will stay the same throughout.*

When describing the staffing situation for the year and the need to rotate the teachers, staff member X explained how they felt it affected different sets:

> *I think the set 1 will have been less motivated having lost their classroom teacher but conversely set 4 who've gained a proper maths teacher for want of a better expression, they'll increase their motivation, because they do pick up certain 'triggers' from the teacher.*

However they go on to explain the difficulties in trying to manage a shortage of staff, believing that if the pupils go into a classroom and the teacher is well prepared and has designed a good lesson then the pupils will pick up on this and over the course of a few weeks their motivation will improve because they will feel that their work is being valued and that their mathematics lessons must be important because they are being well prepared. Conversely, if the pupils keep going into a classroom and seeing a supply teacher with worksheet after worksheet (in the case of short-term supply teachers the work is often set by other members of the department such as the head or second in department and is often a worksheet or something similarly straightforward which the class can access with limited input from the teacher to allow for non-specialist teachers. Longer term supply teachers had more input in the planning but were heavily supported by the department. Consequently, there is a culture of supply teaching as being simply an 'administration of given worksheets' then they will realise that this is a stopgap and not feel that they are being valued, so will not value the work that they complete, or the work being set for them.

To reduce this impact staff member X explains how the decision was made to rotate the staff:

> *for the year 10s, what have we done? Well we've done what we can in terms of trying to swap kids around and trying to keep them as much as possible with a regular teacher and with a maths expert, who is someone who is, for want of a better word again, a 'proper' maths teacher. I'm sure there's more we could have done and if year 10 was the only year that was affected we would have done other bits, but in terms of intervention and monitoring – and you can always intervene more and you can always monitor more – but realistically when you've got other years, year 11 and sixth form and so on, and the 11s have been affected and the 9s as well, you kind of, you are spreading it a little bit, what you can do.*

They then went on to explain how the year 10s have been a little more motivated due to having exam papers (which have been described as demotivating by some staff) and being reminded of their exams by staff members who are not within the department, such as tutors.

Staff member W also agreed that pupils like having consistency explaining that pupil motivation had improved because:

> *they've got consistency so they know they've got the same teacher each day and for their lessons and they know, they're getting used to my ways and they know for example routines have been established like homework again, books have been marked so they're getting feedback…..consistency and knowing that somebody cares enough to be bothered to mark their work and give them feedback and set homework and think about tasks that are going to be motivational to them.*

Staff member V felt that some of the year 10 pupils were affected by a trainee teacher that they had in year 9:

> *I think interestingly most of the kids from the X half would say that they're more motivated because they had such a poor life with XXXX. They still talk about him, and how they didn't like his lessons and how he couldn't control the class and didn't do anything to inspire them and I think a lot of them are so appreciative for having that consistency now, that they know what they're going to get every lesson and even nice kids like XXXX who never says anything bad about anyone will say "oh they were awful you know, we didn't learn anything.*

Staff member U also mentioned the staffing difficulties in that particular year:

> *I've heard anecdotal evidence that when they move from one teacher to another teacher, one teacher explains it in another context and they say sir has said it and we know about it already so you've got this cross-referencing of different teaching styles*

but I think for some students they don't flourish with multiple teachers throughout the year, they do like the set teacher, he or she has set patterns where they operate and they quite like that comfort blanket of being with that one person. There're set seats, there's set times, just the whole regularity of everything, it gives them framework and structure.

They go on to detail how it has affected the year 7 classes:

the lower sets year 7s I think it's had a negative impact because they do feel they've been pushed around, they've had cover teachers and supervisors and the same work and the same worksheets so the actual planning that's gone into lessons is negligible compared to a subject teacher.

The effect on year 10 is also described:

the 10s haven't been affected apart from a period post Christmas and you can see the room, the whole tempo, the drive in that room was taken away because it was a long term cover to another long term cover by which time the exam times are coming up and it's too late. But I think, personally, the less abilities do appreciate having one person, because they know that person and they're used to that person whereas the high abilities I think they quite enjoy that dotting around different rooms.

Staff member T also mentioned the changes in staff, attributing the decrease in year 10 motivation to this:

I would say it's changed from not having one teacher all the way through. I think as soon as my class changed, and we mixed them up…… they're split up from the friends they'd already worked well with and settled with sort of unsettled them. Then only having a teacher for 2 weeks and then moving on they took the seriousness out of their work, they almost lost interest in doing well.

4.5.3 Summary of the theme: importance of stability of teachers

The data indicates that there were positive and negative impacts from this staffing situation. A positive effect for staff was that they had less planning to do because they taught the same section of work to multiple classes and for some of the staff at least, they went from having two groups once a week to one group twice a week so felt more motivated to plan lessons and build relationships with the classes. There appears to be an acceptance here that teachers will not plan as dutifully when they only see a class once versus if they have them multiple times. Despite an acknowledgement that pupils respond better to consistency and cues that the teacher cares such as consistent routines, books marked, lessons well planned etc, teachers appear to be giving care and attention proportionally to how many times a week they see that class, as opposed to treating all lessons with equal importance.

The staff seemed to recognise the negative impact the rotation of staff had on reporting and parents' evenings because one teacher was not responsible for one class and could not comment on the year so far for that class. Evidence of this was seen in an increase in parental complaints during that year, but again this situation appeared to be accepted rather than challenged by the department.

An apparent positive impact for pupils was that rather than one class being faced with a year of supply teachers, due to the rotation they did have some exposure to a 'proper' mathematics teacher during the school year, however the negative impacts on the pupils were that some of them became unfocused, negative and lost motivation towards the subject. The department all appeared to recognise the impact that not having a regular teacher had on the pupils and whilst they acknowledged that rotating pupils unsettled some classes, they felt that the system minimised the disruption for other classes.

The department felt that when pupils know what to expect in a classroom and see the same teacher who is well prepared then this helps to motivate them and reinforces that their learning is valued. Whilst the department strived to minimise the disruption caused to the year 10 pupils, the data appears to show that the staff felt that there was a limit as to how much they could intervene when they were also trying to minimise the staffing disruption for other examination years, however all the staff members acknowledged that rotating teachers and the lack of consistency did not help to increase pupil motivation in this year. Lack of consistency can be an issue even when the teacher is a stable presence because one teacher in one year can use a particular kind of explanation and the next year there might be a different explanation. To overcome this the department had agreed to teach certain methods for key topics so that there was a consistent approach for the pupils. These staff feelings imply that the department recognised that there was more that they could do but did not feel able to act upon them. The discussion of staff feeling constrained is continued in more detail in chapter 6.

4.6 "It would be better if we didn't do algebra, we don't need algebra in life" Students' experiences of mathematics lessons and suggestions for improvements

4.6.1 Student views

Although I have not researched teaching directly, the answers to some of the questions in the questionnaire have allowed me to see what a varied range of lessons the pupils have experienced. When the pupils were asked to describe their favourite mathematics lesson, group work was mentioned by years 6, 7 and 9 which shows that they have experienced group work in their lessons. Other ideas were going to an ICT suite, practical lessons, competitions, challenges, puzzles, codebreakers, Pi Day activities, murder mystery and mathematics games. Although these might not be in the pupils' lessons every day, it suggests that the pupils have experienced them to be able to recall the memory.

This variety was also present in the responses to the question

What would you do to enthuse a class if you were the maths teacher for a day?

with many suggesting interactive lessons, prizes, practical lessons, lessons outside, posters and puzzles. This again reiterates the variety of lesson types that the pupils are experiencing or would like to experience.

When asked to describe their year in mathematics, three year 7 boys used the word fun and 3 year 7 girls said that it had been good or enjoyable, with another 2 girls feeling that they had increased in confidence. When the pupils were asked what mathematics was like in the focus groups, fun was a consistent reply from groups in all years (6,7,9 and 10), with about a third of the groups describing mathematics as fun in each year. However, in the questionnaire responses fun was not mentioned by the year 10s, but one year 10 girl did acknowledge that she had had a fun teacher and two boys described their year as great and one boy felt more confident about the upcoming exam. These positive descriptions contrast with the other negative descriptions given by the year 10s.

When discussing cartoon image number 2 (discussing the number of lessons of mathematics a week, see Appendix B), three groups in each year felt that they enjoyed mathematics and so the number of lessons that they had in a week did not matter to them

> *it's not really that bad for me though because I like maths so I would probably be like 'yeah we've got maths 4 times a week'*
>
> *I don't agree with it because maths is one of my favourite lessons that I do here, I just really like it, I'm really excited about it because it's well fun*.

Despite these positive descriptions in the focus groups, in the questionnaires, when asked how mathematics lessons could be improved girls in years 6, 7 and 9 wanted more fun as well as boys in year 9. While some pupils are describing their year in mathematics as fun, in contrast others ask for mathematics to be more fun.

Three year 7 girls and one year 10 girl felt that they had learnt a lot in the year and in the focus group discussions between 15-30% in all years said that they enjoyed mathematics when it was challenging.

When asked how mathematics lessons could improve, girls in both year 9 and 10 felt that mathematics would improve if it was easier and boys in both years would prefer fewer tests. Working in groups was suggested as an improvement in years 9 and 10, but not in years 6 or 7. The relevance of mathematics was only mentioned in years 9 and 10, where it was suggested that mathematics would improve if it was more relevant.

In summary, although mathematics was consistently described as fun, it appears that most pupils wanted mathematics to be even more fun. Despite what the pupils might say about disliking hard work, the data appears to suggest many of them enjoy mathematics when it is challenging and felt that they had learnt a lot in the school year. Pupils in the lower years seem to crave better behaviour in their lessons, whilst older years appear to want mathematics to be easier, with fewer tests.

4.6.2 Staff views

To increase pupils' motivation in mathematics, staff member Z suggested that lessons could be more practical but felt that that was not possible for a class of 30. They also reasoned that having more achievable goals for the pupils would help to increase their motivation (as a result of the OFSTED category mentioned previously, the pupils were receiving very high target grades in order for the school to achieve a greater 'value added' score). This statement appears to show the teacher taking the view that it was all the fault of OFSTED. *Teacher's agency and autonomy* will be discussed further in section *6.5.2*.

Staff member Y points out how easy it is for a teacher to fall back on a repetitive worksheet or textbook activity, noting that an exercise should be motivating to look at from a pupils' point of view so colour or cartoons and help boxes such as tips, possible mistakes and things to watch out for, are features of an exercise which is more motivating than “one great black and white mess of symbols” in more traditional textbooks and worksheets which may be used. Other activities such as dominoes, matching activities and teamwork were also suggested, which reiterates what the pupils also enjoyed about their mathematics lessons.

Staff member X felt that mathematics teachers take for granted that all pupils want to do well in their mathematics exam because it is important, however it is not necessarily true for all pupils and suggested some improvements such as looking at the different careers that use mathematics and areas in life where different topics would be useful. They also recognised that it would be difficult to show how every topic is useful in life and that teachers fall back on the reply of “because it’s in your exam” when asked “why are we doing this?”. However, despite believing that this would increase the pupils’ motivation, they acknowledge that there is not always time to explain the relevance of each topic, instead choosing to just present a topic that is on the exam and telling the class that that is the one that they will try to learn today.

Other improvements suggested by staff member X would be making the lessons more fun and practical, if time allowed; having better facilities, perhaps with iPads and laptops; having teachers with more energy, if they were not asked to teach six lessons a day,

> *you know, you are teaching six lessons a day, marking books etc. it becomes a bit of a vicious cycle where, you know, I’m sure the kids pick up on a certain amount of that you know, sometimes you’re just going through the motions because you have to.*

They also suggested that improvements to timetabling might help so that classes did not have mathematics twice a day because the pupils switch off after the first lesson but also

> *you’d always want maths in the morning, you’d always want it not after PE, you’d always want it maybe just before break also that actually you’ve got a bit of time. If the bells go and the kid is still struggling, instead of shipping them off to the next lesson, there’s a bit of time there for those kids just to hang around and chat about it and just have that better opportunity to kind of reinforce the learning.*

Staff member V wanted more emphasis on the pupils being in control of their learning so that they seek help if they do not understand a topic. They also explain how time constraints which arise due to the pace of the scheme of learning, often mean that a teacher may move on from a topic before the class understand it, thinking that they might pick it up when it gets covered in revision and that this lack of understanding may demotivate the pupils:

I'm really guilty of the fact of trying to push them on too fast and sometimes you need to go back and check they've got those basics and I think a lot of kids switch off when they think things have got too difficult and they think well I can't do this bit I'm not going to be able to do the next bit.

Covering topics at speed was also mentioned by staff member Z in section *4.3.2* and will be discussed further in section *6.5.2.*

Staff member T suggests a more collaborative approach to learning mathematics

maybe we could come together to do activities more often or projects, I think they're not used to projects so when they come to doing any coursework or doing something on their own without your input or telling them what to do, they don't know where to start so I think giving them more groupwork and activities, not just in their class but getting the year group together where they've got to do something and they're all doing the same thing would be quite useful to get them all talking about something that they're all doing together for one topic.

4.6.3 Summary of the theme: students' experiences of mathematics lessons and suggestions for improvements

Although the data shows that mathematics was consistently described in terms of fun, most of the pupils wanted mathematics to be even more fun, suggesting group work, ICT suites, practical lessons, competitions, puzzles, and many others as ways to improve mathematics lessons. Despite what the pupils appear to say about disliking hard work, the data suggests that many of them enjoyed mathematics when it was challenging and felt that they had learnt a lot in the school year. Other changes that the pupils suggested in the data were improved behaviour in their lessons in younger years and fewer tests and easier lessons in the older years.

As they came up with similar suggestions to the pupils, such as worksheets in colour, practical lessons, better facilities, iPads, laptops etc, the data seems to show that the staff were aware of improvements they could make to mathematics lessons. However, they balance these with feelings of constraints on a practical level. Some members of staff appear accepting of the fact that although they can identify ways to improve the pupil experience, factors such as large class sizes, lack of time to cover the curriculum and showing the relevance of each topic, lack of time for planning, as well as difficulties on an organisational level e.g., timetabling, unrealistic targets for the pupils and constraints on resources, seem to be preventing them from making any changes.

The data showed that some staff may take for granted that a pupil wants to do well in mathematics because they view it as important themselves, but that may not always be the case, especially if some pupils do not feel that mathematics is relevant to their future. The staff appeared to believe and to accept that with these constraints it is very easy to fall back on a worksheet or textbook which has a repetitive activity, despite the impact on the pupil experience. This may be what the pupils are describing as 'not fun' but the staff seemed to accept as inevitable.

4.7 "I feel really annoyed because I thought I was good" Changes in pupil mindsets

4.7.1 Student views

From the responses to the question

What does it take to be successful at maths?

I constructed three categories that allow me to understand what the students were telling me (across all the year groups). These categories were behaviours, personal attributes, and external factors. In year 6 there were no responses which were categorised as a personal attribute (such as feeling able to do mathematics or being clever at it). In year 7 one girl and 3 boys suggested being good at mathematics and this idea increased in years 9 and 10. From the data, the overall responses appear to show more of a growth mindset (Dweck, 2006) in year 6 with the pupils describing behaviours such as working hard, asking for help, not giving up etc and by years 9 and 10 the idea of being naturally good at mathematics had started to appear in the data with a third of year 10 girls and nearly half of boys saying that you should be clever at mathematics to be successful at it.

From the questionnaires, a response from a year 7 boy to moving down a set was that he felt annoyed because he thought he was good. In a comprehensive school which is situated next door to two grammar schools it is interesting (and encouraging) that some pupils still had a feeling of self-belief, that they thought they were good at mathematics and that their confidence had not been affected by their secondary school place.

In the focus group discussions, the overwhelming response given by all bar three groups in all the year groups when asked if there was a point in revising, was that there is a point to revising *if I revise, I might learn some more and gather some more information that we weren't taught that might be in the test*

"if you don't bother trying that you're not going to get any better", "you're going to get a better grade after revising than not revising". Every student felt that you had nothing to lose by revising and you may improve

even if you're achieving an E in maths if you revise then you're going to get better at it, it's basically definite, if you revise properly and you revise stuff you don't know then there's no way you can go down in maths you're either going to stay the same or go up you can't go down if you revise.

This comment resembles a growth mindset because there is a belief that revising may change the result of their exams, as opposed to believing that their outcomes are fixed. This does not follow the data for previous descriptions of what it takes to be successful at mathematics which showed more of a fixed mindset with older years.

One year 7 group suggested that if you weren't good at mathematics obviously "just try again until you think you've done the best" whilst another suggested that

just because you don't get the score that you wanted to doesn't mean that you have to give up, you can still keep trying.

In the focus group discussions, the data suggests that when the pupils were picturing and describing a mathematician, the number of groups which suggested being good at mathematics doubled from year 6 to year 9 and the idea of being open to trying new things was only mentioned in year 9.

In summary the data from the lower years suggest that the pupils believe that their attainment in mathematics is related to how much effort they put in, behaviours which they can change. However, as they get older, there are more occurrences in the data of pupils believing that some people are naturally good at mathematics and that you have to be good at mathematics to succeed, although all year groups agreed that it is still worth revising in mathematics to try to improve your grade.

4.7.2 Staff views

Staff member Z felt that having a sixth form at the school, as well as the local grammar school sixth forms next door added pressure to the pupils and felt that if they

can't meet the pressure, they can't do it and therefore their life is written up by the time they are twelve. It doesn't matter what we say as teachers, it's coming from other influences they go on to say

> *there needs to be some way that society needs to realise that actually some kids will never get there and to get an E is good enough. That there are people that will not go to university.*

The implication of this point of view is that there are outside influences effecting how pupils feel about themselves and their attainment and that they may well be aware at a young age of the feeling of having 'failed' because they recognise that they may not make it to university. There also appears to be the belief that some pupils have achieved as well to get an E as others have by getting into university, or perhaps an acceptance that not all pupils have the same capability to achieve in mathematics.

Staff member V describes the attitude of some year 10 boys who just believe that they will do well

> *some of the boys, the homework papers were getting G after G after G and made no impact whatsoever, they didn't care and I think sometimes they think that it'll just happen, I'm going to get my C because I really want it*.

However, once they had spoken to some of the parents, the staff member describes how one boy in particular changed

> *he really turned it around and started to ask questions in lessons and if he didn't get stuff he would come to me at lunchtime and XXX came a couple of lunchtimes and we had a lunch party and he came to every single after school club and his homework papers went up by probably from about 35-40 top mark was 70, 72-73 so he really changed his attitude, again I think the homework papers were a trigger.*

They describe another boy who nearly dropped from set one

> *you know the mock we did back in November, a lot of them were a little bit cocky about it and XXX only just scraped his place in set 1 after the November paper by 1 mark and we found that mark in the lesson. He was all set to drop and I think from there he realised that I need to earn my place and he handed in all his homework papers, you know all of them were a grade A or better so I think the main trigger for a lot of them was the January papers coming out and then realising this is what I need to do and this is what I need to work towards, I think that's been really positive.*

4.7.3 Summary of the theme: changes in pupil mindsets

Overall, the data appears to suggest that pupils in the lower years have more of a growth mindset with older years believing that some people are naturally good at mathematics, although all year groups agreed that revising may help to improve your grade.

Data from the department described different types of pupils. There are those that have been impacted by having selective schools so close to them who may have a feeling of failure for not passing to go to those schools or who perhaps feel that they have failed because they may not be able to go to university. Then at the other end of the scale pupils who feel that they do not need to work at mathematics because they believe that they will just do well. It seemed that until these pupils experienced a shock such as a phone call to their parents or a poor grade in an exam, they did not feel the need to work at mathematics to do well. This raises the question of whether it is the nature of mathematics that pupils feel they do not need to work; a cultural failure to understand the positive benefits of effort; a feeling of hopelessness possibly due to the selection at age 11; or something more which makes these pupils feel that it is acceptable to not work in mathematics.

There appears to be some overlap in the views of pupils and staff here, especially with the older pupils who did not feel the need to work at their exam papers because they just expected to do well, however they were able to change and to see the benefit of revising after certain triggers.

4.8 "Because it is essential to have maths knowledge, but I don't think you need to know or learn everything" The perceived relevance of mathematics

4.8.1 Student views

When asked if they would continue with mathematics after GCSE, the data appeared to show a decrease in the feeling of needing mathematics from year 6 to year 10 for girls, however an increase in the need for mathematics in boys. This was replicated in the idea of mathematics being an important life skill with there being no mention of this by the year 10 girls in the data, but an increase in this response for boys throughout the years. As would be expected, the responses in year 9 and 10 show that the pupils are more aware of what job they may want to do and what qualifications they need to achieve.

These responses were seen again in answer to the question of whether the pupils would continue with mathematics now. The data from the girls in years 9 and 10 appears to suggest that they were more job aware, however the boys seemed to be aware of mathematics being useful for a job throughout the 4 years. The idea of mathematics being useful for life increased in the data for boys as they went from years 6 to 10 whereas this remained constant for girls, with one girl mentioning its use in years 6, 9 and 10 but 6 girls mentioning it in year 7. Mathematics being an important life skill was present in the data, but slightly decreasing for girls between years 6 and 10 but for boys it was not mentioned in year 6, but then increased from years 7 to 10.

In the focus groups, when discussing the cartoon data, pupils in all year groups recognised that mathematics was an important subject which would be useful in life

> *it's school, you need to get a good education, get the right qualifications when you're older so it's not really a big thing because you've got to have lessons,*

"you have to have maths in your life because you won't get a job or anything". Although this was a common answer in the younger groups, it was mentioned by nearly all the year 10 groups in the data.

Similar results were seen in response to the focus group question of what mathematics is like and what should it be like, with the idea of mathematics being useful being a prevalent result in the year 6 data but then it did not come up again. The need for mathematics to be more relevant was mentioned in the year 9 data but not by any other years.

In the focus group discussion data, between a quarter and a half of groups recognised that some students may take mathematics beyond GCSE because it would help with their career; "they realise that they need it in life", "maths is important, I wouldn't give up on it. I'd make sure I had done it eventually", "if we're going to do a certain job, we can use it" and

> *maths is very important in jobs and everything because if you don't have maths there's not really a right range of jobs you can get.*

4.8.2 Summary of the theme: the perceived relevance of mathematics

To summarise, the data suggest that the older pupils were more aware of what qualifications would be useful for different jobs than the younger years. The feeling of needing mathematics and it being an important life skill increased in the data throughout the years for boys but decreased for girls. Mathematics was seen as a useful skill in the year 6 focus groups but was not discussed by older years, instead the idea of mathematics lacking relevance in the older year groups became apparent.

This chapter has described the themes from the qualitative data and presented the student and staff views where appropriate. The following chapter presents the quantitative data from the questionnaires.

Chapter 5 Findings: quantitative data

I refer back to the research aim for this study:

To explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aims:

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

Chapter 4 presented the qualitative data in the study and in the following chapter I detail the steps taken to analyse the quantitative data from the questionnaires (see Appendix A), using SPSS. The section is split into two sections: *checking the attitude scale* including *investigating normality*, and the *analysis of data*. On the whole I have only included the statistically significant results in this chapter but comparisons that showed no statistical significance can be read in Appendix J.

The main aims of the analysis in this section are to explore:

- the attitudes of the pupils towards mathematics and whether they change over time
- whether factors such as gender, parents, teachers and prior-attainment grouping are related to the attitudes of the pupils
- the relationships between attitude and whether the pupils would choose to study mathematics, if they enjoy mathematics, and how they view their prior attainment
- the main factors affecting the motivation of the pupils towards mathematics.

5.1 Checking the attitude scale

To investigate whether motivation and attitude change as the pupils move across a transition point, I needed to try to quantify the attitude feelings of the pupils, so I created a value for attitude for years 6 and 9 which was called 'pre attitude value' and the same value was created for years 7 and 10, called 'post attitude value'. This decision is discussed in further detail in section *3.4.4.10 'Creating an attitude scale'.*

At first this attitude value was created by adding up the mean scores of Q1-20 for years 6 and 9 and Q1-19 for years 7-10. For years 6 and 9 Q19 was excluded because it was not well answered due to a double negative; Q19 had also been removed from the 2015 questionnaires and all analysis in 2014.

Due to the wording of the questions e.g.

I usually enjoy maths lessons	1	2	3	4	5	I do not usually enjoy maths lessons

a low attitude value means that the pupil has a more positive attitude towards mathematics than a higher value, that would indicate more negativity. This may seem counter-intuitive but as I was concerned to investigate apparent negativity towards mathematics it seemed more appropriate.

This allowed me to use the quantitative data to explore -

- Do motivation and attitude change for individuals after they go through a transition point?
- Are factors such as gender, age, set changes, parents etc related to attitude?
- Does the attitude value vary according to what set a pupil is in?
- Is there a relationship between how a pupil sees their prior attainment and attitude value?
- Does the 'total' attitude relate to whether a pupil would choose mathematics?
- How does mathematics anxiety change over time?
- What are some of the main factors affecting the motivation of pupils?

For a scale to be accepted as reliable, it is generally expected that Cronbach's alpha should be above 0.7 (Pallant, 2010; Zimmermann, et al., 2011). Table 8 shows the Cronbach's alpha values for this first attitude scale:

Year	Cronbach's Alpha
6	0.61
7	0.73
9	0.61
10	0.66

Table 8 Cronbach's alpha values for attitude value

As there were Cronbach's alpha values that did not meet the 0.7 requirement, I removed questions with a low reliability to get to a point where the alpha values were acceptable (although year 9 was still slightly below the required 0.7), as shown in Table 9.

Year	Cronbach's Alpha
6	0.75
7	0.82
9	0.69
10	0.71

Table 9 Cronbach's alpha values for attitude value with Q10,12,13,17,20 deleted

So in this study, the attitude value consists of the mean scores of Q1-9, 11, 14, 15, 16, 18. Table 10 shows the mean scores for these 14 questions by year group as well as the total mean score for attitude value for each year group.

Question	Year 6	Year 7	Year 9	Year 10
1	2.52	2.33	2.65	2.77
2	3.22	2.67	2.89	2.89
3	2.86	2.84	2.90	2.96
4	2.77	2.42	2.62	2.55
5	2.60	2.42	2.55	2.71
9	2.31	2.03	2.23	2.31
7	2.45	1.92	1.90	1.95
8	2.76	2.28	2.50	2.13
9	2.25	2.12	2.33	2.28
11	2.01	1.38	1.40	1.40
14	2.21	1.73	1.53	1.47

15	2.19	1.71	2.04	2.19
16	2.36	2.23	2.31	2.58
18	2.68	2.67	2.96	3.11
Total Mean Score	2.51	2.20	2.34	2.38

Table 10 Mean scores of Q1-9, 11, 14, 15, 16, 18 by year

The mean was used because it uses all the values in the data set so is a good representation of the data.

Throughout this process the value for year 9 was always below the other years and even with referring to the 'Alpha If Item Deleted' column, unless other questions were removed from the scale (which would compromise the other years), it did not seem appropriate to do this to get a value for year 9 above 0.7 as it was so close (0.69).

The arrangement of the sets when the year 9 pupils started year 10 was going to change dramatically because up until now the pupils had been taught either in their tutor groups, or with pupils in their half of the year in classes such as mathematics which are set. In year 10 the pupils would be mixed with the other half of the year and be streamed across mathematics, English and science and would be in a class with some pupils who they may never have mixed with before. They were also about to start their GCSE course, which would be the first official set of exams they would have taken, but additionally for many of them would see an end to compulsory education, learning mathematics and possibly school in general. As the pupils knew that these changes were going to take place when they completed the questionnaire, there is a possibility that this lower Cronbach's alpha score is the effect of the year 9's understandable apprehension about going into the next year.

Despite the alpha value for year 9 not being above 0.7, due to the other three year groups showing that the scale was reliable, and year 9 being so close to 0.7, I have proceeded with the attitude value.

The next section of analysis is to see if the attitude value was normally distributed (it has the greatest frequency of scores in the middle with small frequencies of scores at the two extremes) or not.

5.1.1 Investigating normality

Before doing any statistical analysis, it is important to check that any underlying assumptions for each test are not being violated. The range of statistical techniques form two groups: parametric and non-parametric statistical techniques. More powerful, parametric statistics make assumptions about the population that the sample has been drawn from, i.e. that the underlying distribution of scores in the population has a normal distribution. Non-parametric techniques do not make assumptions about the population distribution but tend not to be as powerful as parametric statistics and may fail to detect differences between groups which do exist, but the test is not sensitive enough to pick them up (Pallant, 2010). Before doing any analysis on the data, I needed to investigate whether parametric or non-parametric techniques would be most suitable for my data.

The normality of a variable can be assessed by analysing skewness and kurtosis. Skewness gives an indication of how symmetrical the distribution is, whilst kurtosis provides information about how peaked the data may be. Table 11 shows the results for skewness and kurtosis for the pre and post attitude value.

	Pre attitude	**Post attitude**
Skewness	0.84	0.56
Kurtosis	0.66	0.51

Table 11 Skewness and Kurtosis for the pre and post attitude value

If the distribution of the value was normal, then the skewness and kurtosis value would be 0. The values for both pre and post attitude show a positive skew which means that the scores are bunched towards the lower values i.e. to the left-hand-side of the graph. As a low pre or post attitude value means a more positive attitude towards mathematics, the positive skew shows that more pupils have a positive attitude towards mathematics, than a negative one.

Positive kurtosis values imply that the distribution is peaked, with a cluster in the centre and long thin tails (Pallant, 2010). With a large sample (over 200 and I have 264 pupils making up both the pre and post attitude variable) this skewness should not make a substantive difference, but the shape of the distribution ought to be checked to be sure (Tabachnick & Fidell, 2007). Histograms of the distributions can be seen in Appendix I.

The Shapiro-Wilk test can also be used to check normality. A p value of less than 0.05 gives a high likelihood that the assumption that the variable is normally distributed is not met. The significance value for both pre and post attitude was 0.01 which implies that the data is not normally distributed.

Finally, I have looked at the mean and median of the two variables as this offers a quick way to see if a distribution is normally distributed. If a variable is normally distributed, its upper and lower quartiles are symmetrical and its median and mean are the same, in the middle of the graph. If the mean equals the median, then it is a good indication of normality, so the ratio of mean divided by median should be 1. If the ratio is in the range 0.95-1.05 then it is acceptable to assume a normal distribution. Table 12 shows the values for the mean divided by the median are both very close to 1.

	Pre attitude	**Post attitude**
Mean	2.42	2.30
Median	2.36	2.26
Mean/Median	1.03	1.02

Table 12 Mean, median and mean/median for pre and post attitude

In summary, I think it is ambiguous whether the attitude values come from a normal distribution, so I have chosen to use non-parametric statistics to analyse the quantitative data. This decision is not only driven by the calculations to check normality, but also because if there is a relationship indicated between pupils' anxiety and pre attitude for example, I would not want this to be dismissed because of incorrectly using parametric methods. By choosing to analyse the data using non-parametric statistics then any relationships which are found will be worthy of report, even though some relationships may be missed because the non-parametric statistics are not as sensitive, I feel that this is preferable to 'false' relationships that may be based on assuming the data is normally distributed when it is not (Allen & Seaman, 2007). If any relationships are found as a result of the non-parametric tests, then they are likely to be backed up by previous studies in my literature review or with the results from the quantitative data which I have already analysed. Therefore, I can be 'sense checking' the results from the quantitative data as I go along to ensure that any relationships which are found are not appearing falsely.

5.2 Analysis of data

Effect size is an indication of the "amount of the total variance in the dependent variable that is predictable from knowledge of the levels of the independent variable" (Tabachnick & Fidell, 1996, p. 53), and where applicable has been calculated by dividing the z value by the square root of N. In the following case the effect size is equal to:

$r = \frac{2.137}{\sqrt{528}} = 0.093$

and shows how much variance in the post attitude value is predictable from the pre attitude value. The larger the effect size is, the stronger the relationship is between the two variables.

5.2.1 Is the post attitude value less than the pre attitude value after a transition point?

In order to examine this, the attitude scale data, comprised of the median score on the 14 questions remaining in the scale after the reliability analysis, from year 6 and 9 was compared against year 7 and 10. The Wilcoxon Signed Rank Test is designed to be used when something is measured on two occasions or under two conditions. The test converts scores into ranks and compares them at two separate times (Pallant, 2010).

The Wilcoxon Signed Rank Test revealed a statistically significant increase in attitude value when years 6 and 9 were combined and compared to years 7 and 10, $z = -6.49$, $p<0.05$, with a small effect size ($r = 0.09$). The median post attitude value decreased from years 6 and 9 (median = 2.36) to years 7 and 10 (median = 2.26) which means that the pupils became more positive towards their mathematics lessons after a transition point.

5.2.2 Exploring the relationships between attitude value and other factors.

The following section explores whether there is a relationship between attitude value and the following factors –

- Year
- Gender
- Pleasing parents
- Pleasing teacher
- Changing set
- Direction of set change
- Number of teachers
- Set number
- Views of prior attainment
- Choosing mathematics

5.2.2.1 Year

The Mann-Whitney U Test was used to test for differences on a continuous measure between two independent groups. The test compares medians by converting a continuous score into ranks and then comparing across two groups (Pallant, 2010).

Although comparing years 6 and 9 does not compare the same pupils, it would be useful to know if there is a difference between the pre attitude values in year 6 and year 9 as the research aims of the study are to explore the changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school, this provides an opportunity to look at the difference between pupils in year 6 and older pupils in year 9.

The Mann-Whitney U Test revealed no statistically significant difference between the pre attitude values in year 6 (median = 2.36, n = 123) and year 9 (median = 2.36, n = 141), U = 8317, z = -0.57, p =0.57. This result implies that there is no difference between the attitudes of pupils in year 9 and those in year 6.

A repeat of the Mann-Whitney U test for years 7 and 10, showed a statistically significant difference between the post attitude values in year 7 (median = 2.14, n = 123) and 10 (median = 2.23, n = 141), U = 6684, z = -3.22, $p<0.05$, r = 0.20. This result shows me that as the pupils move through secondary school year 7 pupils have a more positive attitude towards their mathematics than year 10 pupils.

Overall, there was no statistical difference between the pre attitude values of year 6 and 9 but there was a statistically significant difference between the post attitude values of years 7 and 10, with year 7 being more positive than year 10.

5.2.2.2 Gender

The data for year 6 and 9 combined was again analysed using the Mann-Whitney U Test and revealed that there was no statistically significant difference in the pre attitude values of girls in years 6 and 9 (median = 2.43, n = 129) and boys in years 6 and 9 (median = 2.29, n = 135), U = 7605, z = -1.78, p = 0.08, r = 0.11.

For years 7 and 10 combined a Mann-Whitney U Test showed that there was a statistically significant difference in the post attitude values of girls in years 7 and 10 (median = 2.29, n = 129) and boys in years 7 and 10 (median = 2.21, n = 135), U = 7391, z = -2.13, p <0.05, r = 0.13. To see if this difference is in year 7, 10 or both I have re-calculated the Mann-Whitney U Test for each year group.

In year 7, the Mann-Whitney U Test showed that there was no statistical difference between girls post attitude value (median = 2.14, n = 65) and boys post attitude value (median = 2.00, n = 58), U = 1614, z = -1.38, p = 0.17, r = 0.12, however in year 10 the Mann-Whitney U Test showed that there was a statistical difference between girls post attitude value (median = 2.57, n = 64) and boys post attitude value (median = 2.29, n = 77), U = 1899, z = -2.35, p = 0.02, r = 0. 20. Therefore boys have a lower post attitude median value than girls, which means that they have a more positive attitude towards mathematics than the girls, although as the effect size is small, the relationship between the two variables is weak.

Overall there was no statistically significant difference between genders for pre attitude values in years 6 or 9, or for post attitude values in year 7, but in year 10 there was a statistically significant difference between the post attitude values of girls and boys, with boys having a more positive attitude towards mathematics than girls.

5.2.2.3 Pleasing parents

The Kruskal-Wallis Test is used to compare the scores on a continuous variable (attitude value) for three or more groups (Pallant, 2010). I am using the responses to the question scale to categorise the pupils into 5 groups.

A Kruskal-Wallis Test revealed that there was not a statistically significant difference in the pre attitude value across the Question scale for question regarding the pupils pleasing their parents, χ^2 (4, n = 261) = 1.688, p = 0.79.

Table 13 shows the mean rank for the five options on the Question scale and shows that those pupils who scored a 5, on the scale had the most positive pre-attitude towards mathematics.

		Pre-attitude value			**Post-attitude value**		
		N	**Mean**	**Mean Rank**	**N**	**Mean**	**Mean Rank**
1	Pleasing my parents/guardians is the main reason that I work hard in maths	22	2.46	134.77	20	2.20	118.38
2		49	2.43	130.49	58	2.19	117.68
3		97	2.48	136.95	87	2.39	144.13
4		57	2.42	127.38	54	2.18	115.49
5	Pleasing my parents/guardians is **not** the main reason that I work hard in maths	36	2.29	119.10	42	2.41	148.14

Table 13 Mean and mean rank for Pleasing my parents/guardians is the main reason that I work hard in maths

A Kruskal-Wallis Test revealed a statistically significant difference in the post attitude value across the Question scale for this question, χ^2 (4, n = 261) = 9.47, p = 0.05.

Table 13 shows the mean rank for the five options on the Question scale and shows that those pupils who scored a 4 on the scale had the most positive post-attitude towards mathematics.

Overall, pleasing their parents does appear to have a statistical significance on the pupils' attitude towards mathematics, but it is not the main reason why the pupils work hard in mathematics.

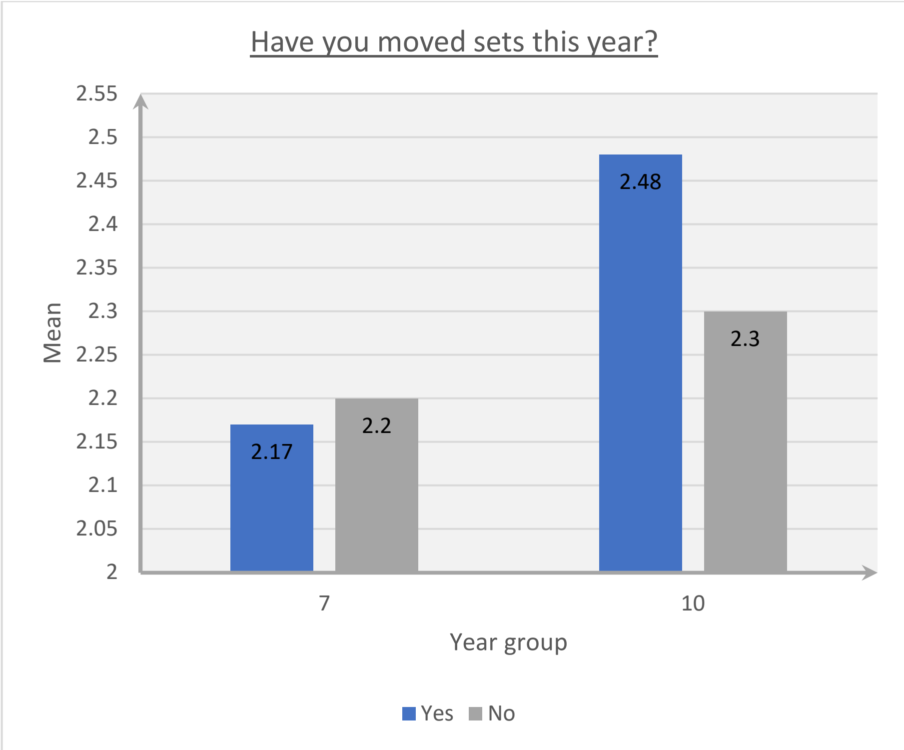
5.2.2.4 Pleasing teacher

Again, the Kruskal-Wallis Test was used to compare the scores on a continuous variable for three or more groups (Pallant, 2010).

A Kruskal-Wallis Test showed that there is not a statistically significant difference in the pre attitude value across the Question scale for this question, χ^2 (4, n = 264) = 3.21, p = 0.53. As this significance value is greater than 0.05 there is no statistical relationship between the pupils' pre attitude values and pleasing their teacher.

A Kruskal-Wallis Test revealed no statistically significant difference in the post attitude value across the Question scale for this question, χ^2 (4, n = 263) = 8.84, p = 0.07, which again means that there is no statistical relationship between the pupils' post attitude values and pleasing their teacher. Overall, pleasing their teacher does not appear to have any statistical significance on the pupils' attitude value.

5.2.2.5 Changing set

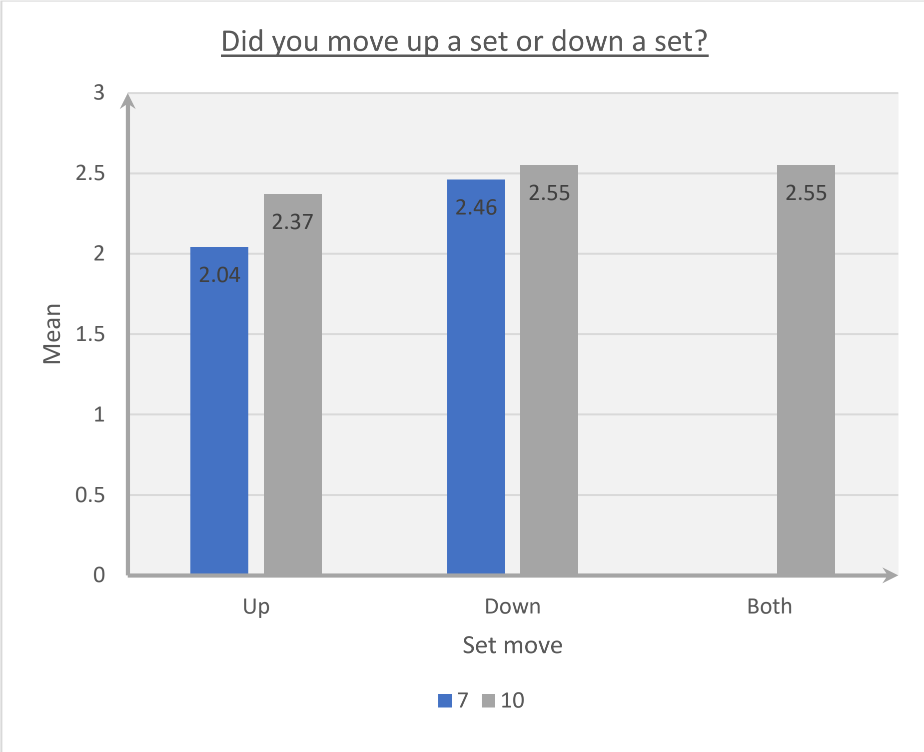


Bar Chart 1 Mean post attitude value for 'Have you moved sets this year?' by year

This question was only asked in 2015, to the year 7 and 10 pupils because the year 6 pupils may not have been set or experienced a set change. Bar Chart 1 shows that the pupils in year 7 who had moved sets had a more positive attitude towards mathematics, whereas the pupils in year 10 who had not moved sets had a more positive attitude towards mathematics. This may be linked back to the rotation of classes which had occurred in this academic year due to staffing shortages. However, a Kruskal-Wallis Test showed that there was not a statistically significant relationship between moving sets and post attitude values, χ^2 (1, n = 247) = 1.93, p = 0.17.

5.2.2.6 Direction of set change

Although moving set did not seem to have a statistically significant effect on the post attitude value I wanted to see if the direction of the set change influenced the pupils' attitude towards mathematics. Bar Chart 2 shows that, as would be expected, those pupils who move up a set appear to have a more positive attitude towards mathematics than those who have moved down a set. The mean attitude value was the same if the pupils had moved down a set or had moved twice, although the number of pupils in these cases were quite different at 18 and 4 respectively.



Bar Chart 2 Mean post attitude value for 'Did you move up or down a set?' by year

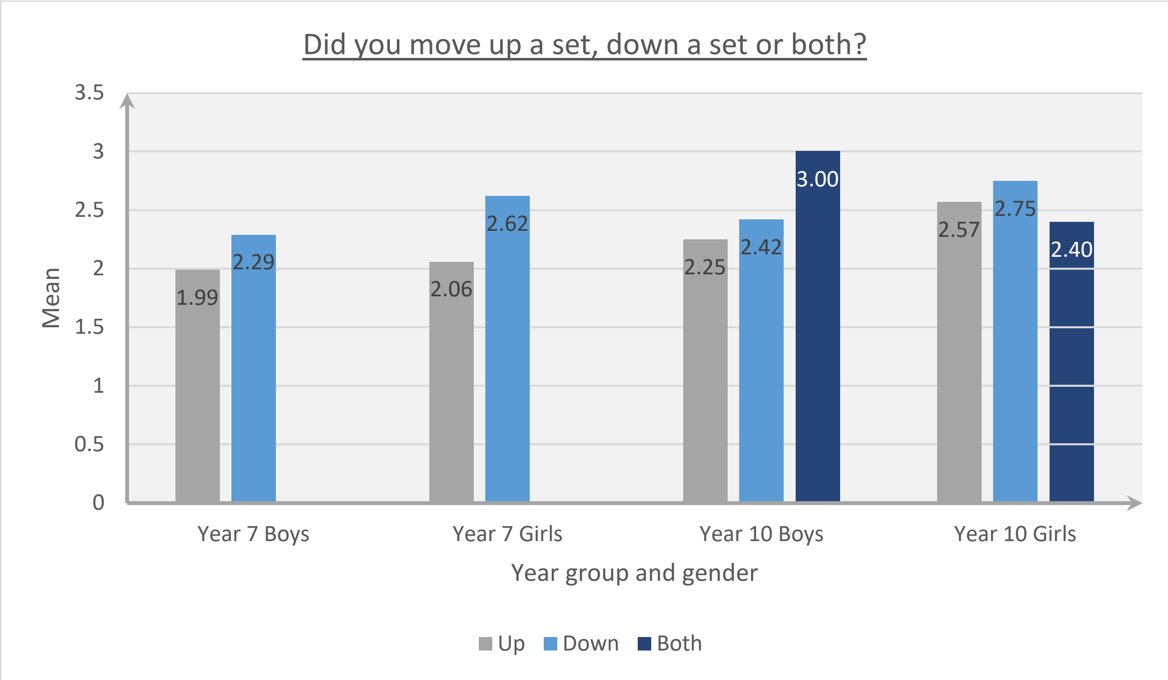
I used a Mann-Whitney U Test to see if any differences in the post attitude value were to do with whether a pupil had moved up or down a set. The test compares medians by converting a continuous score into ranks and then comparing across two groups (Pallant, 2010).

In year 7, the Mann-Whitney U Test showed that there was a statistically significant difference in post attitude values of pupils who had moved up (median = 1.89, n = 20) a set or down (median = 2.36, n = 15), U = 82.5, z = -2.25, p = 0.02, r = 0.38. Those pupils who had moved up a set had a more positive attitude towards their mathematics, with a medium effect size.

In year 10, the Mann-Whitney U Test showed that there was not a statistically significant difference in post attitude values of pupils who had moved up a set (median = 2.26, n = 30), down a set (median = 2.54, n = 18) or moved twice (median = 2.57, n = 4), U = 192.5, z = -1.65, p = 0.10, r = 0.24.

In case there was a difference between genders and the effects of changing set I also looked at boys and girls. Bar Chart 3 shows that in year 7, as would be expected, both boys and girls had a more positive attitude towards mathematics if they had moved up a set. Although the attitude value of year 10 did not seem as affected by set changes as in year

7, year 10 boys had a less positive attitude towards mathematics if they had moved sets twice, whereas for girls moving sets twice gave the most positive attitude towards mathematics.



Bar Chart 3 Mean post attitude value for 'Did you move up or down a set?' by gender and year group

For girls, the Mann-Whitney U Test showed that there was a statistically significant difference in post attitude values of pupils who had moved up (median = 2.14, n = 23) a set or down (median = 2.64, n = 10), U = 62.5, z = -2.06, p = 0.04, r = 0.36, with a medium effect size. If the pupil had moved twice, the median was 2.07. The girls who had changed set twice had the most positive attitude towards mathematics, followed by those who had moved up. Unfortunately, I do not know if the pupils that had moved twice moved down and then up or vice versa, or even moved up or down two sets, to know which way may have affected them the most.

For boys, the Mann-Whitney U Test showed that there was not a statistically significant difference in the post attitude values of pupils who had moved up a set (median = 2.21, n = 24), down a set (median = 2.36, n = 18) or moved twice (median = 3.00, n = 1), U = 118.5, z = -1.05, p = 0.29, r = 0.18.

In summary the direction of a set change had a statistical impact on the post attitude values of year 7 with those that had moved up a set having a more positive attitude towards mathematics. Girls were also affected by moving set, those that had moved set twice had the most positive attitude towards mathematics, followed by those who had moved up a set. Moving up or down a set did not have a statistically significant impact on the post attitude values for year 10 pupils or boys.

5.2.2.7 Number of teachers experienced in the academic year

This question was only asked in 2015, to the year 7 and 10 pupils because of the staffing difficulties that the department were faced with that academic year.

The results of the Kruskal-Wallis Test for year 10 shows a statistically significant difference in the post attitude value across the different number of teachers, χ^2 (4, n = 132) = 13.28, p = 0.01.

Table 14 shows the mean rank for the number of teachers and shows that the pupils' attitude towards mathematics is less positive as they experience more teachers.

Number of teachers	N	Median	Mean Rank
1	53	2.14	52.65
2	10	2.46	79.80
3	14	2.36	69.71
4	17	2.29	68.35
5	38	2.50	80.30

Table 14 Mean ranks for number of teachers and attitude value in year 10

Overall, the number of teachers that the pupils had been exposed to in one year did not have a statistically significant impact on their post attitude values, however when I split the year groups up there was a statistically significant difference for year 10 but not for year 7, boys, or girls. Pupils in year 10 had a more positive attitude towards mathematics when they only experienced one teacher.

5.2.2.8 Set

Whether which prior attainment group a pupil is in affects their attitude value can only be investigated in years 7, 9 and 10 because I do not know specific details about how the pupils were taught in primary schools. In the study school there were 4 sets in each half year group in years 7 and 9, and in year 10 the pupils were streamed across the year group in mathematics, English and science to form 9 sets.

The data were analysed with a Kruskal-Wallis Test for each year group. In year 7 there was a statistically significant difference in the post attitude value according to set, χ^2 (3, n = 123) = 32.41, p = 0.01.

Table 15 shows the mean rank for the four sets and shows that the pupils' attitude towards mathematics is less positive as you move from set 1 to 4 (set 1 is the highest prior attaining set).

Set	N	Median	Mean Rank
1	38	1.81	35.87
2	47	2.28	67.94
3	26	2.44	79.85
4	12	2.55	82.83

Table 15 Mean ranks for sets 1-4 and attitude value in year 7

In year 9 there was statistically significant difference in the post attitude value according to set, χ^2 (3, n = 141) = 15.86, p = 0.01. Table 16 shows the mean rank for the four sets and shows that the pupils' attitude towards mathematics is less positive as you move from set 1 to 4.

Set	N	Median	Mean Rank
1	53	2.14	59.70
2	43	2.29	69.78
3	37	2.46	78.50
4	8	2.86	117.75

Table 16 Mean ranks for sets 1-4 and attitude value in year 9

In year 10 there was statistically significant difference in the post attitude value according to set, χ^2 (8, n = 141) = 28.69, p = 0.01. Table 17 shows the mean rank for the 9 sets and shows that overall, the pupils' attitude towards mathematics is less positive as you move from set 1 to 9. However, due to staffing issues in this academic year, from mid-November until March sets 2,3 and 4 were mixed to form three parallel groups, and then put on a rotation of teachers so that one set did not have a supply teacher all of the time. From March the groups were re-set again, based on their past exam paper homework scores and set 6 had a supply teacher for the rest of the year (please see section *4.5* for more information). This may explain the differences in mean rank value in sets 2,3 and 4 in the following table.

Set	N	Median	Mean Rank
1	26	2.07	43.90
2	21	2.39	71.86
3	16	2.31	65.78

4	18	2.78	101.78
5	18	2.24	56.47
6	17	2.52	83.97
7	13	2.41	73.69
8	7	2.55	85.36
9	5	2.59	95.30

Table 17 Mean ranks for sets 1-9 and attitude value in year 10

Overall, in all years there is a statistically significant difference between what set the pupils are in and their attitude value. The attitude value increases (so attitude becomes less positive) as you move from set 1 through to the lower prior attaining sets (set 4 in years 7 and 9 and set 9 in year 10). Therefore, in years 7 and 9, the higher prior attainment set a pupil is in, the more positive their attitude towards mathematics in the study school. Whilst this may also be true in year 10, the pupils' attitudes appear to have been affected by their experience of staff shortages in the academic year.

5.2.2.9 How pupils view their prior attainment

The following question helped me to investigate whether pupils' views of their prior attainment had an effect on their attitude value. I used the question to categorise people according to their response on the Question scale.

Work in maths is too easy for me	*~~1~~*	*~~2~~*	*~~3~~*	*~~4~~*	*~~5~~*	*Work in maths is too hard for me*
	5	*4*	*3*	*2*	*1*	

The answers to this question were reversed so that 5 = 1, 4 = 2 etc. The following analysis is with the reversed code. The data was analysed with a Kruskal-Wallis Test for each year.

In year 6 there was not a statistical difference in the pre attitude value across the Question scale, χ^2 (4, n = 122) = 6.88, p = 0.14. Table 18 shows the mean rank for the Question scale and shows that overall, there was not much variation in the pupils' attitude towards mathematics across the Question scale.

	N	**Median**	**Mean Rank**
1 (work in maths is too hard for me)	6	2.90	84.75
2	16	2.68	73.53
3	69	2.44	7.53
4	24	2.48	55.48
5 (work in maths is too easy for me)	7	2.72	73.86

Table 18 Mean rank for the Question scale for whether maths is too hard in year 6

In year 7 there was statistically significant difference in the post attitude value across the Question scale, χ^2 (4, n = 121) = 12.84, p = 0.01. Table 19 shows the mean rank for the Question scale, with the most positive attitude for pupils who put a value 4, which is that 'work in maths is too easy for me'.

	N	Median	Mean Rank
1	2	3.32	113.25
2	19	2.39	73.18
3	71	2.15	59.53
4	24	2.03	46.75
5	5	2.52	83.10

Table 19 Mean rank for the Question scale for whether maths is too hard in year 7

In year 9 there was a statistically significant difference in the pre attitude values across the Question scale, χ^2 (4, n = 140) = 14.24, p = 0.01. Table 20 shows the mean rank for the Question scale and shows the most positive attitude was also for those pupils who put a value 4, which is that 'work in maths is too easy for me'.

	N	Median	Mean Rank
1	10	2.62	95.85
2	32	2.51	85.11
3	82	2.28	64.38
4	12	2.05	47.29
5	4	2.55	85.38

Table 20 Mean rank for the Question scale for whether maths is too hard in year 9

In year 10 there was not a statistical difference in the post attitude value across the Question scale, χ^2 (3, n = 140) = 4.02, p = 0.26 Table 21 mean rank for the Question scale and shows that the pupils' attitude values do not vary greatly across the Question scale.

	N	Median	Mean Rank
1	6	2.71	97.17
2	31	2.43	76.27
3	92	2.35	67.66
4	11	2.33	63.41
5	0		

Table 21 Mean rank for the Question scale for whether maths is too hard in year 10

Overall, for years 7 and 9, there was a statistically significant difference between the attitude value and whether the pupils felt that the work in mathematics was too easy for them. Although care should be taken with the interpretation of this data because some pupils may feel that the work is too hard for them because they lack confidence, whilst others may not realise that they are struggling with the work but believe that it is at the correct level for them, it is still interesting to note that the pupils in years 7 and 9 with the most positive attitude felt that the work was on the easier side for them.

5.2.2.10 Choosing to study mathematics after GCSE

I will probably continue with maths after GCSE. Circle one –				
Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly Disagree*

The data was analysed with a Kruskal-Wallis Test for each year group. In year 6 there was a statistically significant difference in the pre attitude value across the Question scale, χ^2 (4, n = 121) = 13.02, p = 0.01. Table 22 shows the mean rank for the Question scale and shows that the pupils' attitude towards mathematics becomes less positive as they become less likely to continue with mathematics after GCSE.

	N	**Median**	**Mean Rank**
Strongly agree	7	2.00	36.64
Agree	64	2.42	55.13
No opinion	36	2.61	65.72
Disagree	12	2.98	83.29
Strongly disagree	2	3.68	104.75

Table 22 Mean rank and attitude value for year 6

In year 7 there was statistically significant difference in the post attitude value across the Question scale, χ^2 (4, n = 121) = 13.02, p = 0.02. Table 23 shows the mean rank for the Question scale and shows that the pupils' attitude towards mathematics again becomes less positive as they become less likely to continue with mathematics after GCSE. However, those pupils in year 7 who chose the 'strongly disagree' response appeared to be as positive towards mathematics as those pupils who answered 'no opinion'.

	N	Median	Mean Rank
Strongly agree	10	2.07	41.36
Agree	52	2.00	56.29
No opinion	45	2.35	62.93
Disagree	12	2.58	91.13
Strongly disagree	0	2.19	65.00

Table 23 Mean rank and attitude value for year 7

In year 9 there was statistically significant difference in the pre attitude value across the Question scale, χ^2 (4, n = 137) = 25.33, p = 0.01. Table 24 shows the mean rank for the Question scale and shows that overall, the pupils' attitude towards mathematics becomes less positive as they become less likely to continue with mathematics after GCSE.

	N	Median	Mean Rank
Strongly agree	16	1.96	39.56
Agree	65	2.24	61.75
No opinion	34	2.43	77.03
Disagree	17	2.70	99.65
Strongly disagree	5	2.70	98.60

Table 24 Mean rank and attitude value for year 9

In year 10 there was not a statistical difference in the post attitude value across the Question scale, χ^2 (4, n = 137) = 7.61, p = 0.11. Table 25 shows the mean rank for the Question scale and shows that the pupils' attitude towards mathematics does not differ largely if they selected options 2-5.

	N	Median	Mean Rank
Strongly agree	11	1.96	47.28
Agree	40	2.23	68.43
No opinion	38	2.38	71.47
Disagree	33	2.51	83.68
Strongly disagree	16	2.72	79.20

Table 25 Mean rank and attitude value for year 10

Overall, for all year groups, the pupils' attitude towards mathematics was most positive if they would choose to continue with mathematics after GCSE and became less positive as their likelihood of choosing mathematics decreased.

The following question asked if the pupils would choose mathematics now, which may be more relevant to years 6 and 7 who might not have considered being able to choose subjects after GCSEs.

5.2.2.11 Choosing to study mathematics now

If maths was an option now, I would probably choose it. Circle one –				
Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly Disagree*

The data was analysed with a Kruskal-Wallis Test for each year group. In year 6 there was a statistically significant difference in the pre attitude value across the Question scale, χ^2 (4, n = 115) = 12.22, p = 0.02. Table 26 shows the mean rank for the Question scale and shows that overall, the pupils' attitude towards mathematics becomes less positive as they become less likely to choose mathematics now.

	N	Median	Mean Rank
Strongly agree	7	2.28	42.29
Agree	62	2.39	52.45
No opinion	24	2.54	65.58
Disagree	12	2.93	56.38
Strongly disagree	10	3.03	87.15

Table 26 Mean rank for the Question scale for whether pupils would choose maths now in year 6

In year 7 there was a statistically significant difference in the post attitude value across the Question scale, χ^2 (4, n = 119) = 27.61, p = 0.01. Table 27 shows the mean rank for the Question scale and shows that the pupils' attitude towards mathematics becomes less positive as they become less likely to choose mathematics now.

	N	Median	Mean Rank
Strongly agree	18	1.92	37.39
Agree	55	2.03	51.24
No opinion	29	2.40	75.91
Disagree	12	2.42	79.63
Strongly disagree	5	3.06	98.40

Table 27 Mean rank for the Question scale and attitude value in year 7

In year 9 there was statistically significant difference in the pre attitude value across the Question scale, χ^2 (4, n = 139) = 17.85, p = 0.01. Table 28 shows the mean rank for the

Question scale and shows that overall, the pupils' attitude towards mathematics becomes less positive as they become less likely to continue with mathematics now.

	N	Median	Mean Rank
Strongly agree	27	2.10	50.59
Agree	60	2.29	64.57
No opinion	26	2.46	78.88
Disagree	18	2.73	95.39
Strongly disagree	8	2.54	90.25

Table 28 Mean rank for the Question scale and attitude value in year 9

In year 10 there was a statistical difference in the post attitude value across the Question scale, χ^2 (4, n = 138) = 36.71, p = 0.01. Table 29 mean rank for the Question scale and shows that the pupils' attitude towards mathematics becomes less positive as they become less likely to choose mathematics now.

	N	Median	Mean Rank
Strongly agree	23	2.05	43.54
Agree	65	2.29	59.28
No opinion	13	2.50	82.46
Disagree	27	2.66	94.80
Strongly disagree	10	2.86	110.45

Table 29 Mean rank for the Question scale and attitude value in year 10

Overall, for all year groups, the attitude towards mathematics was most positive if the pupils would continue with mathematics now and became less positive as their likelihood of choosing mathematics decreased.

5.2.3 How does mathematics anxiety change over time?

I feel anxious about the work in maths	*~~1~~*	*~~2~~*	*~~3~~*	*~~4~~*	*~~5~~*	*I do not feel anxious about the work in maths*
	5	*4*	*3*	*2*	*1*	

(Please note that Q8 has been reversed to a result of 1 = 5 etc)

Although the question on mathematics anxiety was included in the attitude value because mathematics anxiety was traditionally thought to increase with age (Carey, et al., 2019) and as it was identified as a key element in the literature, I have looked at mathematics anxiety as a factor on its own.

The Wilcoxon Signed Rank Test reveals a statistically significant change in anxiety levels from year 6 to year 7, z = -3.59, $p<0.05$, with a medium effect size (r = 0.32). The median response to this question was 3 in year 6 and 2 in year 7, therefore the pupils felt less anxious about mathematics in year 7 than in year 6.

The Wilcoxon Signed Rank Test reveals a statistically significant change in anxiety levels from year 9 to year 10, z = -3.44, $p<0.05$, with a medium effect size (r = 0.29). The median response to this question was 2 in year 9 and 2 in year 10, the mean response to this question was 2.50 in year 9 and 2.13 in year 10, therefore the pupils felt less anxious in year 10 than in year 9. This finding does not follow with the findings in the literature review which traditionally thought that mathematics anxiety came as a result of more complex mathematics (Maloney & Beilock, 2012), however other studies have shown that mathematics anxiety is present in pupils as young as seven (Young, et al., 2012).

It was not possible to analyse across sets due to year 6 not being set and pupils moving between sets (i.e. just because a pupil is in set one in year 9, does not mean they will be in set one in year 10), although this may be something to research in the future, so I have calculated the mean scores in sets 1-4 in year 9 and 1-4 in year 10 (as year 9 did not have sets 5-8).

Set	**N**	**9**	**10**
1	52	2.42	1.92
2	43	2.51	2.05
3	34	2.62	2.38
4	8	2.50	2.88

Table 30 Mean anxiety scores by set for years 9 and 10

Table 30 shows the mean scores for sets 1-4 in years 9 and 10 and shows that the pupils feel less anxious towards mathematics in sets 1-3 in year 10, but pupils in set 4 feel more anxious. This may be due to the pupils completing past papers for the first time and seeing a GCSE grade on their papers.

5.2.4 Analysis of single questions

In the questions above the questions in the attitude scale were combined to provide an overall attitude towards mathematics lessons, there were several questions in the questionnaire which provided responses that, whilst not suitable for combined analyses, were deemed appropriate to explore in order to evaluate whether they played a role in the pupils' attitudes towards mathematics.

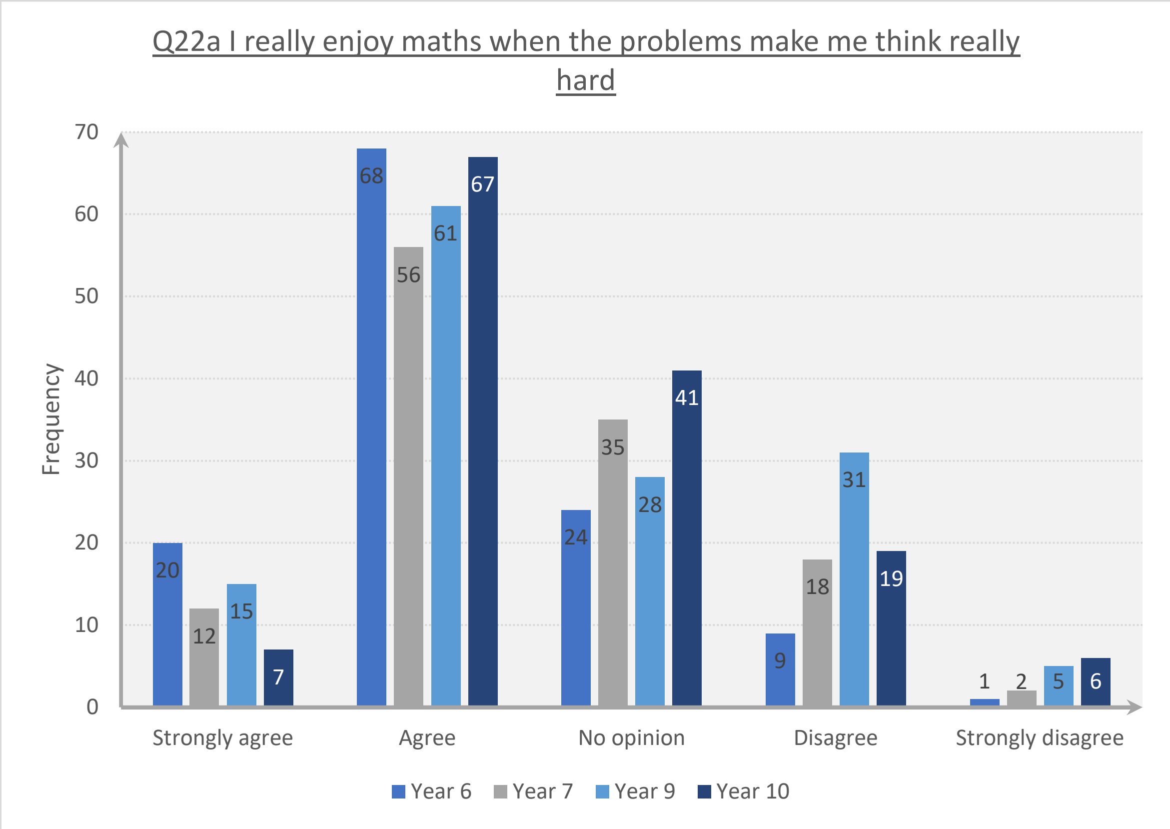
So for the following sections I have not calculated inferentials but have reported the descriptives, using SPSS to count the responses from the pupils and bar charts to show the frequency of pupil opinion. On the bar charts the x axis shows the option boxes to the questions (1-5 on the Question scale or strongly agree to strongly disagree) and the y axis is the frequency of responses. I have only included the questions where there was a notable difference between the responses in the year group or any other interesting feature. All the remaining graphs can be seen in Appendix K.

5.2.4.1 I really enjoy maths when…

Please note that I have only discussed the responses to parts a and c here, parts b and d can be found in Appendix K as they did not show a notable difference between year groups.

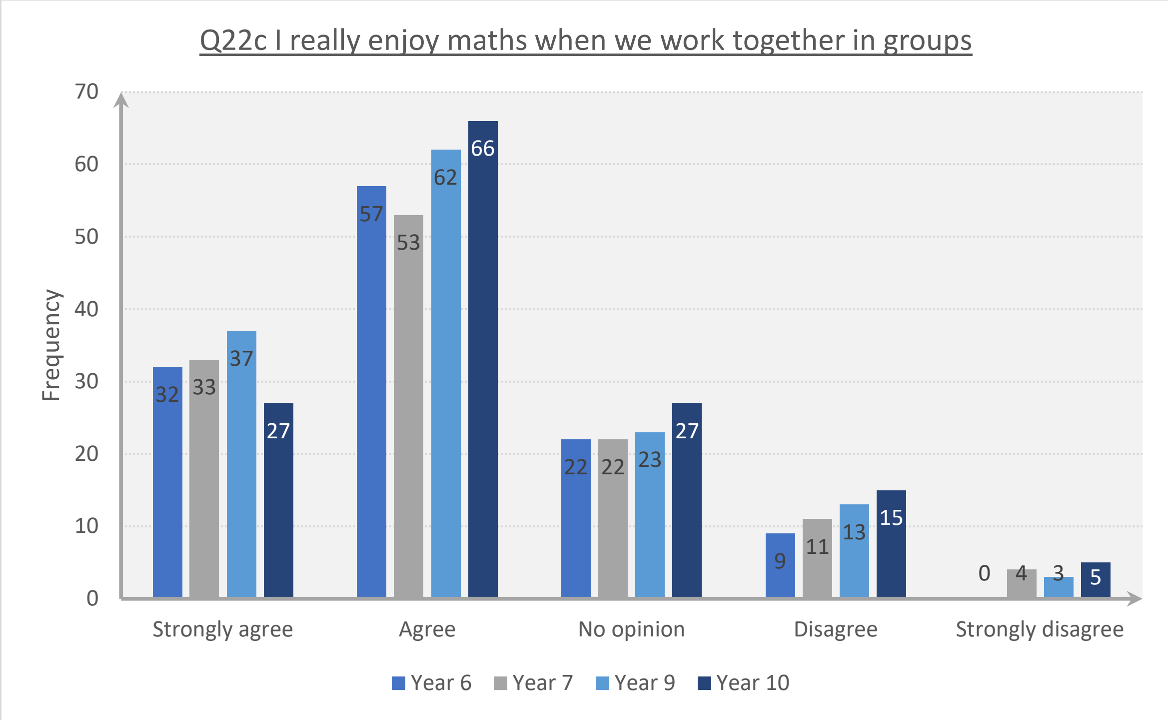
I really enjoy maths when – (in each row, please put a tick in one of the boxes)

	Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly disagree*
a) The problems make me think really hard					
b) I am the only one who can answer the question					
c) We work together in groups					
d) I am the first one to get the answer right					



Bar Chart 4 I really enjoy maths when the problems make me think really hard

Bar Chart 4 shows that the majority of the pupils do enjoy mathematics when they are faced with a problem which makes them think, although this may be the opposite of what they say in practice as they often want mathematics to be easier or say that they dislike it because it is too hard.



Bar Chart 5 I really enjoy maths when we work together in groups

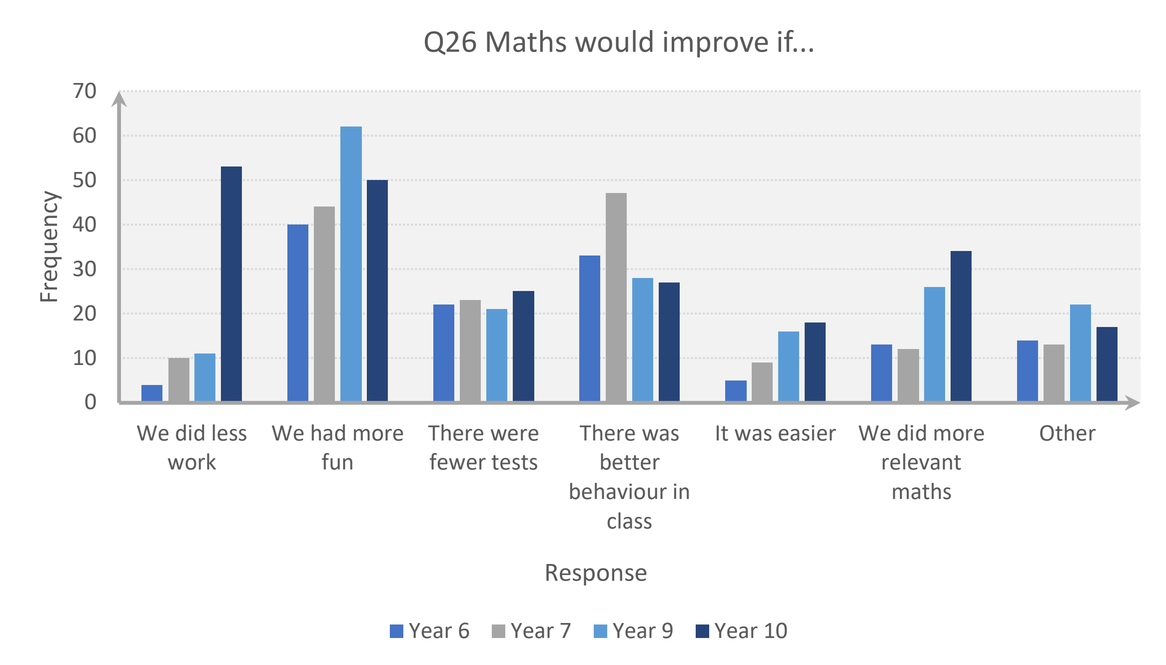
Bar chart 5 shows that all years enjoy working in groups with very few pupils selecting options disagree or strongly disagree.

5.2.4.2 Maths lessons would improve if….

Maths lessons would improve if …….. (Circle any that apply)

a) We did less work	*b) We had more fun*	*c) There were fewer tests*
d) There was better behaviour in class	*e) It was easier*	*f) We did more relevant maths*
g) Other		

The most popular response from both year groups appears to be part b 'we had more fun', which supports the findings from the qualitative data where fun was a popular idea for how mathematics could be improved.



Bar Chart 6 Maths lessons would improve if... (count)

As it is hard to draw conclusions from this question because I allowed the pupils to circle any number of appropriate responses, I have counted each response selected as opposed to the combinations so if a pupil selected options b d e then I have added those individually to the counts for response b, response d and response e. Therefore Bar Chart 6 is the number of times each of the 7 options were selected across the four year groups.

Bar Chart 6 shows that the modal result for year 10 was that mathematics lessons would improve if the pupils did less work, however this was the least popular response for year 6. Year 9 modal response was that maths lessons would improve if they had more fun whilst year 7 felt that maths lessons would improve if the behaviour of the class improved. This concern for behaviour in year 7 was mentioned in the qualitative data too, but I am surprised to see how strong the feelings were because I usually assume that the behaviour in year 7 is better than older year groups. These findings may be due to the staffing issues experienced that year. Option f shows the strength of feeling of year 10 for maths to be more relevant to them.

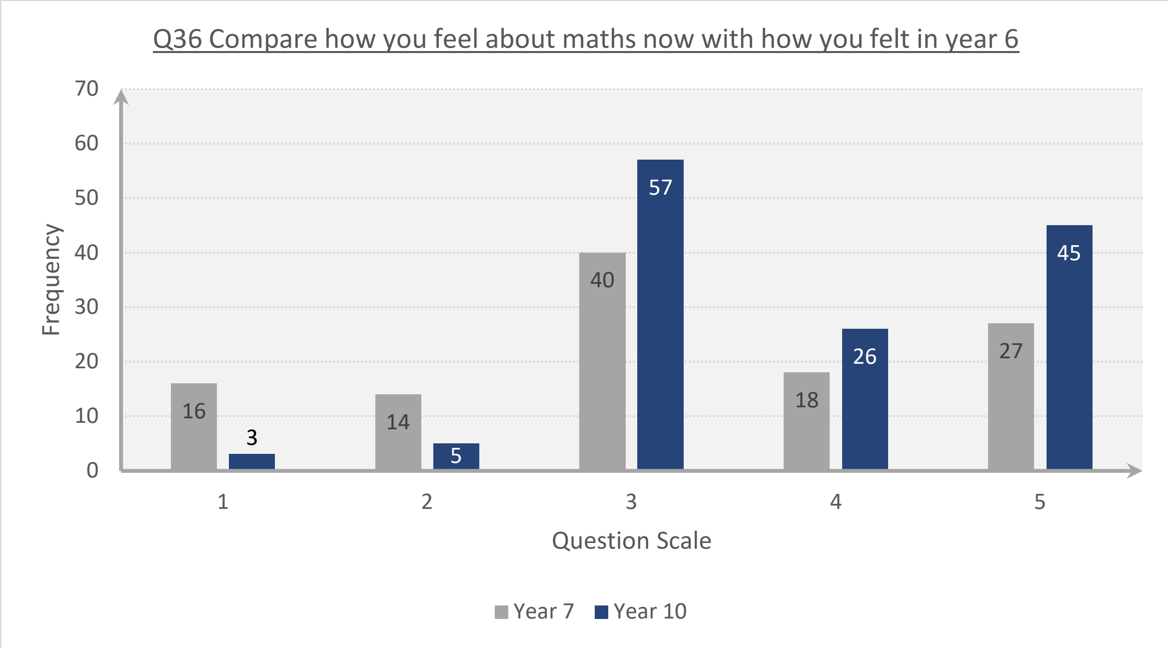
5.2.4.3 Compare how you feel about maths now with how you felt last year

Compare how you feel about maths now with how you felt in Year 6.

In the following questions please circle the number which represents how you feel:

Maths was more boring in Year 6	*1*	*2*	*3*	*4*	*5*	*Maths is just as boring in Year 7*

The year 10 class had the same question only it was comparing year 9 to 10.



Bar Chart 7 Maths was more boring in year 6/9

The modal result for both year groups is neutral here, although there are far more year 10 responses saying that maths is just as boring in year 10. The year 7 results are slightly more positive with many pupils feeling that maths was more boring in year 6 than year 7.

5.2.5 What are some of the main factors affecting the motivation of pupils?

In this section I have looked at the responses to certain questions in the questionnaire to investigate what factors motivate a pupil to work hard in mathematics. In this case it does not make sense to calculate a motivation value because how these questions are answered does not make you more or less motivated towards mathematics but may reveal some of the factors which affect the motivation of the pupils. For example, in responding to the question:

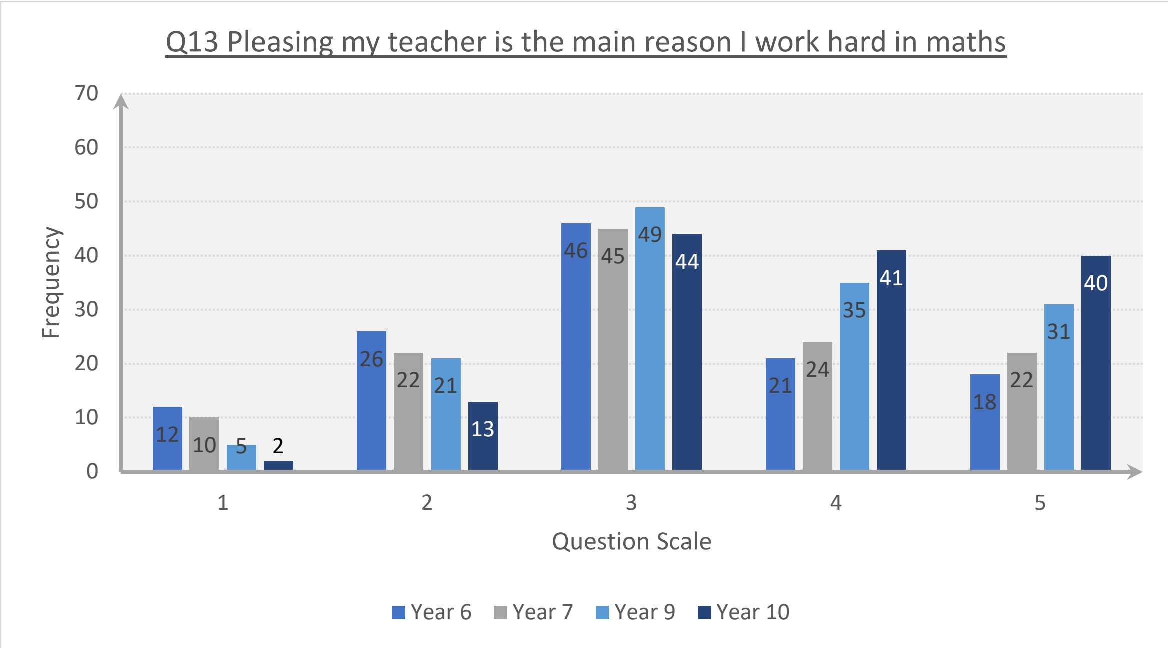
Pleasing my parents is the main reason that I work hard in maths	*1*	*2*	*3*	*4*	*5*	*Pleasing my parents is not the main reason that I work hard in maths*

a pupil may circle 5, but that does not mean that they are any more or less motivated than someone who circles a 1, but simply that the reasons behind their motivation may be different. As a result, I have not calculated inferentials for these questions but have reported the descriptives for the sections below.

5.2.5.1 Pleasing my teacher

Pleasing my teacher is the main reason that I work hard in maths	*1*	*2*	*3*	*4*	*5*	*Pleasing my teacher is not the main reason that I work hard in maths*

Bar Chart 8 shows the responses to this question for the four year groups, with Question scale on the x axis and frequency on the y axis.



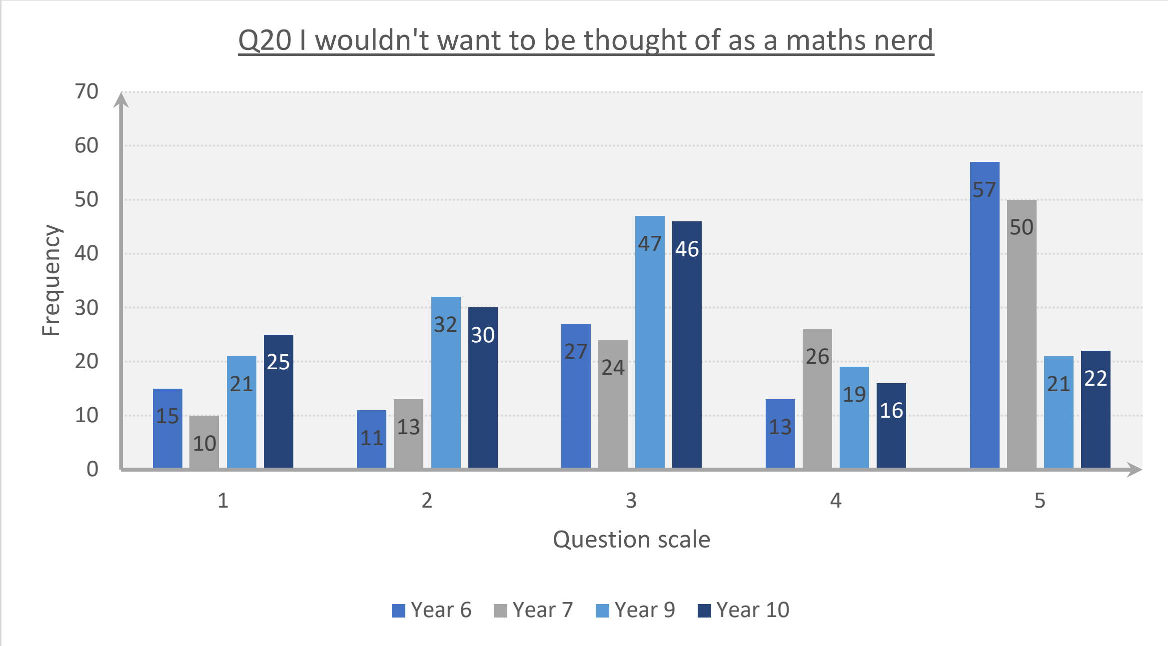
Bar Chart 8 Pleasing my teacher is the main reason that I work hard in maths

The graph clearly shows that years 9 and 10 are not motivated to try hard in mathematics to please their teacher, whereas the younger years have a more even spread across the Question scale.

5.2.5.2 Maths nerd

I wouldn't want to be thought of as a 'maths nerd'	*1*	*2*	*3*	*4*	*5*	*I would not mind to be thought of as a 'maths nerd'*

Bar Chart 9 shows the responses to this question for the four year groups, with Question scale on the x axis and frequency on the y axis.



Bar Chart 9 I wouldn't want to be thought of as a 'maths nerd'

The graph clearly shows that years 6 and 7 do not mind being thought of as a 'maths nerd' but pupils in years 9 and 10 either feel impartial or do not want to be thought of as a 'maths nerd'.

Overall, year 10 pupils find mathematics just as boring as they did the previous year and parents and teachers were not factors motivating them to work hard in mathematics, but they were more aware of how they were perceived by others, not wanting to be thought of as a nerd. The younger pupils were more motivated by pleasing their parents or teachers and did not mind if others considered them to be a 'nerd' in mathematics.

5.3 Summary

The following paragraph summarises the findings in this chapter in relation to the aims of the thesis.

Thesis aim: within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?

Findings:

- Pupils had a more positive attitude towards mathematics after a transition point.
- Year 10 pupils were less positive towards mathematics than other years.
- Year 10 boys were more positive towards mathematics than year 10 girls.

Thesis aim: What influences pupils' attitudes and motivation in mathematics in the study school setting?

Findings:

- Pleasing their parents was important to the pupils.
- Changing set had a statistically significant impact on the attitude value of girls but not boys.
- Year 7 had a more positive attitude if they had moved up a set.
- Year 10 had a more positive attitude if they had not moved sets.
- In year 10, the number of teachers the pupils' experienced had a statistically significant effect on their attitude value.
- Pupils in higher prior attainment sets had a more positive attitude towards mathematics in years 7 and 9 but not year 10.
- Positive attitudes towards mathematics were associated with the choice to study it now or after GCSE.
- Pupils enjoy problem solving in mathematics.
- Mathematics lessons could be improved by being more fun, having better behaviour and involving more group work.

The quantitative findings reported in this chapter and the qualitative findings in Chapter 4 will be synthesised and discussed in the next two chapters.

Chapter 6 Discussion

The UK is facing a mathematics crisis as the number of adults who have functional mathematics skills is less than half the percentage who have functional literacy skills, which means employers are incurring higher costs as employees struggle to check their numbers are sensible (National Numeracy, 2014). As the socio-economic background of a child influences their mathematics achievement (National Numeracy, 2014) and less numerate people can earn less, lack of numeracy could be adding to a cycle of poverty (Carey, et al., 2019).

There is a consensus that mathematics is an important subject and so many countries are trying to improve attainment and non-compulsory participation (Carey, et al., 2019) but mathematics continues to be one of the subjects which generates negative emotions (Martino & Zan, 2011), with pupils feeling like they "would rather die" (Brown, et al., 2008) than study A-level mathematics. These negative feelings are a cause for concern as how a pupil views their mathematics ability may have an impact on how well they achieve in mathematics (Askew, et al., 2010).

Studies have tracked the decline in pupils' attitudes towards mathematics as they get older (Middleton & Spanias, 1999; Lewis, 2013) with many pupils experiencing a mathematics classroom that is boring and dis-interesting (Lewis, 2013; Nardi & Steward, 2003; Vogel-Walcutt, et al., 2012). In most developed countries, attitudes towards school see the sharpest decline after the first term in secondary school (Galton, et al., 2002), with a consistent, specific marked decline in attitudes towards mathematics (Coleman, 2011).

Pupils' attitudes have a significant influence on their aspirations and career decisions (Hernandez-Martinez & Pampaka, 2017). Improving motivation in mathematics can improve standards because if affect in mathematics, and its interaction with cognition and learning can be understood, then it may be possible to improve engagement towards mathematics and consequently overall attainment (Lewis, 2013). It is therefore important to study how these change throughout a pupil's school life.

To improve enjoyment, increase attainment and encourage more pupils to continue with mathematics when it is no longer compulsory, there is a need to continue to investigate the reasons behind the changes in pupil motivation and attitude towards mathematics as they move through secondary school, and therefore I refer again to the research question and aims of this thesis:

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

In the period since the inception of this study (2012) there has been further theoretical work done to bring coherence in the field of motivation, in particular the development of self-determination theory by Ryan and Deci (Ryan & Deci, 2017; Ryan & Deci, 2019; Ryan & Deci, 2020). The key constructs that are relevant to this thesis will be discussed in the following section.

Figure 18 shows the four major subtypes of extrinsic motivation specified by self-determination theory from behaviours which are driven by external rewards and punishments through to integrated regulation which is the most autonomous form of extrinsic motivation where the person recognises and identifies the value of the task which matches their core interests (Ryan & Deci, 2020). Amotivation, seen too often in classrooms, can be caused by a lack of felt competence, value or interest and has been a strong negative predictor of engagement and learning (Ryan & Deci, 2020).

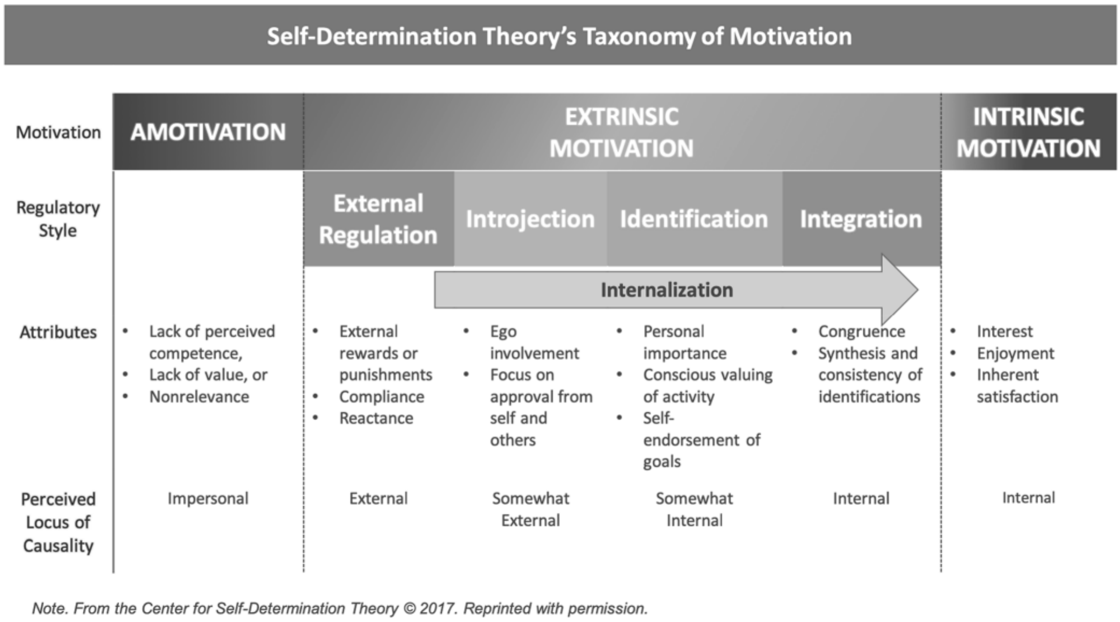


Figure 18 Self-determination theory's taxonomy of motivation (Ryan & Deci, 2020, p. 2)

In an educational setting, intrinsic and well-internalised (and therefore autonomous) forms of extrinsic motivation can predict many positive outcomes, which are enhanced by support for the pupils' basic needs for autonomy, competence, and relatedness (Ryan & Deci, 2020). There is a strong link between teacher and pupil motivation as teachers are impacted and constrained by management, systems, and leadership pressures (Ryan & Deci, 2020). According to Ryan and Deci (2020), despite the wealth of evidence demonstrating the importance of meeting psychological need satisfactions in an educational environment, many practices and policies

> *remain anchored in traditional motivational models that fail to support students' and teachers' needs, a knowledge versus policy gap we should aspire to close* (Ryan & Deci, 2020, p. 1).

The failure of traditional educational settings to satisfy the three basic psychological needs of pupils during adolescence, accounts for the decline in intrinsic motivation during this time (Gnambs & Hanfstingl, 2016). Therefore, support in schools for these basic needs is crucial to maintain intrinsic academic motivation during adolescence (Gnambs & Hanfstingl, 2016).

Findings from a study of 1412 high-school students found that the students were autonomously motivated to engage in self-regulated learning when their teachers and the environment in the classroom was supportive and their schoolwork interesting and purposeful. It was found that autonomous motivation pushed students to persist and exert effort, even if they felt the subject became boring, and to engage in deep-processing. This resulted in improved achievement in mathematics (Leon, et al., 2015)

Relevant (and timely to the project) research into these areas was summarised in Chapter 2 where the orientation in Figure 19 was introduced. In the remainder of this chapter I will reflect on the review that influenced my study and update it in the light of the framework provided by self-determination theory (as constructed by (Ryan & Deci, 2017; Ryan & Deci, 2019; Ryan & Deci, 2020)) to illuminate some aspects of pupils' motivation and teacher insights given their educational context.

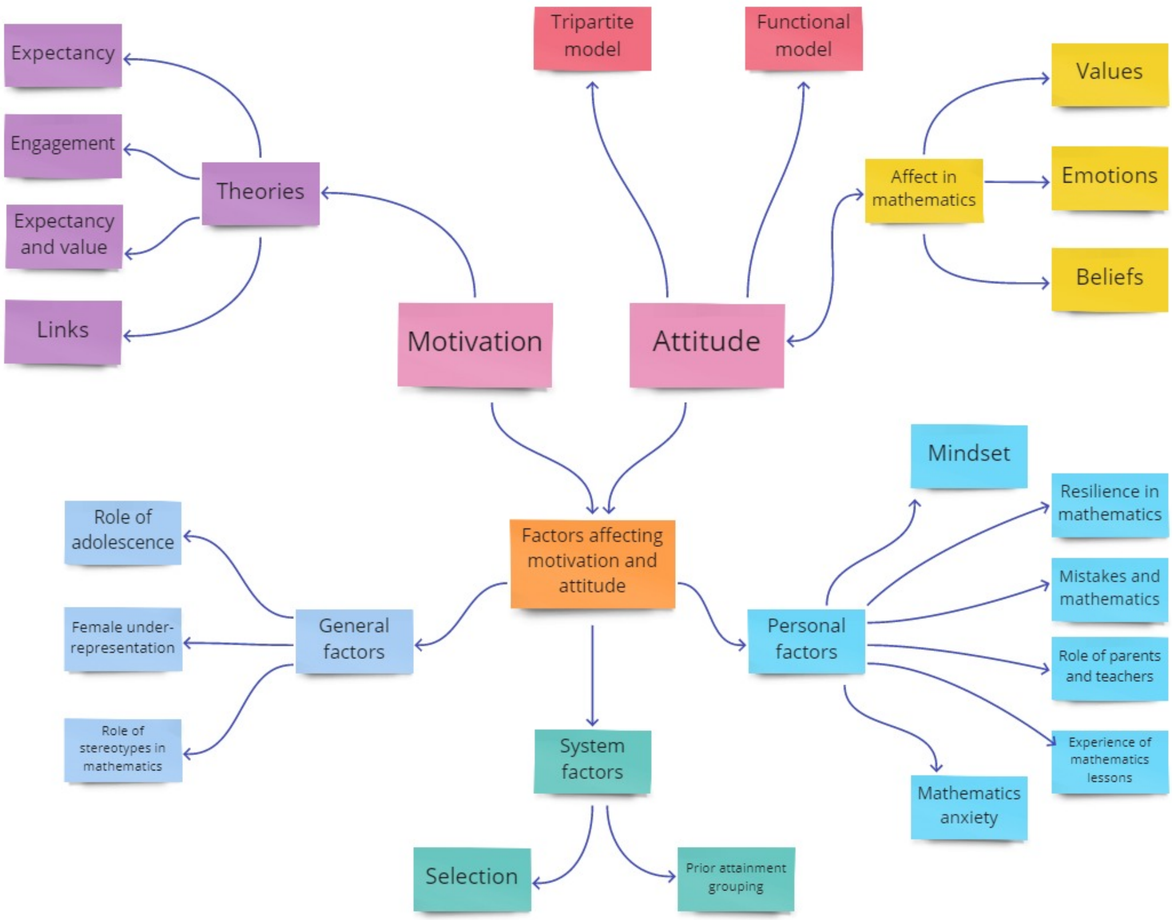


Figure 19 Concept map informed by the literature review

The next section of this chapter looks at the key ideas from the literature review and explains how they relate to the findings from the study school. The following factors are discussed in the light of findings from the research:

- Personal factors
- System factors
- General factors

which contain a collection of factors with different dimensions as detailed in Table 31, as well as the relevant section numbers from the *Literature Review* and *Discussion* chapters:

Factor	**Section**	**Literature Review**	**Discussion**
Personal	Mindset	2.5.1.1	6.1.1
	Resilience in Mathematics	2.5.1.2	6.1.2
	The Role of Parents and Teachers	2.5.1.4	6.1.3
	Students' Experience of Mathematics Lessons	2.5.1.5	6.1.4
	Mathematics Anxiety	2.5.1.6	6.1.5
System	Prior attainment Grouping	2.5.2.1	6.2.2
	Primary Schools		6.2.3
General	The Role of Adolescence	2.5.3.3	6.3.1
	Female Underrepresentation	2.5.3.2	6.3.2
	The Role of Stereotypes in Mathematics	2.5.3.1	6.3.3

Table 31 Personal, general and system factors with links to relevant chapters

This chapter concludes with three summary models which are pupil and teacher centred as well as a narrative from the point of view of a fictitious learner, pupil P.

6.1 Personal factors

6.1.1 Mindset

The difference between the idea that you are born with the ability to do mathematics and that it is a fixed attribute and the idea that working hard would affect achievement (Dweck, 2006) was clearly seen throughout the data in the study school. Younger pupils in the study school felt that behaviours such as working hard, asking for help and not giving up would all help them to be successful at mathematics as seen in questionnaire responses to the question

What does it take to be successful at maths?

The following quotes from the year 7 focus groups provide more evidence of this growth mindset

> *if you weren't good at mathematics obviously just try again until you think you've done the best*

and

> *just because you don't get the score that you wanted to doesn't mean that you have to give up, you can still keep trying*.

These were classified as behaviours (which could be changed) and pointed towards a growth mindset but as the pupils got older they felt that personal attributes (which were classified as cannot be changed) such as being naturally good at mathematics helped people to be successful at mathematics, and by year 10 a third of the girls and nearly half of the boys suggested that you needed to be clever at mathematics to be successful at it in their questionnaires.

Further evidence of feelings of being naturally good at mathematics in older pupils can be seen when the pupils were asked to describe a mathematician in the focus groups, and the notion of being 'good at maths' doubled from year 6 to year 9.

This data suggests a change in mindset as pupils get older which may be due to mindset not having an impact until pupils face setbacks (Dweck, 2008), as pupils face increasing challenges in mathematics as they move up through secondary school, especially the year 9 and 10 students as they start their GCSE course.

The danger of overemphasising natural intellect and talent is that pupils are left vulnerable when they are faced with failure (Dweck, 2007) and may become helpless, decreasing their effort and concentration (Diener & Dweck, 1978; Dweck, 1975; Dweck & Bush, 1976; Dweck & Reppucci, 1973) in a bid to attribute their failures to factors beyond their control (Licht & Dweck, 1984). However, staff member V who taught the higher attaining set experienced the opposite of this, describing a male pupil who just believed that he would do well so did not need to put in any extra effort, even when he was faced with failure. This teacher explained how the pupil really changed their effort and behaviour (and attainment) after an intervention by her – the external influence of a phone call home.

This member of staff described seeing the impact of another external influence having an impact on a pupil's behaviour and effort. A pupil who was very confident only retained his place in the prior attainment set by one mark (this is discussed further in *A lack of agency and autonomy*, section *6.5.2*), which was found whilst going through the paper in the lesson. This realisation that he may not have achieved enough to stay in the 'top set' made him realise that he needed to change his behaviour and from then on, he gave in all his homework papers which were grade A or better.

This is a good example of a "mastery-orientated" pupil who responds to a challenge by increasing their effort and concentration so that they improve their performance and may even perform better than they have before (Diener & Dweck, 1978; Dweck, 1975; Dweck & Bush, 1976; Dweck & Reppucci, 1973).

This feedback suggests that the pupil was likely to move down a set due to his exam result alone, as opposed to any consideration of his past performance. This is an area for further research as I did not ask the department how they enacted set changes – whether it was examination results alone, prior attainment, teacher discussions etc., or how tactfully the pupils were told of their set change, but this would be worth exploring if anyone was doing a similar study in their school.

Throughout the teacher data there was no mention of how the pupils may feel when they move sets, however a year 7 boy felt annoyed when he moved down a set because he thought that he was good at mathematics. This comment implies that the pupil had an opinion about his ability in mathematics and, when that was challenged, he does not give any signal that he believes that he has the ability to go back up to the set. Some pupils believe that there are fixed boundaries for individuals when it comes to learning mathematics and to try to go beyond them can be very difficult and frustrating. These boundaries can be caused by exams and the curriculum etc (Brown, et al., 2008). As a teacher in the study school, I was pleased that he originally had belief in himself but saddened that he was not resilient when faced with a set change. Rather than striving to move back up to his previous set, he seems to have accepted his new position.

Some research suggests that although growth mindsets can be developed in schools if teachers encourage and develop it (Robinson, 2017), many school practices in England are founded on the idea of a fixed ability which can limit the attainment of the pupils (Boaler, 2013). One teacher, who specialised in teaching sets of lower prior attainment, felt that the geography of the school (having a sixth form at the school, as well as the local grammar school sixth forms next door) added pressure to the pupils and felt that some pupils feel as if their life is decided by the time they are twelve, despite what teachers may say to them, they are getting a message from other influences that they may not make it to university.

This teacher's comments suggest they have a fixed mindset themselves as they appear to be predicting the future for some pupils. Previous research found that teachers who believe that mathematics ability is fixed are more likely to quickly judge a pupil as having a lower ability and more likely to use statements such as “not everyone is good at maths” which devalues effort (Rattan, et al., 2012) and reduces the chance that these pupils will put in any additional effort (Dweck, et al., 2004).

In summary the pupils felt -

- that their ability in mathematics is related to how much effort they put in, behaviours which they can change, in younger years
- some people are naturally good at mathematics and that you must be good at mathematics to succeed, in older years
- annoyed if they move down a set and lack a belief that they can move up a set (there was no mention from the department of how set changes may affect pupils).

Staff within the department felt that -

- factors such as proximity of selective schools (selection is discussed in more detail in section *2.5.2.2*) and the feeling of having failed from a young age may affect pupil mindsets
- some pupils believe that they did not need to work at mathematics because they believed that they would do well, despite seeing evidence in their mock and homework exam papers to the contrary
- external effects of parents (triggered by a teacher’s phone call home) or the fear of moving down a set can trigger these “mastery orientated” pupils to increase their effort.

6.1.2 Resilience in mathematics

Research has shown that pupils demonstrate mathematical resilience by approaching mathematics positively so that they can overcome challenges whilst learning mathematics (Johnston-Wilder & Lee, 2010). It follows on from mindset because if pupils believe that their intelligence is fixed then they may view academic challenges as a sign that they are ‘dumb’ which compromises the resilience of even high achieving pupils (Blackwell, et al., 2007). Pupils’ attitudes towards a subject and how they perform in it has been shown to greatly influence whether they choose to study it (Johnston, 1994) and evidence of this was seen in the study school when the pupils were asked

Would you continue with maths after GCSE?

In all year groups the pupils who felt that they would continue with mathematics after GCSE had a more positive attitude (see '*Creating an attitude scale' 3.4.4.10*), which became less positive as their likelihood of choosing mathematics decreased. Similar results were seen when the pupils responded to

If maths was an option now, I would probably choose it

I asked this question as well as the post GCSE question because I thought GCSEs might seem a long way off for the year 6 and 7 pupils and make answering the question very difficult. As before for all year groups, the pupils who felt that they would choose mathematics now had the most positive attitude overall and this decreased as their likelihood of choosing mathematics decreased. The experiences of pupils in the study school will be discussed further in '*Student experience of mathematics lessons' 6.1.4*, but a study into why pupils choose to not continue studying mathematics found that many perceived it to be 'hard', 'boring' and 'useless' (Osborne , et al., 1997).

Bartholomew et al. (2011) found that many pupils in a secondary mathematics classroom attribute their rejection of mathematics to the type of person that they believe they are. The data from the study school as presented in chapter 4 seems to point to pupils with a positive attitude being more likely to continue with mathematics, which may be because if pupils approach mathematics with a positive attitude and growth mindset they may be more likely to show resilience in the face of challenges, increasing their effort and improving their attainment. This might increase their self-efficacy and if they feel that they are succeeding in a subject they may be more likely to choose it.

A finding which was a surprise to me as teacher researcher came from a year 10 pupil who felt that

> *I'm terrible at maths but I do like it but I'll never be very good at mathematics because it's just never going to be a subject that I'm strong at but it's actually quite fun to do and like having to struggle.*

The data shows this pupil had a low self-efficacy. She had received extra help in mathematics at primary school and was often negative about her capability in the subject as she lacked confidence. Despite this, she achieved a grade C in her early entry GCSE exam. This suggests that low self-efficacy can be persistent, even when there is evidence to the contrary and implies that there is a view that being good at mathematics means finding it easy. The comment possibly illustrates the complexity of the relationships between challenge, achievement, intrinsic motivation, and attitude. Self-determination theory can partly explain this pupil's comment as she is showing autonomy in choosing to work hard, competence at a level that she does not herself recognise and relatedness as she seems to think that the teaching she experiences is allowing her to have a positive attitude to the subject (Ryan & Deci, 2017).

In summary the data suggested that -

- pupils with a positive attitude towards mathematics would choose to continue with it
- low self-efficacy appears to be persistent which could be an area of exploration for anyone doing similar work in their school.

6.1.3 The role of parents and teachers

Cockcroft (1982) suggested ways in which parents can influence the attitudes of their children towards mathematics. One way is that the expectations of parents can result in motivational beliefs and behaviours which are nonadaptive (Cockcroft, 1982). This was seen in the study school as data from the questionnaire showed that there was a statistically significant relationship between the pupils' attitudes towards mathematics and pleasing their parents, although this was not as prominent in year 10.

Teachers have a large part to play in how pupils feel towards mathematics. They need to communicate the joy of mathematics and have a huge impact in positively or negatively shaping a pupil's experience of mathematics (Takeuchi, et al., 2016; Towers, et al., 2017), however in the study school pleasing their teacher had no statistically significant relationship with attitude. In fact, as the pupils got older, trying to please their teacher had less impact on their motivation. This may be due to the older pupils realising the personal benefit that a mathematics GCSE may offer them as an entry to sixth form, college or perhaps a job which could be an area for further research. This could be evidence of extrinsic motivation beginning to be more part of the pupils' view of self and is an example of identified regulation as the pupils are experiencing a willingness to carry out the subject because they can consciously identify with the value of it (Ryan & Deci, 2020).

The level of support that parents and teachers offer a pupil in mathematics may alter whether the pupil values the subject and can encourage greater mathematical ability (Hurst & Cordes, 2017). If the pupils experience a teacher with high support (caring, fair and friendly) then their interest, value and perceived usefulness of mathematics can increase from year 6 to year 7, however the converse is also true and this can affect lower achieving pupils more (Midgley, et al., 1989). Many studies have shown how a need-supportive classroom environment drives more autonomous motivation in pupils (Ryan & Deci, 2020).

In the study school during this academic year, the mathematics department was understaffed and so had decided to rotate some classes on a fortnightly basis so that they did not have a supply teacher for too long. Table 7, in section *4.5* details the changes that the pupils experienced throughout the year. Although I did not know that the department was short staffed when I started this research, the issues caused by this shortage frequently came up in the data by those pupils who were affected.

Despite the quantitative data showing that overall, the number of teachers that the pupils had been exposed to in one year did not have a statistically significant impact on their post attitude values, when I analysed the data by year groups there was a statistically significant difference for year 10. This finding is reiterated in the focus groups where an overwhelming number of year 10 pupils who had been affected by the rotation of classes, discussed the effect this had on them. Although this was done by the department to manage a difficult situation, the pupils did not like the instability of not having a regular teacher.

Further evidence of the effects of this rotation on the pupils was detailed in the staff interviews when they described pupils who became unfocused and negative, making comments such as “I can’t do it” and “I’m going to fail”, however once those pupils came back to their regular, stable group the teachers endeavoured to increase their confidence and motivate them by getting them to “repeat after me, you can do it”. This member of staff appears to be trying to encourage a growth mindset, after the rotation caused the pupils to believe that they were not going to achieve (Dweck, 2008).

Although rotating teachers had an impact on the pupils, it also had an impact on the staff. Those involved in the rotation had less planning to do because they delivered a two-week topic three times, some were more motivated to build relationships with the pupils because they saw the class more often (they had two classes once but switched to one class twice a week) and they confessed to putting more effort in to planning the lessons. This appears to suggest that it may have had an impact on the quality of the teaching the pupils were exposed to but as I did not probe what they meant by ‘planning differently’ I cannot comment on how it varied from their usual planning and teaching, which is a limitation of the study.

The lack of a stable teacher also resulted in more issues and complaints from parents, as well as the parents not knowing who to contact about their child's mathematics education. These difficulties extended to whose responsibility it was at parents evening and report writing and the member of staff who did the parents evening could only comment about a pupil for a certain number of weeks.

Many of the department were able to see the impact that the situation had on the pupils describing it as demotivating for them but often balanced that with an improved situation for those classes who would otherwise have faced a supply teacher for the year. They noted the issues of going into a classroom and seeing a supply teacher with multiple worksheets instead of their usual well-prepared teacher, making the pupils see the work as less valuable. It seems to me that, despite the department feeling that they were doing their best, the school was unable to meet the needs of the pupils which may mean that they become progressively more dissatisfied with the education system (Zimmer-Gembeck, et al., 2006) and less motivated to learn as the 'stage-environment' did not fit (Eccles , 2004). Therefore, these pupils have been unintentionally affected negatively. The staff did not appear to question whether there was a better way of dealing with the staffing situation but seemed to accept that this was the best option for the pupils. They blamed a structural issue which was beyond their control and this lack of autonomy will be discussed further in '*A lack of agency and autonomy*', section *6.5.2.*

Some members of staff recognised the lack of consistency for the pupils in terms of classroom routines and the marking of books and feedback and felt that this would have a detrimental impact on the pupils' motivation, as the pupils may feel that nobody cared enough to mark their work. The social impact of the rotation was also identified by the department as the pupils had settled in with a new class at the start of the year (the year group were now streamed across the whole year whereas previously they had been in sets across half year groups, please see '*Checking the attitude scale' 5.1*) and then had to be re-set for the staff rotation, which is a concern as the social environment of a classroom has a significant impact on the motivational behaviour of the pupils with the most important factor being the level of friendship that the pupils have for each other (Anderson, et al., 2004). Another member of the department had heard the pupils discuss how they had to adjust to the different teaching methods and routines of the variety of teachers, which the teacher felt would have had a serious impact on the lower attaining sets in year 7.

Despite the intentions of the department, the head of department noted that there is always more that could be done but again justified the decisions taken by blaming the constraints on the system such as meeting the needs of other exam classes.

A further direction of exploration for anyone doing a similar study is that it would be interesting to track these pupils and monitor their feelings towards mathematics and whether this disruption has a long-term impact. From my teaching experience, many year 7 pupils start school with enthusiastic feelings towards mathematics, but I wonder if staffing issues at this young age result in older pupils who are disillusioned with mathematics, lack effort and motivation and ultimately do not achieve their potential. Evidence of this seen in the data was a member of staff who commented on how some of their year 10 pupils felt that they were affected by a trainee teacher they had had in the previous year. The teacher felt that the pupils were more motivated with them because they appreciated the teacher's experience, behaviour management, consistency, routine, and teaching that inspired them. Another staff member commented that the tempo and drive in some of the year 10 lessons had declined as a result of going from one long term cover to another and by "the time the exam times are coming up and it's too late". When a pupil and school are judged on examination results (by examination boards, senior management, OFSTED, future employers etc), disruptions such as staffing are not taken into account but clearly have a large, long-term impact on the pupils.

A final note on the layout of this section, although the impact of the staffing issues appears to be a *System factor*, I decided to discuss it as a *Personal factor* because it was the students mentioning it in various ways in their questionnaires and focus groups which made me realise the impact that it had had on them. I have therefore interpreted the system issue of staffing, in terms of the personal affect which the role of teachers has on their pupils.

In summary the data appears to show -

- a statistically significant relationship between the pupils' attitude towards mathematics and pleasing their parents
- no statistically significant relationship between the pupils' attitude towards mathematics and pleasing their teacher

- a statistically significant relationship between the number of teachers a pupil had experienced in one year and their attitude towards mathematics.

The rotation of mathematics groups in year 10 left staff –

- feeling that they had less planning to do as they delivered a topic more than once
- dealing with more issues and complaints from parents
- witnessing their pupils becoming demotivated
- seeing the inconsistency in routines, marking and feedback experienced by the pupils
- recognising the social impact on the pupils of mixing classes up
- easing their personal responsibility on the impact this situation had on pupils by blaming constraints on the system
- appearing to lack autonomy, agency and accepting a system which does not serve the pupils well, as inevitable (this will be discussed further in section '*A lack of agency and autonomy 6.5.2'*).

6.1.4 Student experience of mathematics lessons

There is a clear overlap between the content of the '*Student Experience*' section and '*The Role of Parents and Teachers'* where I have discussed the experience of the pupils due to the rotation of staff. However, I have organised the chapter in this way as the pupil experiences due to the teacher rotation was a unique situation because of staffing issues in that academic year. The following section will cover more general experiences of mathematics lessons, not related to the specific staffing issues of that year. I have broken this section down into four headings; *'Achievement breeds success', 'Disruptive behaviour', 'Relevance of mathematics'* and *'Suggestions for improvement to mathematics lessons'.*

6.1.4.1 Achievement breeds success

Data from the pupils in the study school showed that they felt that the more successful a pupil is in mathematics, the more confident they will feel. This was seen in undergraduate mathematics students who felt that how successful they were, was one of the main factors which influenced their attitude, with those feeling that they were not succeeding having little motivation (Brown, et al., 2005). Evidence of this was seen in the study school with one pupil explaining it clearly as "the better you do in maths the more confident you become". Further evidence was seen in the focus groups where around half of the groups felt that they enjoyed mathematics more when they achieved and therefore were more motivated. Conversely, the pupils recognised that if a pupil struggled at mathematics, they would not enjoy it as much. These ideas were emulated in the responses from staff who commented that they can see the motivation of a pupil drop when they get a poor mock exam result. This reaction to a poor mock result is linked to pupil mindsets, which was discussed in the section on *'Mindset' 6.1.1.* The disillusionment the pupils feel when they get a poor mock result or struggle in mathematics may be due to how obvious failure in mathematics is compared to other subjects (Brown, et al., 2005), which can result in feelings of stress, which was mentioned by between a third and half of all year groups. Pupils described feeling frustrated and pushing their papers away, so they do not have to see a poor grade. Data from the questionnaires showed that there was a statistically significant relationship between their attitude value and whether the pupils felt that mathematics was too easy for them. Pupils could deem that the work is too easy for them because they are succeeding, therefore showing that pupils who succeed in mathematics have a more positive attitude towards it, or perhaps the pupils naively think that the work is too easy for them, although this would still mean that these pupils have a high self-efficacy and shows that pupils who have a positive self-efficacy have a positive attitude towards mathematics. The lack of data in this area is a limitation of the study but is an area for further research.

Research has shown that if pupils use the word 'bored', it indicates that they struggled to learn the mathematics (Andersson, et al., 2015) and this was seen in the study school when a year 7 student described pupils who say mathematics is boring as not bothering to try but if pupils do try then they will find the subject more fun. A year 6 pupil summed up the idea of achievement breeding success when discussing how coming top in a mathematics test would

> *make me want to do more of it. You came top of the test and you want to get compliments, or you want to do more of it because you just worked out, you now know 'I can do this', I want to do more, I want to have more, do it more.*

6.1.4.2 Disruptive behaviour

The data as presented in chapter 4 suggests that pupils in both year 6 and 7 felt that their lessons would improve if there was better behaviour in their lessons. A further direction of exploration for anyone doing similar research in their school would be to explore if some of the behaviour issues are caused by setting because as a teacher I have regularly seen the difficulties in managing behaviour in sets, as often pupils who exhibit poor behaviour are moved out of higher prior attainment sets and seem to fall through other sets, before ending up in the lowest attaining set, which frequently has issues with behaviour already. If a year 7 pupil is in a set which has poor behaviour, then this will have an impact on their mathematics lessons. Setting is discussed in more detail in the section on *'Prior attainment grouping' 6.2.2.*

The issue of disruptive behaviour was echoed by a member of the department who commented on the impact that one de-motivated pupil can have on the class, describing them as "actively encouraging others not to work" even though they were "bright enough that he should be in that group". It is possible that pupils who disrupt the learning to this extent are moved out of the set to allow the others to learn as disruptive behaviour makes it very difficult for the teacher to create an atmosphere conducive to learning and to build relationships with the other pupils, but again this would be an area for further research.

Despite this, pupils were praised by another member of staff for remaining focused even when they were in a disruptive environment, however they note that it is often the ones who are most disruptive who get the attention whilst the ones who quietly get on are ignored. From my experience as a teacher, this is a common guilt that teachers face as they do not have enough time in the lesson to see each pupil so end up giving more attention to the louder, disruptive pupils to maintain a calm environment in the lesson. Those pupils who keep their head down and look like they are working can easily get ignored and may never ask for the help which they might need. The impact of this apparent inequality in attention could be another area for further research.

6.1.4.3 Relevance of mathematics

In the study school pupils in years 9 and 10 felt that mathematics could be improved by becoming more relevant as evidenced by the responses to the questionnaire and in the focus groups. The data suggests a change in the pupils' perception of the relevance of mathematics as they move through secondary school, which may mirror the increase in complexity as the pupils approach their GCSE. An example of this can be seen in this year 9 focus group

> *we'll be doing more things to do with real life because like you learn things like Pythagoras' Theorem, I guess it's important if you've got a certain job and stuff but like it's really hard and it's kind of aggravating that you might not have to, don't need to learn it at all even though you spend so long like figuring it out and stuff.*

It may be possible that the mathematics that pupils learn at primary school relates well to real life, and often the exercises the pupils complete have a real-life context, whereas at secondary school the pupils' experience of mathematics is often as a string of numerical questions which lack real life context. In response to opinions such as these, Andersson et al. (2015) suggest that tasks should be contextualised to increase engagement in lessons as well as allowing time for students to discuss their work, collaborate and manage their use of time (Andersson, et al., 2015).

Other possible reasons for this lack of relevance may be due to the nature of the curriculum and how the pupils are examined (although since this research was conducted, mathematics exams have become more problem based with questions embedded in real life situations), or the content itself, for example there are some topics which appear to have lost their use in real life, especially when we rely on electronic equipment so much, but still appear in the curriculum. The pupils may also be growing more mature and questioning their education because they are adolescents (Coleman, 2011). This will be covered in the section on *'The role of adolescence' 6.3.1*. The reasons behind the change in relevancy of mathematics could be an area for further exploration.

Despite the comments in the focus groups, when the pupils were asked if they knew more about how mathematics was used in the real world in year 7 and 10, more year 10 pupils felt that they did know more about how mathematics is used in the real world. This may be due to the teachers adding context to the learning or the use of exam papers helping the pupils to see the relevance, but in spite of this, the pupils craved more relevance and justification for why they were learning the topics that they had to cover.

This feeling was echoed by staff as evidenced by a teacher who recognised that pupils wanted to have more relevance in their lessons and suggested that they needed to look at different careers and areas in life that use mathematics in lessons so that they could answer the common question of "why are we doing this?" with something other than "because it's in your exam" which does not support pupils' autonomy by allowing them to take ownership of their work and offering them meaningful choices to engage their interests (Ryan & Deci, 2020). However, the department justified their lack of inclusion of real-life context by describing the constraints on time in lessons, with teachers reporting that they present topics as they are in the exam as opposed to explaining the relevance of each topic.

Teacher autonomy will be discussed further in section *'A lack of agency and autonomy 6.5.2'*.

This lack of relevance is one of many reasons why pupils in the study school choose not to continue with mathematics beyond GCSE. Despite efforts by the government and mathematicians to communicate the importance of mathematics, this idea is not being heard or believed by pupils (Brown, et al., 2008)[3] with many sixth-formers believing that A-level mathematics would not be as useful as other sciences for their careers and that it was too narrow, traditional and not interesting enough to choose, despite studies finding that people who take A-level mathematics earn around ten percent more than those who do not (Wolf, 2002). However, this potential increase in earning capacity is not common knowledge in the study school as when the pupils were asked if people with mathematics qualifications earn more the responses from all year groups showed a spread across the Question scale, despite pupils in all years recognising that mathematics was an important life skill that would help them get a job.

6.1.4.4 Suggestions for improvements to mathematics lessons

Previous research has shown that pupils view themselves as someone who can do mathematics if the classroom climate is caring and supportive and if they are presented with activities which are enjoyable and challenging. These activities should allow the pupils to gain a deeper understanding of the mathematics whilst giving opportunities for them to collaborate and ensuring that each pupil feels equally valued (Kyriacou & Goulding, 2005). However as can be seen in the previous section, this is not always the experience of pupils in the study school.

Despite mathematics in the study school consistently being described as fun, generally pupils felt that they wanted even more fun, with the most common suggestions for improvement being activities such as group work, the use of ICT, practical lessons, competitions, and puzzles. These ideas were mirrored by the staff who were aware of the possible improvements that could be made to mathematics lessons and came up with similar suggestions such as practical lessons, better facilities, and the use of ICT. However constraints such as large class sizes, lack of time to cover the curriculum and show the relevance of each topic, lack of time for planning, as well as difficulties on an organisational

[3] This observation is a little out of date with the recent introduction of Core mathematics at A-level standard (OCR, 2022).

level e.g. timetabling and unrealistic targets for the pupils (the pupils were set targets for their GCSEs based on KS2 results and some of these grades appeared very high and unrealistic, which had an impact on the pupils who felt that they were unattainable, as well as the teacher) prevent this.

It appears that the pupils are really asking for variety as opposed to lesson after lesson of worksheets and textbooks. Although I would expect that more variety may become 'normal' to the pupils and they would crave something further, research seems to indicate that this is not the case with younger children's engagement levels, as when they are able to access 'experiential learning' over longer periods of time it does not appear to become routine for them (Laevers, 2013).

Organisational improvements suggested by the department were timetabling mathematics so that pupils did not have it twice a day because the pupils switch off after the first lesson but also to have mathematics in the morning, not after PE but before break so that if a pupil is still struggling at the end of a lesson they can stay back and receive help, instead of having to go to their next lesson. This would provide an opportunity to reinforce the learning that was covered in the lesson and to build on teacher pupil relationships.

Further improvements suggested by the department were to give pupils more control over their learning (this links to environment-fit in *'The role of adolescence' 2.5.3.3*) so that they are responsible for seeking help if they do not understand a topic, which is a very limited form of autonomy (Ryan & Deci, 2019). These suggestions mirror the literature as reasons that pupils find mathematics boring were a lack of stimulation, challenge or an opportunity to be creative, and when pupils were able to make decisions for themselves and saw tasks in a contextual situation they did not ask "why are we doing this?" (Andersson, et al., 2015).

However, time constraints were stated as an obstacle by teachers in the study school who felt they had to move on from a topic before all the class understood it. Ryan and Deci (2020) acknowledge that given the constraints on time and resources in schools, autonomy-supportive teaching is not always easy and as teachers have the same basic psychological needs for autonomy, competence and relatedness, they must experience need support themselves to enable them to support their pupils (Ryan & Deci, 2020). In the study school, rather than questioning why some pupils were left behind, teachers seemed to accept the situation was inevitable. Although the teachers intended to revisit everything in revision, this lack of understanding may demotivate pupils and is in conflict with achievement breeding success. Teacher autonomy is discussed further in *'A lack of agency and autonomy 6.5.2'*.

More collaboration across year groups was suggested by the department to improve pupil motivation, giving them opportunities to discuss mathematics and to be more in control of their learning. This would help them manage their learning if they were faced with coursework or project work in the future. Providing pupils with activities which are both enjoyable and challenging means the pupils can gain a deeper understanding of the mathematics, whilst providing opportunities for pupils to collaborate (Kyriacou & Goulding, 2005). Providing the pupils with opportunities to gain a deeper understanding helps to meet their need for competence whilst allowing them to manage their learning allows for autonomy (Ryan & Deci, 2017).

Working in groups was suggested as an improvement by all years. Research has shown that pupils usually prefer group work if they are struggling because they can discuss things with their peers, whereas students who feel that they achieve in mathematics often do not enjoy having to help others in a group environment (Towers, et al., 2018).

Previous research has shown that mathematicians enjoy the experience of working something out and some feel that this excitement is missing from schools today (Gallagher, 2014), as many pupils feel that they are taught to the test (Reay & Wiliam, 1999). Evidence of this was seen in the study school as nearly a third of pupils felt that they enjoyed mathematics when it was challenging them, but girls in both year 9 and 10 felt that mathematics would improve if it was easier and boys in both years would prefer fewer tests.

With increased testing comes a pressure on staff to meet targets and improve performance, irrespective of the impact that this may have on the pupils (Reay & Wiliam, 1999) and evidence of this can be seen in the discussions with one staff member (who specialises in sets of lower prior attainment) describing the work in year 7 as being so fast paced that even if a pupil did not understand a topic, they are not left behind because the class moves on so quickly. This member of staff seemed to accept this situation as inevitable and did not question their role in facilitating this or what they could do to improve the experience for pupils. This will be discussed further in *'A lack of agency and autonomy 6.5.2'*.

If this pressure on staff to meet targets is present in lessons, it was reassuring to see that the modal response for all years was that the teacher thinks that ‘enjoying maths’ was the most important part of the lesson, with the second most popular result in year 10 being ‘thinking deeply about maths’. It is an encouraging sign of the professionalism of the department that the pupils feel that their teachers care more about them enjoying their lessons than other options in the questionnaire such as doing lots of work, learning lots of rules and keeping up with the rest of the class, especially as enjoyment is an expression of intrinsic motivation (Ryan & Deci, 2000).

A member of staff recognised that the department may take it for granted that pupils want to do well in mathematics because they view it as important. The staff reported that, because of the constraints they experienced, it was often easy to fall back on a worksheet or textbook with a repetitive activity, which the students would then feel was ‘not fun’. This position again appeared to be accepted as inevitable as opposed to being questioned and challenged. This is discussed further in *‘A lack of agency and autonomy 6.5.2’*.

Some of the department felt that the future exams were a motivating factor for the year 10 pupils as they had increased their focus as the exams were approaching, giving evidence that the pupils would get low grades when they started to complete past papers but these increased over time.

In summary, the pupils felt –

- that their lessons would improve in years 6 and 7 if the behaviour of the class was better
- that mathematics appeared to lose its relevance with older pupils
- unaware of the increased earning capacity for those with mathematics A-level
- they knew more about what career they wanted in years 9 and 10 and so would choose to study mathematics if it was necessary
- increased feelings that mathematics was a useful life skill (boys), whereas this decreased for girls as they went through secondary school
- that they would enjoy mathematics more if there were fewer tests
- that their teachers valued them ‘enjoying maths’ above everything else
- stressed, frustrated, disillusioned and anxious by poor test results
- more positive towards mathematics if they felt that the work was too easy for them

- that pupils who describe mathematics as boring often cannot be bothered to try hard in the subject
- that coming top in a mathematics test would make them want to do more mathematics.

Both pupils and staff felt –

- success breeds success so if a pupil feels that they are achieving in mathematics they are more likely to enjoy it and continue with it when offered the choice
- that lessons should be more fun and varied.

The staff felt –

- that GCSE exams, homework past papers and mock exams helped to motivate the pupils
- that a poor result could disillusion a pupil and make them switch off
- that one de-motivated pupil can impact the whole class
- that they needed to make mathematics more relevant and contextualised but felt that they did not have sufficient time to achieve this
- that constraints beyond their control such as large class sizes, lack of equipment, planning time etc meant that they could not always deliver more fun and varied lessons.

6.1.5 Mathematics anxiety

Feelings of anxiety towards mathematics is different from general anxiety and although are not linked to lower levels of intelligence, have strong links to lower grades in mathematics (Batchelor, et al., 2017). Definitions of mathematics anxiety include feeling helpless, dread and mental disorganisation when faced with a mathematical problem (Zakaria & Nordin, 2008) and appear to have many causes such as teacher attitude, lack of understanding due to rote learning, low self-image and poor coping skills (Norwood, 1994). Increased mathematics anxiety could result in lower achievement and reduced motivation (Zakaria & Nordin, 2008).

In the study school the pupils felt statistically significantly less anxious about mathematics in year 7 than in year 6 and in year 10 than in year 9. Although in previous studies mathematics anxiety has been seen to increase with age (Carey, et al., 2019), other studies have shown that mathematics anxiety is present in older primary aged pupils (Young, et al., 2012). The data from the study school seems to suggest that pupils are becoming less anxious towards mathematics as they get older, but this may be due to how I am using the data. I have compared the pupils' responses to the question on anxiety in consecutive years (i.e., compared the same pupils in years 6-7 and years 9-10) as opposed to asking the pupils to compare how anxious they feel this year compared to last or creating a way of comparing how anxious one pupil was against another. This may be an area for further research in the future.

Further triggers for mathematics anxiety are the transition from primary to secondary school and how the pupils are grouped, especially if they are compared to their peers. Pupils with mathematics anxiety are more sensitive to negative experiences such as poor test performance or being teased by their peers and these negative feelings can become so overwhelming that they dread mathematics lessons and can exhibit poor behaviour in class (Carey, et al., 2019). All of these factors were seen in the study school with pupils describing feelings of anxiety if they "did not know something" or "when the teacher asks me a question or if there's a really hard sum on the paper". Under the previous heading in this section *'Student experience of mathematics lessons' 6.1.4*, mathematics anxiety showed itself in the pupil who felt that they had to push their paper away so that they did not have to view their poor result and in *'The role of parents and teachers' 6.1.3*, it was clear the huge impact that parents and teachers both play in mathematics anxiety. Mathematics anxiety can be created by pupils feeling confused with poor teacher explanations or interactions or if they experience a variety of teaching methods (Carey, et al., 2019), which during this particular academic year many of the pupils did, due to the staff shortages. This is covered in greater detail in the section on *'The role of parents and teachers' 6.1.3*.

I found it particularly difficult to read how stressful some of the students found mathematics lessons. Around one fifth of the focus groups discussed feelings of stress and the topic dominated these discussions. Causes of stress were being picked on by the teacher to answer a question, not knowing an answer, feeling embarrassed, being made fun of and the seating arrangements in the classroom. Pupils commented on how they can spend too long on a question if they cannot work it out and then they lose time. As a teacher it is hard to read that students 'panic', are 'nervous' and are 'stressed' by mathematics lessons, as illustrated by the following quote from a pupil

> *I feel kind of like nervous every single day, like whenever it's maths; I think it's just me but like that's my weak spot, maths is really hard for me sometimes….*

It seems to me that this will certainly hinder their enjoyment and progress in the subject. These feelings of stress were discussed in primary school too as a year 6 student sadly noted that "I never get anything high because I'm really bad at maths" and from a year 9 pupil

> *I remember at primary school doing lots of mental maths things and everyone used to be like 20 out of 20 and there would be just me with like 6 and oh I remember just always crying because I used to hate it so much and it's just like when you get like a low grade it like feels so like the end of the world and you can't stop thinking about it all day.*

As a teacher it is quite upsetting to hear how disappointed the students feel when they do not do well and the impact that this has on them for that day and future mathematics lessons.

The data from the study school show that pupils feel more anxious in mathematics as the set number increases i.e., pupils in set one are less anxious about mathematics than pupils in set two etc. This is only based on the mean scores of the pupils' responses, so may be an area for further investigation.

In summary the pupils felt –

- less anxious towards mathematics in year 7 than in year 6 and in year 10 than year 9
- anxious towards mathematics in all years
- mathematics anxiety even in primary school
- factors such as previous experiences, low self-efficacy, variety of teaching styles, tests, student experiences in lessons, peer reactions and parental influence affect mathematics anxiety
- more anxious in lower prior attainment sets than higher prior attainment sets in years 9 and 10.

6.1.6 Summary of personal factors

Figure 20 shows the conceptual connections underpinning this study, which I have used to structure this section of the discussion chapter:

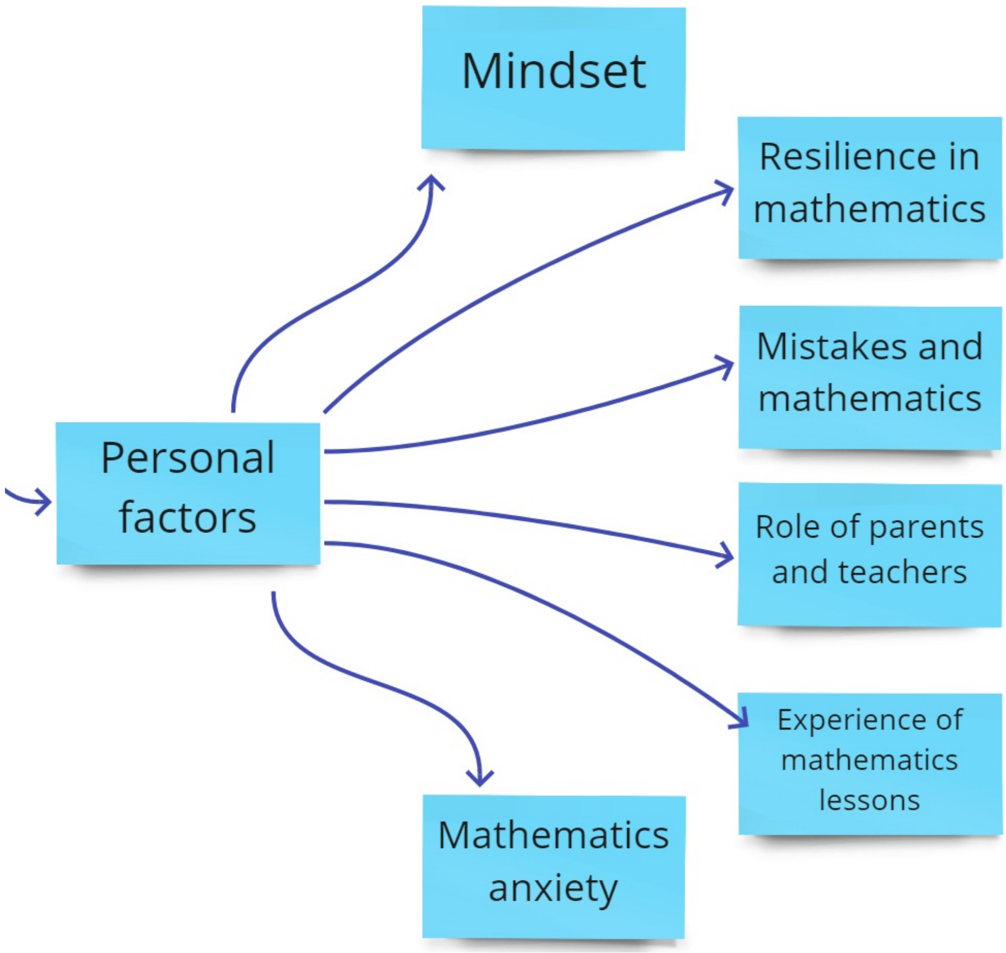


Figure 20 Section of the concept map informed by the literature review

However, in the study school Figure 21 is a more appropriate model for the personal factors which affect motivation and attitudes towards mathematics. This shows that *'Mistakes and mathematics'* was not a factor which showed through in my data; however, this may be due to the questions which I asked, which will be discussed further in the section on *'Limitations of the study' 7.5*. The red arrows on the model show new links between factors which was evidenced in the data. The arrowhead shows which way one factor influences another and double headed arrows show that the two factors affect each other. So that the detail of the model can be seen I have only included the parts that are relevant to this section of the chapter.

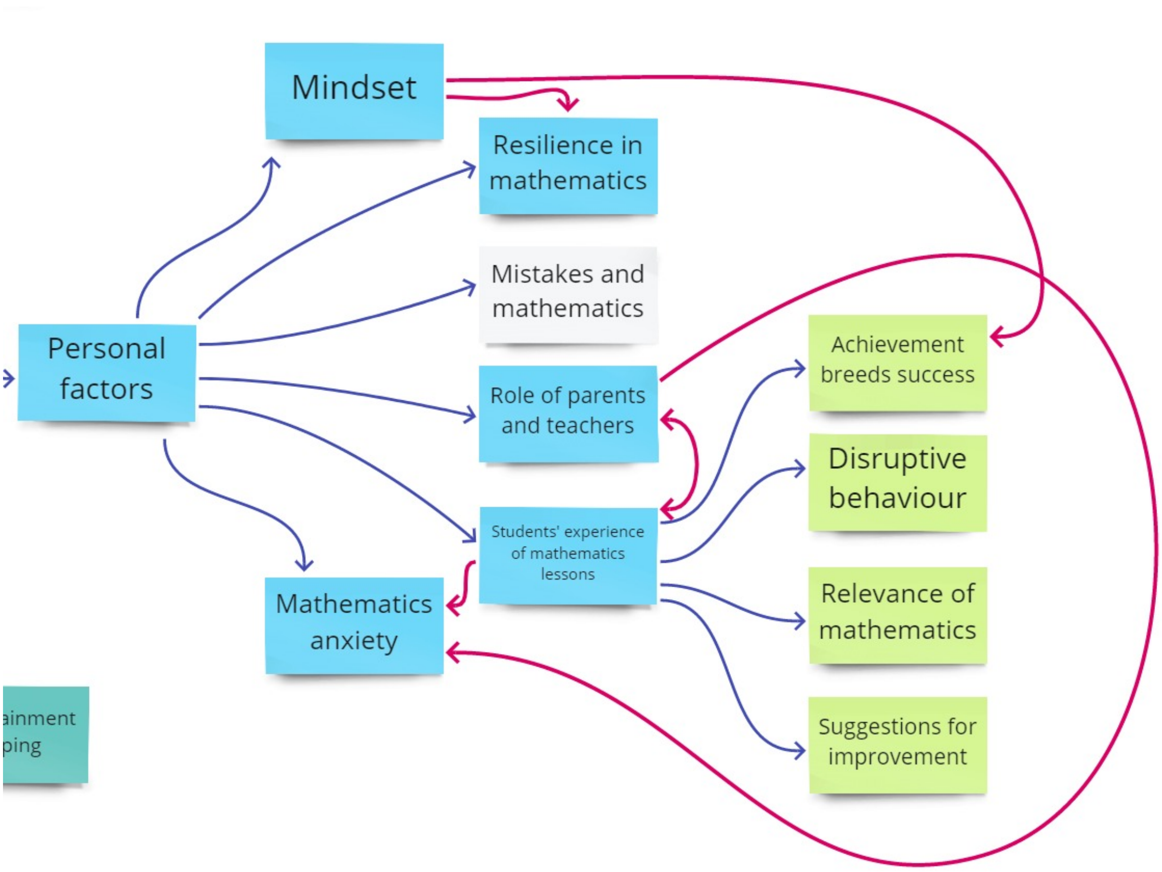


Figure 21 Personal factors model in the study school

6.2 System factors

The impact of staffing could be discussed here, but as I have reported it from a pupil perspective, it is discussed in the section on *'The role of parents and teachers' 6.1.3* in *'Personal factors'*. Although the issue of selective schools did not come out directly in the data from the pupils, it was mentioned in passing by teaching staff, and literature on selectivity leads me to consider the possibility that it may be a contextual factor which is highly specific to the study school, and I cannot assume that the pupils have not been affected by their experiences as people can carry the feeling of rejection from the 11+ exam for a long time.

6.2.1 Selection

The study school is a comprehensive secondary school, and despite the abolition of the traditional 11+ exam in the 1960s, it is in a county which has some of the 163 state-funded schools in England which are still selective 'grammar' schools (Smith-Woolley, et al., 2018). Research has linked selective schools to higher academic achievement, greater acceptance at university and the potential for higher earnings compared to non-selective schools

(Smith-Woolley, et al., 2018), so a primary concern of the selective system is that the negative reputation of a school will affect a pupils' self-esteem and view of their academic capabilities as it has been shown that being placed in a school with a low status affects other people's image of a pupil, which in turn may lower their personal self-worth (Gamoren & Berends, 1987; Oakes, 1985; Ahmavaara & Houston, 2007). Further research has found that the aspirations of pupils are strongly related to the type of school they attend, with those in a selective school having higher aspirations for their achievement (Ahmavaara & Houston, 2007).

A study by Skipper and Douglas (2016) found that pupils who had failed the 11+ exam and those who had not taken the exam had similar negative outcomes (Skipper & Douglas, 2016) so the impact of the examination to get into the selective school is likely to affect pupils from the time that discussions regarding secondary schools start. As the exam to get into the grammar schools is voluntary the pupils may experience a feeling of failure for not having sat it, or been offered to sit it, so to some pupils (but not all as some actively choose to go to a non-selective school), although this issue did not explicitly arise in my data from the pupils, being at the study school may be seen as a failure. One member of staff may have implicitly described the impact of selection when they discussed a "generation of students who are very aware of their place in the hierarchy" and as a teacher in the school I had first hand experience of the impact of the local grammar schools when I witnessed the opening scenario in this thesis where the pupils arrived at a local competition and immediately felt that they did not stand a chance when they saw pupils from the neighbouring grammar school arrive (see section *1.1*).

Selection could be an area for further research because as a teacher in the study school I expected the issue of selectivity to be regularly raised by the pupils in their questionnaire and focus group responses, without having to bring the topic up through the questions I asked but perhaps this reflects that the staff view selectivity as an issue more than the pupils.

6.2.2 Prior attainment grouping

The pupils in the study school would most likely have been exposed to prior attainment grouping when they were in primary school. A conservative estimate is that eighty-eight percent of children that are placed into sets at age four, remain in those groups until they reach school-leaving age (Dixon, 2002) and ability grouping is more common in mathematics and science than other subjects (Kutnick, et al., 2005).

Staff in the study school were aware of the impact of setting, describing a

> *generation of students who are very aware of their place in the hierarchy and how they relate to other people not only who are in that group but within the year group.*

Research has found that pupils as young as four or five years old have formed a belief as to how hard or easy mathematics is and have positioned themselves and others in relation to these beliefs (Towers, et al., 2018). This teacher felt that pupils may cap their belief in what they can achieve according to what set they are in, which was reiterated by another member of staff who felt that although some pupils were motivated by the possibility of moving up to the next set, others feel that they do not make any progress; "I'm going to work really hard and still be this grade, so why bother". To counteract this self-fulfilling prophecy, the staff described efforts to boost the confidence of the pupils and to try to undo any poor experiences in mathematics that they may have had in previous years, describing it to the pupils as a "fresh start".

In the study school, there was a statistically significant difference between what set the pupils were in and their attitude; pupils in the top set had the most positive attitude with attitudes becoming less positive as you went down the set numbers. This was true in all years, but in year 10 the changes in attitude value varied more in certain sets (i.e. not necessarily decreasing as the set number increased) which matched those sets which had been affected by the staff shortages in the department that year, see section *4.5*.

Both the pupils and staff felt that there were benefits to setting. A member of staff felt that setting helped to motivate the pupils in year 7, which was evidenced in the year 7 focus group as pupils described enjoying having "everyone around the same level" and feeling "more confident" after being moved down a set because they did not enjoy being put on the spot as it caused them to panic. These feelings of panic overlap with the section on *'Mathematics anxiety' 6.1.5*.

The benefits of moving out of a higher attaining set were felt by a year 10 pupil who explained that it was

> *annoying for me because I like doing harder maths but we do get to choose what we do and when we do it in maths so I choose the hardest thing I can do and then work backwards compared to last year I had to do the normal stuff that everyone*

else was doing so I had no challenge really. I just sat there being bored for half the lesson.

The data from this pupil suggests that they are finding a lower set more challenging because they are pushing themselves to do the hardest work possible, whereas when they were in the higher attaining set, they felt that they were doing the same work as the rest of the class. This pupil is showing good resilience towards setbacks in mathematics, as discussed in 'Resilience in mathematics' 6.1.2. However, not all pupils were as resilient to changing sets, something both teachers and pupils in the study school agreed upon. One teacher acknowledged that changing to a lower set can affect the motivation of a pupil but felt that pupils who moved up a set were more motivated. Pupils felt that more thought was needed for set changes and did not appreciate moving sets multiple times, as described in the questionnaire responses. A year 10 pupil felt "emotionally unstable" as they had experienced moving sets twice and a year 7 boy felt annoyed because he thought he was good when he described the impact of moving down a set. With the study school in close proximity to two grammar schools, it is encouraging to see this feeling of self-belief (see the previous section on *'Selection' 6.2.1*) although research has shown that many pupils are vulnerable to the possibility of suddenly learning that they are not good enough anymore, (Bartholomew, et al., 2011) which may explain what the pupils are feeling when they move down a set.

The direction of a set change had a statistically significant impact on the attitude of year 7 pupils and girls; however, it did not have a statistically significant impact on the attitude of year 10 pupils or boys. Interestingly, girls who had moved set twice had a more positive attitude than those who had moved up a set. The questionnaire did not ask pupils to clarify how they had moved sets if they had moved more than once so as it had a positive impact on their attitude, I assume that these girls had moved down a set and then returned to their original set, or perhaps had moved up two sets. Further investigation into the impact of the number and direction of set changes may be beneficial for anyone doing similar work in their school.

The staff did not mention any negatives to setting in the data, which is surprising given the wealth of data from the pupils about how they about being in sets. The staff did not appear to question the system of setting but accepted it as a part of the fabric of the system. This is discussed further in section *6.5.2*.

In summary, pupils –

- in years 7 and 9 felt more positive towards mathematics in the top prior attaining groups and less positive as the group number increased
- in year 10's attitude towards mathematics did not vary explicitly by prior attainment group number but by their experience of disruption due to staff shortages
- in year 7 and 10 felt panicked being in too high a group and more confident when they had moved down a prior attainment group
- in year 7 and girls had a statistically significantly more positive attitude towards mathematics after a set change (girls who had moved set twice were more positive than girls who had moved set once)
- felt more care was needed for set changes to avoid pupils moving multiple times.

Both pupils and staff felt –

- year 7 were more confident being surrounded by peers with a similar ability
- pupils were motivated by moving up a group but demotivated by changing to a lower group.

The staff –

- felt that pupils were aware of their position in relation to their peers and the community
- felt that some pupils can cap what they believe they can achieve according to which prior attainment group they are in
- did not appear to question the efficacy of setting but accepted it as part of the fabric of the system.

6.2.3 The importance of primary schools

The head of department within the study school acknowledged that a lot of the motivation and enthusiasm that the year 7 pupils had towards mathematics was due to the pushing and stretching that they received in their mathematics lessons at primary school. As a result of the study school focus being on examination groups, the year 7s did not have any interventions such as revision in tutor time; that may have been running in other year groups.

In summary, the head of department felt –

- that a lot of the enthusiasm and motivation in year 7 was due to their primary schools
- that year 7 may have been overlooked to focus on exam years.

6.2.4 Summary of system factors

Figure 22 shows the conceptual connections underpinning this study which I have used to structure this section of the discussion chapter:

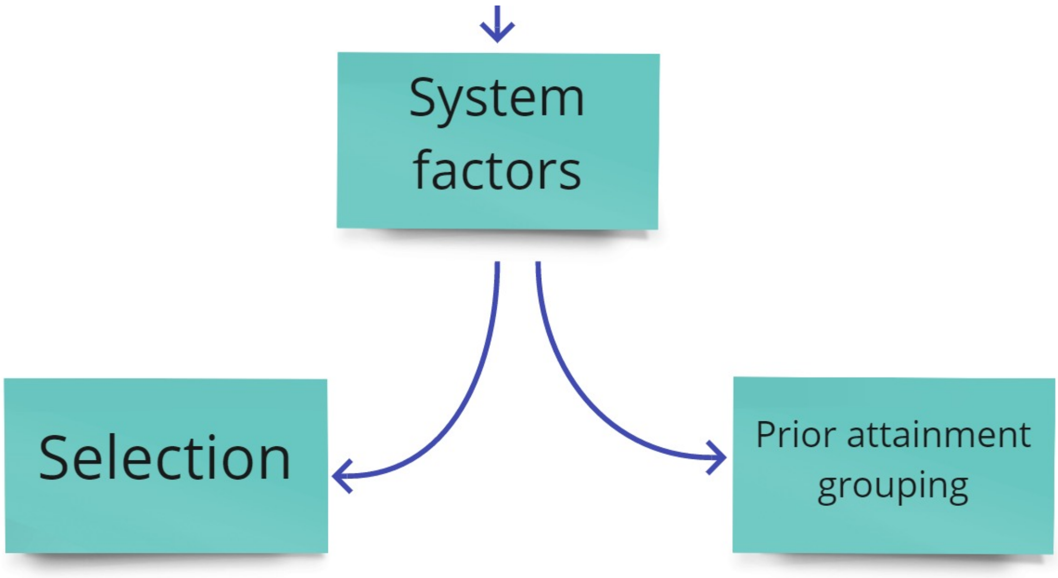


Figure 22 Section of the concept map informed by the literature review

However, in the study school Figure 23 is a more appropriate model for the system factors which affect motivation and attitudes towards mathematics. This shows that selection was not a factor which showed through in my data; however, this may be due to the questions which I asked, which will be discussed further in *'Limitations of the study' 7.5*. The model also shows a new factor *'The Importance of Primary Schools'*. The red arrows on the model show new links between factors which was evidenced in the data. The arrowhead shows which way one factor influences another and double headed arrows show that the two factors affect each other. So that the detail of the model can be seen I have only included the parts that are relevant to this section of the chapter.

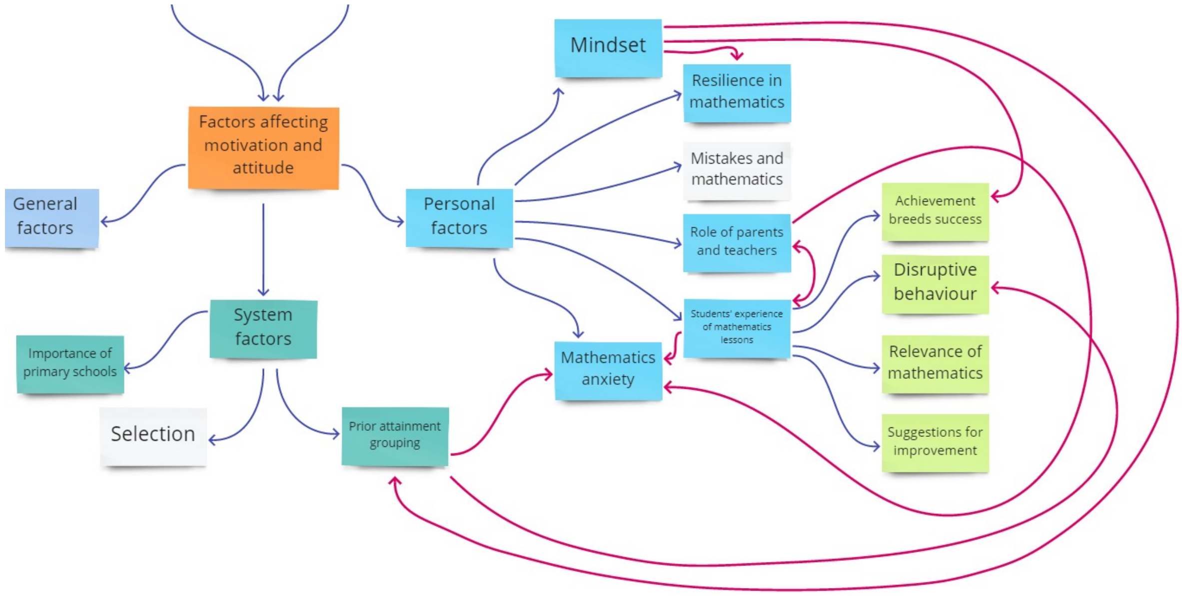


Figure 23 System factors model in the study school

6.3 General factors

6.3.1 The role of adolescence

Adolescence is the transition from childhood to adulthood which creates feelings of anxiety for the future and difficulties finding the balance on things such as effort at school (Eccles & Roeser, 2011). Early adolescence can be the start of a downward spiral which can lead to academic failure and dropping out of school (Eccles, et al., 1993). As this is also the time that the transition from primary to secondary school occurs some potential challenges for pupils are:

- School work – increased expectations from teachers and more homework and work in school
- Teachers – pupils go from one teacher to having to make relationships with many teachers
- Environment – secondary schools are often large which is initially confusing as pupils get used to different lessons in different classrooms.
- Peers – pupils need to make new relationships with a new peer group. They may experience bullying and feel a pressure to conform (Coleman, 2011).

In the study school evidence of these challenges were seen throughout the data, however some of it was conflicting. Pupils in year 7 were statistically significantly more positive towards mathematics than in year 6 and this was seen again with year 10 being statistically significantly more positive towards mathematics than year 9. Pupils in year 7 were statistically significantly more positive towards mathematics than year 10. Evidence for these results was seen in the quantitative questionnaire data, however, the qualitative data showed a decrease in enjoyment of mathematics as the pupils got older with year 9 and 10 pupils finding mathematics more stressful, less fun, more repetitive, and more difficult than in years 6 and 7.

Although all the staff noticed a decline in motivation by the end of year 10, they described different reasons for this. For some teachers it was too much focus on the exams, whilst others felt that the introduction of exam papers had increased the motivation of their pupils. Research has found that too much focus on examinations means that other more interesting and engaging activities are neglected, therefore compromising the quality that teachers offer (Korentz, 2017). The impact of examination papers could be an area for further research as the variety of opinion may be due to the prior attainment group the teachers had, with some groups finding the approaching exams motivating whilst others become demotivated.

The head of department described the year 10 group as having a “significant number, boys and girls, who are not interested in doing well” and felt that all of the motivation was coming from the teacher. These feelings were felt by other members of the department who saw a decline in the motivation of the year 10 pupils, describing them as “motivated” and “hard working” at the start of the year but “less inclined to work and less serious about getting their exam” by the end of the year.

Although the government has tried to stop schools entering pupils early for their exams, when the research was carried out schools were still able to do early entry and this member of staff felt that this decision had contributed to the decrease in motivation, especially in sets of lower prior attainment.

The literature review found that an older pupil may have negative feelings towards mathematics due to struggling over a long period of time or due to one single moment of shame which may be due to a teacher not being compassionate to a pupil’s difficulties (Towers, et al., 2018). In the study school in years 9 and 10 the pupils were starting to sit exam papers which are graded on a national level (A*, A, B etc) as opposed to getting a homework score of 9/10 which they can only compare with their peers. This could be the first time that they see what grade they might get at GCSE, and it may not be as high as what they thought they were going to get. This could be particularly demoralising for sets of lower prior attainment who may realise that they would struggle to get a C grade at GCSE or for those pupils who are put into a foundation tier and were hoping for a higher grade. This could be an area of further exploration for anyone doing similar work in their school.

In summary, the pupils –

- in year 7 were statistically significantly more positive towards mathematics than in year 6
- in year 10 were statistically significantly more positive towards mathematics than in year 9
- in year 7 were statistically significantly more positive towards mathematics than in year 10
- enjoyed mathematics less as they got older, finding it stressful, less fun, more repetitive and more difficult.

The staff–

- noticed a decline in the motivation in year 10, giving opposing reasons -
    - past examination papers had increased the motivation of year 10
    - too much focus on the examinations had de-motivated their class
- felt that too many pupils in year 10 were unmotivated
- felt that they were having to motivate the year 10 pupils.

6.3.2 Female underrepresentation

Although there is a long history of gender inequities in mathematics and science in the UK, with girls characteristically achieving less than boys at GCSE level, research has meant that the achievement level is now roughly equal (Boaler, et al., 2011). In the study school, there was no statistically significant difference between boys' and girls' attitude towards mathematics in years 6,7 or 9 but in year 10 the boys' attitude towards mathematics was statistically significantly more positive than girls. In the academic years 2014, 2015 and 2016, when the research was carried out, the achievement level in mathematics was roughly equal between boys and girls which is in line with the national picture.

In summary –

- there was not a statistically significant difference between gender and attitude towards mathematics in years 6, 7 and 9
- year 10 boys were statistically significantly more positive towards mathematics than year 10 girls.

6.3.3 The role of stereotypes in mathematics

From my experience as teacher in the study school, there seemed to be a culture that being good at mathematics was ‘not cool’ and a stigma was attached to many (but not all) pupils who excelled in the subject. Research has shown that pupils who were labelled as gifted and talented were concerned that they would be called ‘boff’ or ‘swot’ and that their peers may be jealous of them (Fox & Pope, 2005). This was seen in the study school but only as the pupils got older. Pupils in years 6 and 7 did not mind being thought of as a ‘maths nerd’ but pupils in years 9 and 10 did not want to have this label attached to them as evidenced in the questionnaire data.

The focus group data suggests that the older pupils were more likely to feel that their friends would be ‘jealous’ if they came top in a mathematics test whereas ‘jealous’ was hardly mentioned in the younger years. Being called a ‘boffin’ was also more common in older pupils than younger ones. It is possible that these changes in reaction may be due to factors such as increased awareness of peers, competitiveness in the lead up to exams or perhaps the importance of doing well in mathematics as the GCSE exams approach. Adolescent psychology is more peer-focused than for children and adults so the older years may be more susceptible to the opinions of their peers and care more about trying to fit in (Coleman, 2011). This could be an area for further research for anyone doing similar work in their school.

The data in the study school showed an interesting change in how a mathematician was described between years 6 and 7 with some year 7 pupils describing their mathematician as confident and that you could “have a joke around with him”. This may be due to a change in the students’ feelings towards mathematics since starting secondary school or perhaps they are picturing their mathematics teacher when describing a mathematician. Further investigation into what the pupils are describing when they picture their mathematician could be an area for further research.

In summary the pupils –

- in years 6 and 7 did not mind being described as a nerd
- in years 9 and 10 would not like to have that label attached to them
- in older years were likely to experience jealousy and to be called a boffin if they came top in a mathematics test
- in year 7 described a mathematician as being confident and someone who you could joke around with.

6.3.4 Summary of general factors

Figure 24 shows the conceptual connections underpinning this study which I have used to structure this section of the discussion chapter:

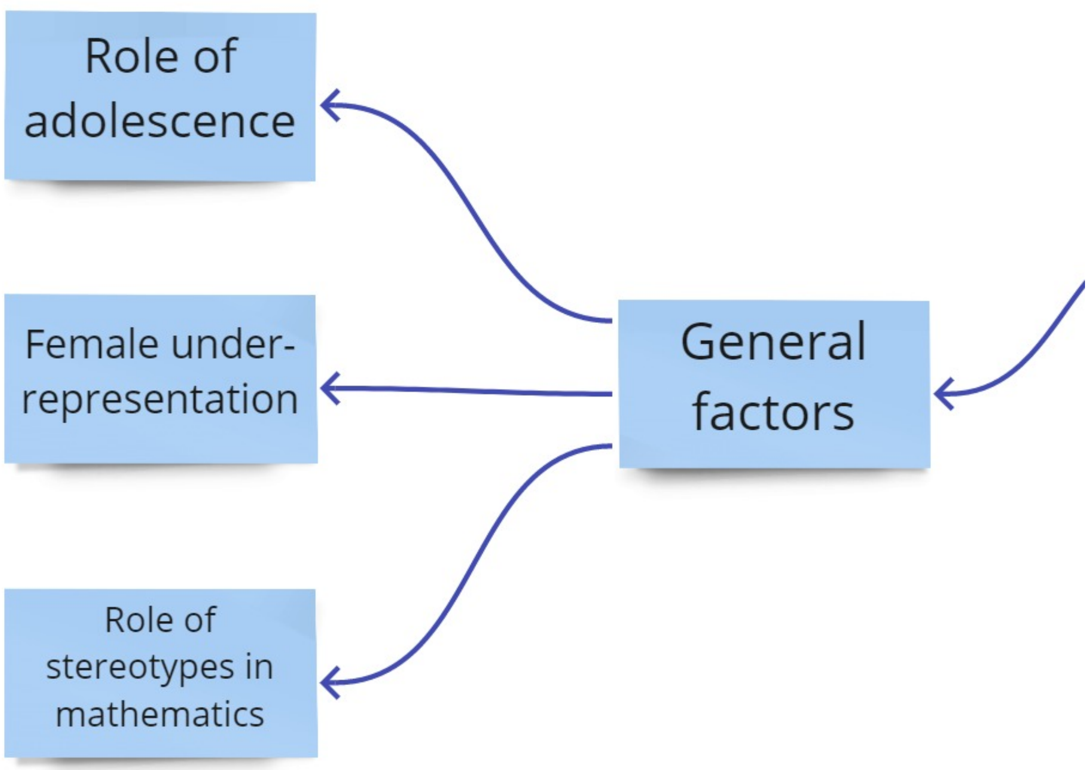


Figure 24 Section of the concept map informed by the literature review

However, in the study school Figure 25 is a more appropriate model for the general factors which affect motivation and attitudes towards mathematics. The red arrows on the model show new links between factors which was evidenced in the data. The arrowhead shows which way one factor influences another and double headed arrows show that the two factors affect each other.

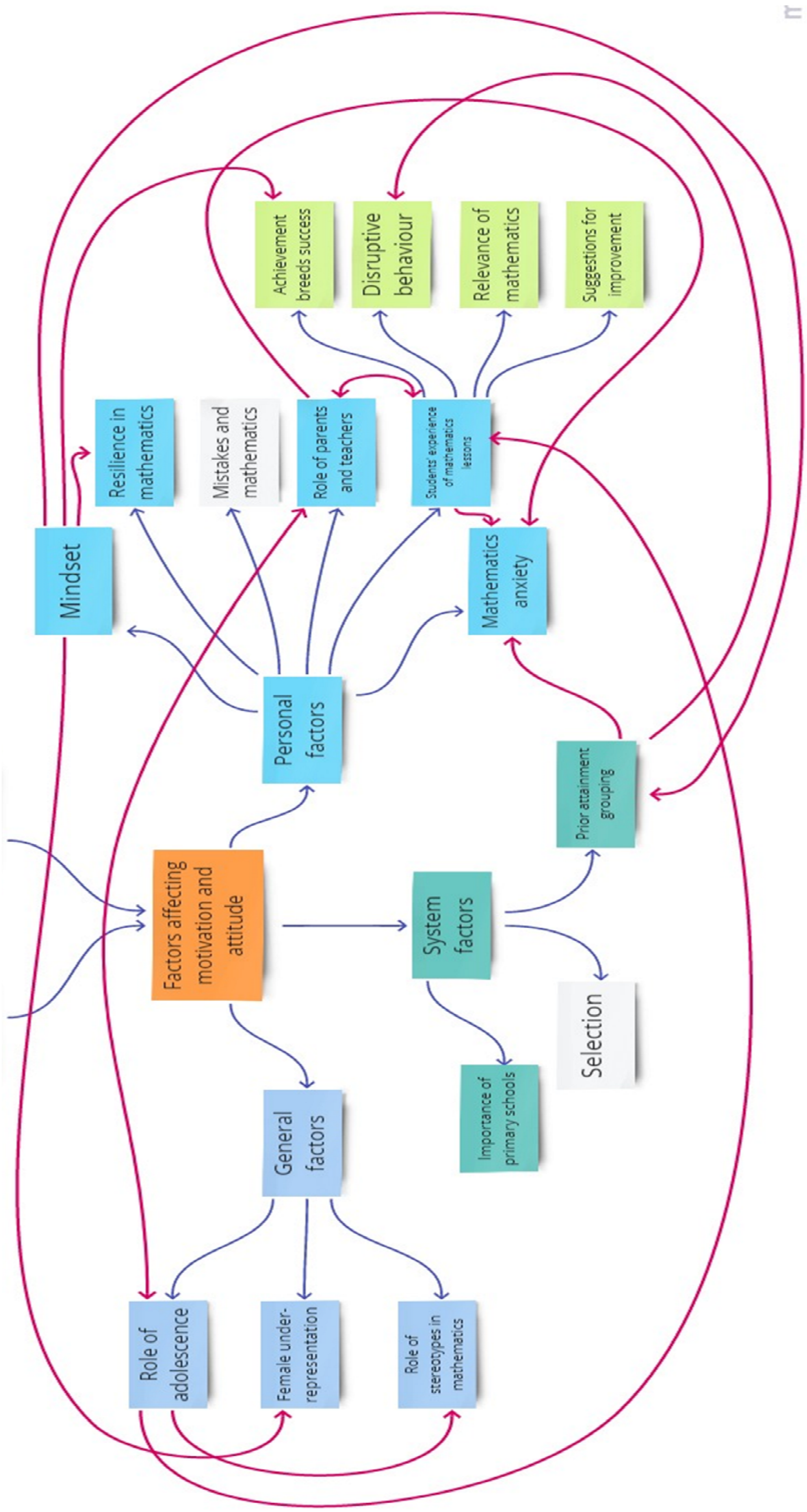


Figure 25 General factors model in the study school

6.4 Summary of factors affecting pupils' motivation and attitude towards mathematics in the study school

To achieve greater clarity of the conceptual connections underpinning this study, Figure 26 shows a pupil centred target diagram as an alternative diagram to Figure 25. The rings represent the collection of factors which are grouped as follows:

- Red ring - Personal factors
- Orange ring - System factors
- Blue ring - General factors.

The arrows show the relationships which I have found between these constructs for pupils in my context and the arrowheads indicate the direction of this relationship.

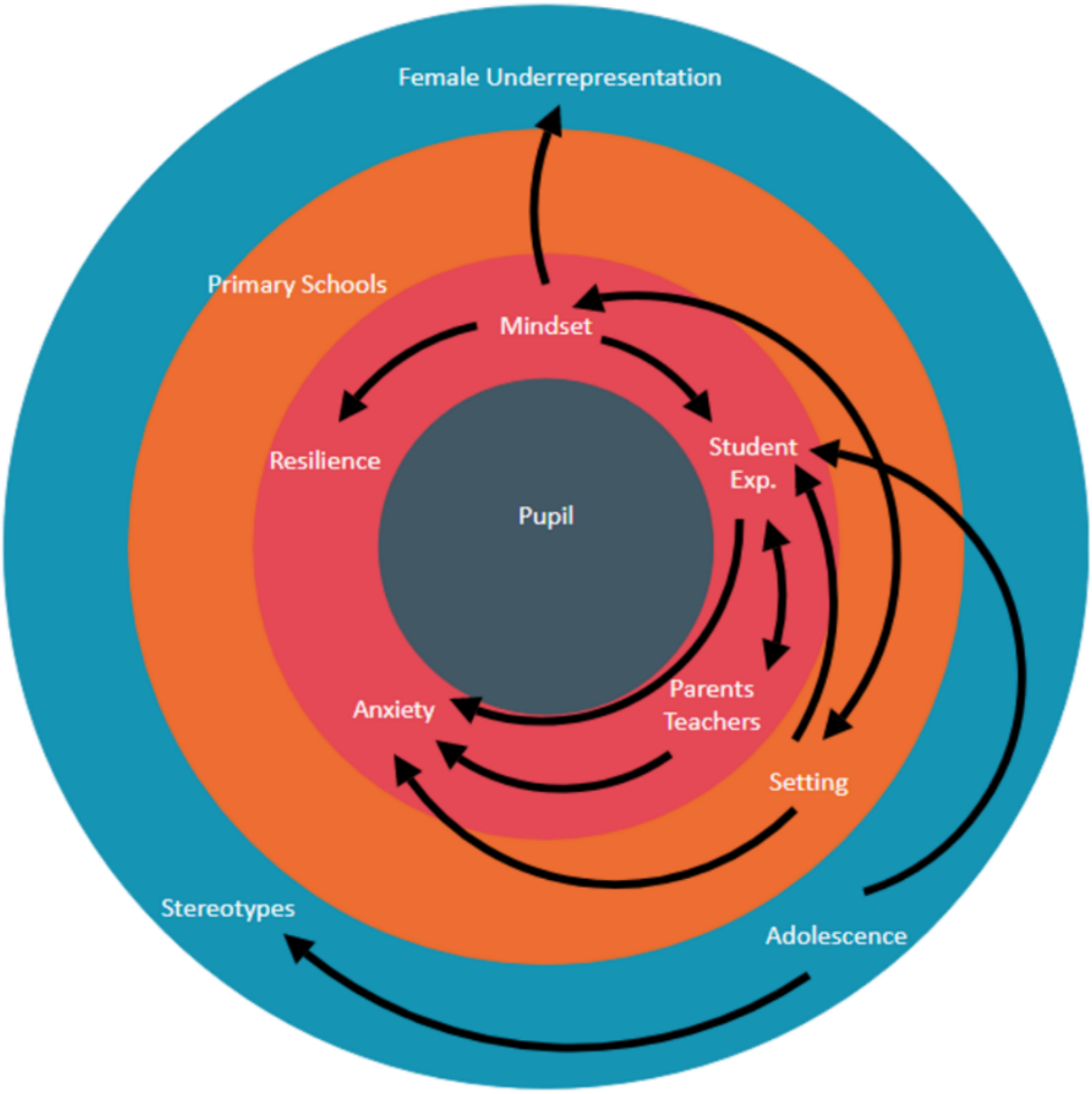


Figure 26 Summary of factors affecting pupils' motivation and attitude towards mathematics in the study school

6.5 Summary of factors staff feel are affecting their ability to improve the pupil experience

6.5.1 Feeling constrained

Throughout this chapter and Chapter 4 there has been the voice of staff within the department explaining their point of view on reasons for changes in pupil motivation and attitude towards mathematics. This data often described ways in which they felt they could improve the learning experience for pupils (e.g. more practical lessons, collaborative learning, including the relevance of mathematics) but also constraints they felt prevented them from making these changes (e.g. large class sizes, lack of time, pupil behaviour). The data appears to show that teachers recognise ways in which the pupil experience can be improved but feel unable to act upon these due to other pressures and constraints. This tension is clearly having an unintentional but not unknown effect on the pupils' experience of mathematics which will impact their motivation and attitude towards the subject.

To clearly show these factors, Figure 27 shows a teacher centred target diagram. The rings represent a collection of factors which have been grouped into:

- Red ring – factors which teachers feel they can affect
- Orange ring – school level factors which impact their teaching (but have not been described as a barrier to change)
- Blue ring – constraints the teachers report as preventing them making changes to the learner experience. This level has been grouped into pupil factors, general factors, and school factors.

The arrows represent the pressures these constraints exert on the staff within the department.

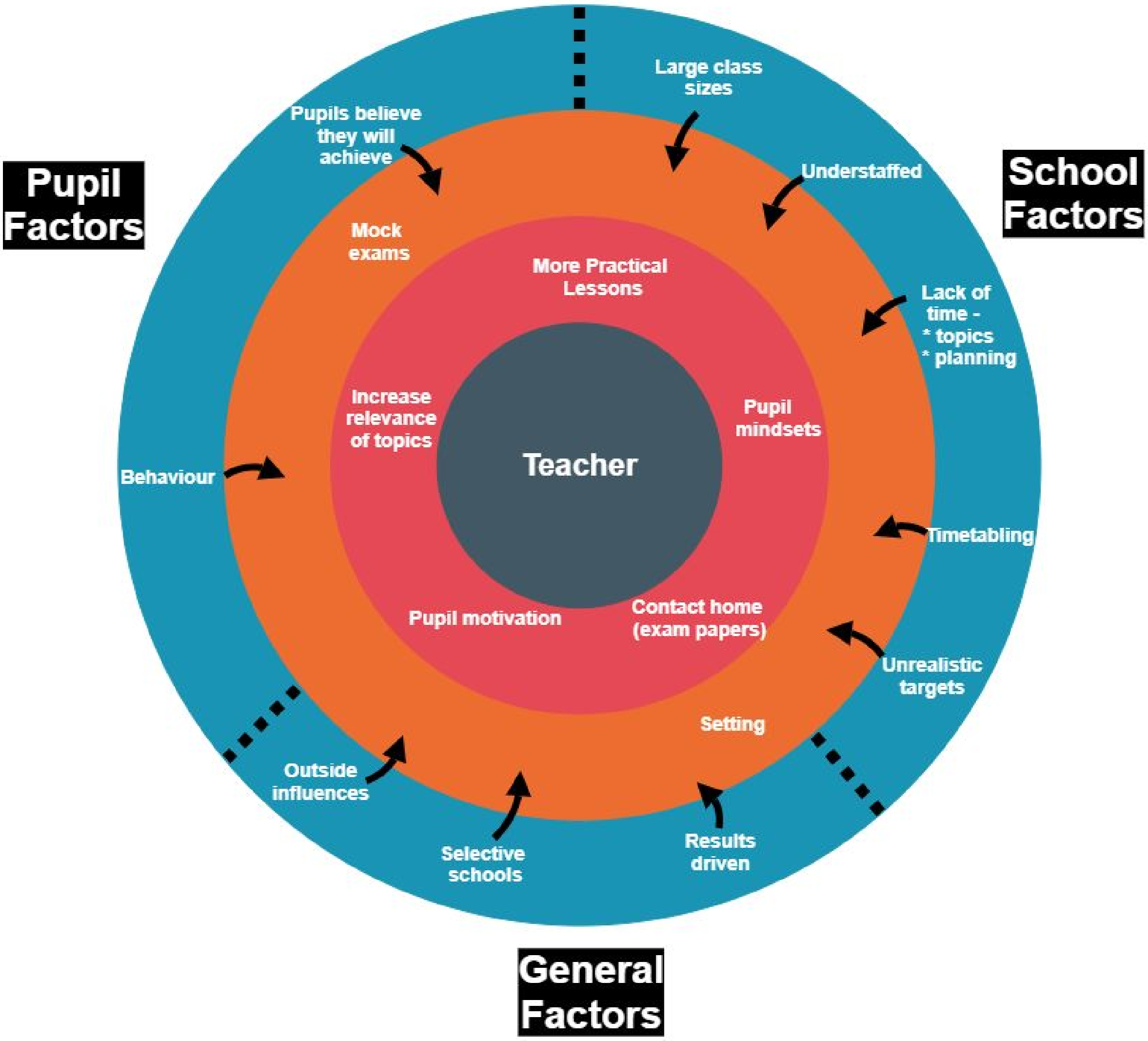


Figure 27 Summary of factors teachers feel are affecting their ability to improve the pupil experience

The previous section has reported teachers who indicate via their responses that they feel like victims of a system, able to articulate ways in which they could improve the pupil experience but unable to enact these changes due to constraints they feel are beyond their control.

The following section will consider how the data shows a lack of autonomy and agency throughout the department and an apparent acceptance of a system which does not serve the pupils well with no question of its efficacy.

6.5.2 A lack of agency and autonomy

The department data suggests the staff accept certain outcomes as unavoidable and appear to not believe that they have any power to change the situation. Evidence of this can be seen in many of the staff interviews and is discussed further below. This section has been split into four sections: *reported constraints, inevitability of constraints, acceptance of constraints* and *unquestioning*.

6.5.2.1 Reported constraints

It appears from the data that the teachers felt like victims, blaming OFSTED, school policy, timetabling and lack of time for preventing them from enacting changes which would benefit the pupils. Evidence of this was seen when the department justified presenting topics as they appear in the examination, with little real-life context, by not having enough time in lessons. Lack of time and large class sizes was justification for the lack of practical lessons pupils experienced and school policy was justification for giving the pupils aspirational target grades (due to the OFSTED category the school was in at the time of the research) which demotivated some pupils who felt they were unachievable.

6.5.2.2 Inevitability of constraints

The data raised scenarios which the staff saw as inevitable, despite how they may be affecting the pupils. Evidence of this can be seen when the staff discussed the speed with which they covered the Scheme of Learning and having to leave some pupils behind, hoping to cover topics again in revision. The teachers did not seem to question whether this was good for the pupils but accepted their role in the system. There seems to be a conflict between an imposed ‘speed’ and the pupils’ experience. One might ask who imposed the speed, how is it imposed and why? Why does the teacher not feel that they have the autonomy to vary the pace so that they could ensure robust learning? In the study school the department followed a Scheme of Learning which was based on the National Curriculum, laid out by prior attainment group, and told teachers what topics to teach and approximately how long to spend on each topic. At this time the study school still entered pupils to sit their GCSE mathematics examination early (at the end of year 10) so the pupils had to get through the course in less time than if they had taken their examination at the end of year 11, a situation which did not seem to be questioned by the teaching staff.

The department described witnessing a decline in motivation and attitude of the pupils in year 10 and frequently suggested that preparation for the examinations could be a reason for this decline, although they accepted this situation seemingly without question. Entering the pupils for their mathematics examination early could be contributing to the speed of the Scheme of Learning which appears to be leaving pupils behind. One might ask why is there a lack of teacher agency over in-class decisions? Why do the teachers feel that they cannot push back? It is possible that the department have become a teaching force who are ‘done to’ rather than in control of what and how they teach, where teachers are technicians rather than professionals. This is described as a ‘semi professional’ state by Etzioni (Etzioni, 1969), where

> *teachers acted willingly as subordinates, and any dissent was regarded as challenging authority, which might lead to professional repercussions, for example, through loss of promotion* (Gray, 2007, p. 201).

6.5.2.3 Acceptance of constraints

The data from the teachers suggests they see themselves as victims who are lacking agency over pedagogic decisions despite being aware of the impact on pupil experiences. Evidence of this can be seen when the teachers discussed how they have had to prioritise examination year groups and not focus on younger years, allowing them to ‘coast’ on the enthusiasm instilled in them from their primary school. This situation appeared to be accepted, despite an awareness of the detrimental impact on pupil experience.

There were several instances in the staff interviews where they appeared to accept other situations for example when describing how easy it is to fall back on a repetitive activity like a textbook or worksheet which the member of staff acknowledged would not be enjoyed by the pupils. Further evidence of this acceptance was when the staff were discussing making topics more relevant to the pupils by including their real-life context but accepting that they do not have time to do this so instead fall back on phrases such as “because it’s in your exam”. It appears to be that the pace of curriculum coverage is being prioritised over learning, with teachers seeming to feel that they do not have the autonomy to change this.

6.5.2.4 Unquestioning

The data suggests that there is either some complacency within the culture of the school where teachers accept victim status - that nothing can be done, because of Ofsted, constraints imposed on them, or that teachers are actively prevented from acting for the betterment of their pupils and are treated simply as technicians who must do as they are told. Evidence of this was seen when the staff appeared to not question if there was a better way to manage the staffing situation, but accepted it as inevitable, despite admitting that it was not offering the best outcomes for the pupils. Further evidence of this unquestioning behaviour was when the member of staff discussed a pupil who nearly moved out of a top prior attainment group by one mark. There was no question as to the impact of this on the pupils and similarly when the staff talked about the impact of the examinations; they openly discussed how their lessons had become about teaching to the examination, how some classes were losing motivation due to so much focus on past papers and how poor mock examination results were demotivating individuals, without questioning whether this was the right route to take for all pupils. As this may be due to the questions I asked, because I did not explicitly ask the staff to critique the department policies, this could be an area of further exploration within the study school.

It seems that these findings could indicate a need for the education system to pay more attention to self-determination theory in its support for teachers, as teachers need to have their psychological needs met to be able to support their pupils' psychological needs, however school policies and styles of leadership can interfere with the satisfaction of teachers' needs and result in less supportive classroom environments for the pupils (Ryan & Deci, 2020). The more that teachers feel pressure on them from above; from the curriculum, colleagues, and results; and pressure from below (pupils), the less they feel self-determined towards teaching and the more controlling of their pupils they become (Pelletier, et al., 2002). This lack of teachers' autonomous motivation for teaching affects the autonomy support they are able to offer their pupils (Ryan & Deci, 2020).

Having been a teacher in the study school I can empathise with the position of the department in feeling constrained, but none of the teachers said that they did not know how to improve things for the pupils, so it is possible that the teachers are becoming so constrained that they are working as technicians as opposed to professionals.

If this is the case, then there is possibly a leadership issue in the study school. There could have been some internal discussions about adapting what the department were doing to better meet the pupils' needs, getting some Continuing Professional Development (CPD) help, being more creative in the classroom, working as a team, helping each other include more context in lessons, being more honest about expected grades, considering adapting teaching methods and so on. There will have been other schools with similar problems, the situation of the study is not totally unusual so they could have learnt from how other schools handle similar issues. One might ask if the department are acting as victims in a system that gives them little autonomy? Or is it that they do not have a culture of change and adaptation in the ways they teach as individual teachers? This needs further research within the study school and would be an area for more exploration for anyone doing similar work in their school.

Figure 28 summarises the factors which affect the motivation and attitude of the pupils in the study school, as evidenced in the department data. These have been grouped according to who can affect them i.e., the school, the pupil, or the teacher. This shows clearly that the teachers have the potential to influence more of the pupil experience than they appear to be willing to take ownership for, which is impacting the experience of the pupils and consequently their motivation and attitude towards mathematics.

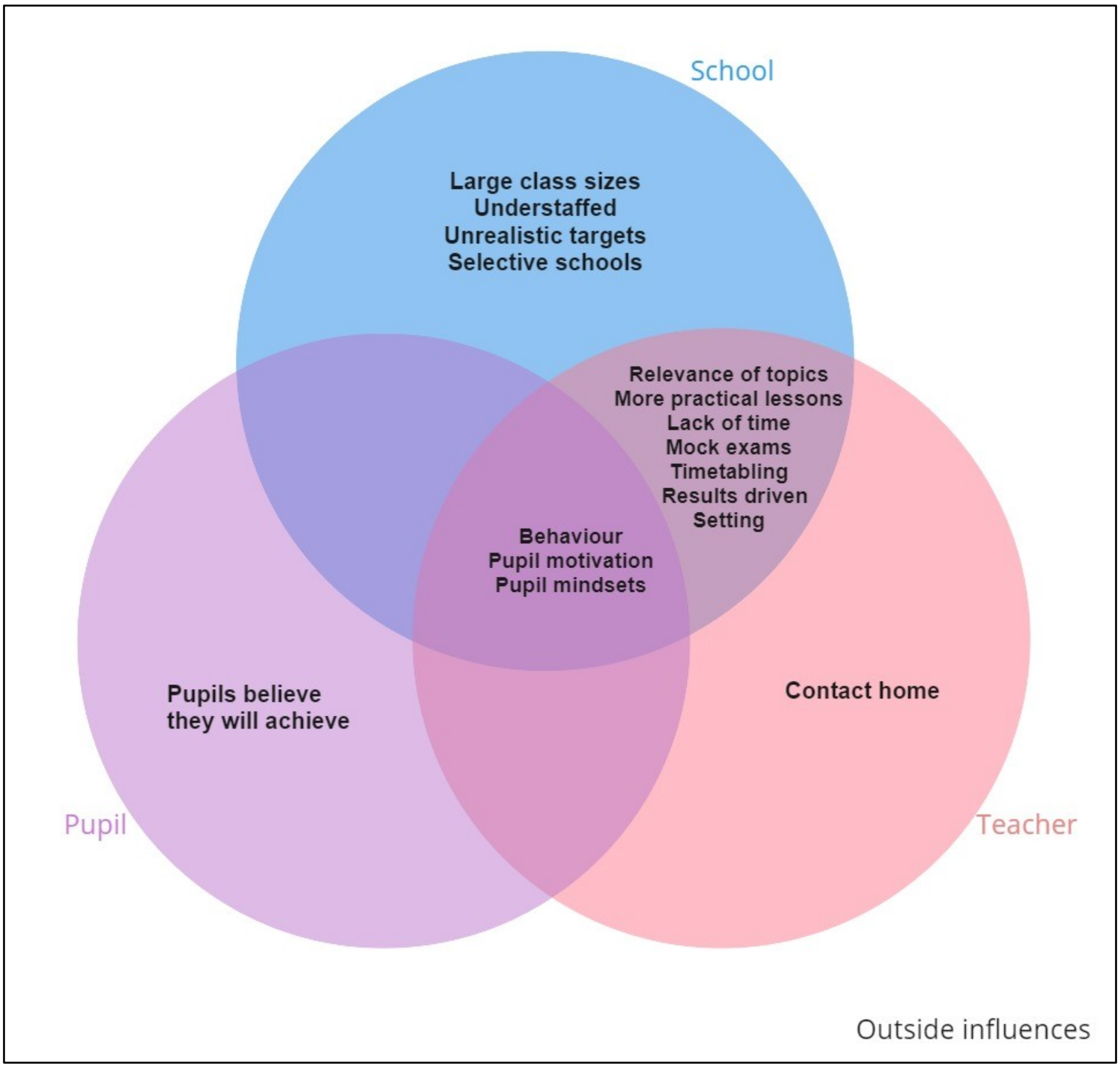


Figure 28 Summary of factors affecting pupils' motivation and attitude towards mathematics in the study school, as evidenced in the staff data, and who can affect them

The overall pupil experience is described in more detail in the following section.

6.6 Pupil experience

This section summarises the experience that a pupil could have in the study school. I would like to emphasise that this section covers the worst possible experience a pupil could have as it assumes the worst of every eventuality. In reality very few if any pupils (I hope) would experience all of these negative scenarios, but every pupil will experience at least some of these throughout their time in the study school and these will all have an impact on their motivation and attitude towards mathematics.

I have described the following section in terms of the experiences of one fictitious pupil called pupil P but I have only described scenarios which were particular to the study school and not factors which every secondary school pupil faces such as mathematics anxiety and adolescence.

6.6.1 Pre-secondary school

Before pupil P started at the study school, they experienced a good grounding in mathematics at their primary school. They were pushed and stretched and started to form an opinion about mathematics and their ability in mathematics. These opinions were influenced by external factors such as parental views, media, and their peer group and pupil P felt that they were quite good at mathematics.

Towards the end of primary school pupil P was aware that they faced a choice about which secondary school they went to. Despite wanting to go to the local grammar school with their friends, they were not entered for the exam. Whilst some of pupil P's friends 'failed' to pass the test to get into grammar school, pupil P felt like they had 'failed' because they had not even been entered for the exam. They received a subliminal message that they were not good enough to go to that school.

Pupil P felt daunted about going to the study school because deep down it was not their first choice of school, they had experienced a blow to their self-esteem and felt intimidated that the school had a sixth form that perhaps they were not able to get the grades to join.

6.6.2 Early secondary school

Within the first week or so of secondary school pupil P was put into a set for mathematics. The advantage of this was that they were in a class with pupils of a similar ability but unfortunately, they were separated from their peers from primary school who were in a higher set, and this gave pupil P a feeling that they were not very good at mathematics.

Pupil P found mathematics very fast paced and felt that they had moved on to a new topic before they had a chance to express to the teacher that they were struggling. At the end of term 2, pupil P did not achieve very well in a test and that as well as some low homework scores meant that they were moved down into the set below them. This change of set really affected how pupil P viewed mathematics, up until now they had enjoyed mathematics and felt that if they worked hard at it, they would be rewarded and achieve. But this run of negative experiences (secondary school choice, allocation of set, set change) had knocked their confidence and they were now starting to feel that mathematics ability was something that you were born with and that perhaps they had reached their potential and were never going to be able to achieve a good grade in it – was there any point in still trying?

Despite these feelings, with encouragement from their parents, in the end of term 4 test, pupil P performed well, and was moved back up into the previous set, but these set changes still left them feeling unsettled and unsure of their ability in mathematics.

Pupil P did not like some of the behaviour of pupils in their lessons and found that it distracted them from their learning. They also found that it was not ‘cool’ to be good at mathematics and that some of their friends were called ‘boffin’ if they got good grades, although they did not seem to care about these comments.

6.6.3 Middle secondary school

Towards the end of year 9 pupil P learnt that as a year group they were going to take their mathematics GCSE early, at the end of year 10. Pupil P felt a mixture of excitement and fear to be taking their GCSE the following year. It felt a bit too soon, but they were keen to try to ‘get their maths exam out of the way’ before year 11.

To prepare for this pupil P and their peers would be streamed across the whole year group and put into new sets at the start of year 10 (see *‘Checking the attitude scale' 5.1* for further details). This meant being in a class with pupils that they did not know and that they would not have mixed with before. This was particularly stressful for pupil P as they liked the pupils in their current set and felt confident to ask for help in the class. Pupil P felt that they would probably feel embarrassed to ask for help in front of pupils that they did not know in their new year 10 class.

6.6.4 Late secondary school

From the start of year 10 the pressure really increased with past exam papers given as homework each week, as well as regular mock exams. Pupil P found it difficult to see a poor grade on their exam paper because it was the first time that they had seen an actual GCSE grade and they tried to hide it from their peers as they were embarrassed by it. Having poor grades in homework papers and mock exams made pupil P feel very disillusioned and this was compounded by an unrealistically high predicted grade in mathematics which felt unattainable. The only good thing about getting low grades was that pupil P was not being called ‘boffin’ or any of the other names that their friends in higher sets were experiencing as being good at mathematics did not make you popular with your peers.

Pupil P felt that the lessons were very fast paced with few practical opportunities but more of a feeling of being taught what was going to be on the exam and lots of worksheets or textbook exercises, however the teachers were able to add a bit more context to the learning or the exam papers helped the pupils to see the relevance because pupils stopped asking the teacher “when are we going to use this in life?” as frequently as they did lower down the school. It did not help that pupil P had mathematics twice in one day and the second lesson was after PE, so they were very tired and found it hard to concentrate.

During year 10 certain sets were mixed up and re-set because the set above pupil P’s had a long-term supply teacher. As a result, pupil P was put into a new set and had a rotation of staff every fortnight (see Table 7 Changes in staffing by set in section 4.5) so that one class did not have a supply teacher for too long. Pupil P did not enjoy this rotation because they liked their original teacher and felt that they had a good relationship with them and had started to get to know their classmates in their new set after the streaming that had occurred at the start of the year. The rotation meant that they had to get used to a new group of peers as well as new teachers, teaching methods, classrooms, and routines. It was particularly difficult when it was parents evening because they did not know which teacher to make an appointment with.

Towards the end of year 10, pupil P was entered for foundation GCSE which meant that they could not achieve above a C grade (this research was carried out before the transition to number grades). Although pupil P would have been pleased with a C grade, the feeling of being entered into a foundation tier and of having their attainment capped at a C reiterated the numerous messages which they had been receiving about their ability in mathematics.

During year 10 pupil P attended many events organised by the school about what to do at the end of compulsory school and many teachers were trying to encourage pupils to stay on for the sixth form and take mathematics A-Level. However, pupil P would not be able to consider taking mathematics because they were entered for the foundation tier, but even if they could take it, they did not want to. They did not feel able to and felt that the sooner they could give up on mathematics the better.

I would again like to reiterate that it is highly unlikely that all these scenarios will happen to one pupil, but they have all happened to some of the pupils. Despite teachers describing ways in which their teaching might generate better learning experiences, they claimed that due to systemic pressures and limitations they were unable to act upon the areas that they recognised could be improved. To put it another way, the story of pupil P demonstrates the cumulative impact on pupil experience that factors outside of school through to department decisions, as well as the teachers' lack of agency and autonomy, have on the pupils and shows how these are compounded by the complex workload issues that staff face, as well as adolescence. Whilst this study only looked at the study school, I am sure that elements of this learner experience are mirrored in other school contexts and highlights some of the wider issues within education.

The contributions of these factors as well as limitations and implications of this research will be discussed in the next, final chapter.

Chapter 7 Conclusion

The final chapter of this thesis summarises the key findings and emphasises the contributions of this study. The implications and pedagogical implications of this research are discussed as well as the limitations of the study and suggestions for further research.

7.1 Summary of findings

A summary of the key findings of this thesis, as evidenced in the data, is given below under the headings; Personal factors, System factors and General factors, as informed by the review of literature.

7.1.1 Personal factors

Mindset

The pupils felt -

- they could change behaviours related to their ability in mathematics in years 6 and 7
- that some people are naturally good at mathematics in years 9 and 10
- annoyed if they move down a set and lack a belief that they can move up a set.

The staff felt that -

- factors such as proximity of selective schools and the feeling of having failed from a young age may affect pupil mindsets
- some pupils believe they will do well in mathematics and do not need to put in effort
- external influences such as a phone call home or fear of moving down a set trigger some pupils to put in more effort.

Resilience in mathematics

The data suggested that -

- pupils with a positive attitude towards mathematics would choose to continue with it
- low self-efficacy amongst pupils appears to be persistent.

The role of parents and teachers

The data appears to show -

- a statistically significant relationship between the pupils' attitude towards mathematics and pleasing their parents
- a statistically significant relationship between the number of teachers a pupil had in the year and their attitude towards mathematics.

The rotation of mathematics groups in year 10 left staff –

- feeling that they had less planning to do as they delivered a topic more than once
- witnessing their pupils becoming demotivated
- seeing the inconsistency in routines, marking and feedback experienced by the pupils
- recognising the social impact on the pupils of mixing classes up
- easing their personal responsibility on the impact this situation had on pupils by blaming other constraints on the system
- appearing to lack autonomy and agency and accepting a system which does not serve the pupils well.

Student experience of mathematics lessons

The pupils felt –

- that they enjoyed mathematics more when they achieved and coming top in a test would make them want to do more mathematics.
- stress, anxious, frustrated and disillusioned by a poor grade.
- behaviour in lessons could be better in years 6 and 7
- that mathematics appeared to lose its relevance with older pupils
- they knew more about what career they wanted in years 9 and 10 and so would choose to study mathematics if necessary
- increased feelings that mathematics was a useful life skill (boys) as they got older, but this decreased for girls
- that they would enjoy mathematics more if there were fewer tests.

Both pupils and staff felt –

- success breeds success so if a pupil feels that they are achieving in mathematics they are more likely to enjoy it and continue with it
- that lessons should be more fun and varied.

The staff felt –

- that GCSE exams, homework past papers and mock exams helped to motivate the pupils
- that a poor result could disillusion a pupil and make them switch off
- that one de-motivated pupil can impact the whole class
- that they needed to make mathematics more relevant and contextualised but felt that they did not have sufficient time to achieve this
- that constraints beyond their control such as large class sizes, lack of equipment, planning time etc meant that they could not always deliver more fun and varied lessons.

Mathematics anxiety

The pupils felt –

- anxious towards mathematics in all years, even primary school
- less anxious towards mathematics after a transition point
- factors such as previous experiences, low self-efficacy, variety of teaching styles, tests, student experiences in lessons, peer reactions and parental influence affect mathematics anxiety
- more anxious in lower prior attainment sets than higher prior attainment sets in years 9 and 10.

7.1.2 System factors

Prior attainment grouping

The data suggested that pupils –

- in years 7 and 9 felt more positive towards mathematics in the top prior attaining groups and less positive as the group number increased

- in year 10's attitude towards mathematics varied according to their experience of disruption due to staff shortages
- in year 7 and 10 felt panicked being in too high a group and more confident when they had moved down a prior attainment group
- in year 7 and girls had a statistically significantly more positive attitude towards mathematics after a set change
- felt more care was needed for set changes to avoid pupils moving multiple times.

Both pupils and staff felt –

- year 7 were more confident being surrounded by peers with a similar ability
- pupils were motivated by moving up a group but demotivated by changing to a lower group.

The staff felt –

- that pupils were aware of their position in relation to their peers and the community
- that some pupils can cap what they believe they can achieve according to their prior attainment group.

The importance of primary schools

The head of department felt –

- that a lot of the enthusiasm and motivation in year 7 was due to their primary schools
- that year 7 may have been overlooked to focus on exam years.

7.1.3 General factors

Adolescence

The pupils –

- in year 7 were statistically significantly more positive towards mathematics than in year 6 and year 10 and year 10 were statistically significantly more positive towards mathematics than in year 9
- enjoyed mathematics less as they got older, finding it stressful, less fun, more repetitive, and more difficult.

The staff–

- noticed a decline in the motivation in year 10, giving opposing reasons -
    - past examination papers had increased the motivation of year 10
    - too much focus on the examinations had de-motivated their class
- felt that too many pupils in year 10 were unmotivated
- felt that they were having to motivate the year 10 pupils.

Female underrepresentation

The data appeared to show –

- there was not a statistically significant difference between gender and attitude towards mathematics in years 6, 7 and 9
- year 10 boys were statistically significantly more positive towards mathematics than year 10 girls.

The role of stereotypes in mathematics

Pupils –

- in years 6 and 7 did not mind being described as a nerd, but older pupils did
- in years 9 and 10 were likely to experience jealousy and to be called boffin if they came top in a mathematics test.

7.1.4 Summary of staff data

Feeling constrained

The data suggests the staff are prevented from improving the experience of their pupils by the following constraints –

- large class sizes
- staffing shortages
- lack of time for planning
- unrealistic pupil targets
- outside influences
- pupil motivation
- lack of equipment
- lack of time for covering topics
- inappropriate timetabling
- being too focussed on exam results
- behaviour
- setting.

A lack of agency and autonomy

The staff lacked agency and autonomy and appeared to accept certain outcomes as inevitable, despite the known impact on their pupils' mathematics experience. Numerous examples of this could be seen in the data such as –

- accepting the impact of the staffing rotation
- acknowledging a lack of real-life context in lessons
- recognising that the speed of topics mean pupils are left behind
- realising that falling back on a worksheet/exercise as opposed to more practical and varied lessons demotivates pupils
- the acceptance of setting and the consequences of moving pupils hastily e.g., 1 mark in their mock paper would result in a set change
- admitting that year 7 were overlooked to allow for more focus on exam classes
- recognising the impact that too much focus on the early entry exams had on certain pupils but without question of its appropriateness.

7.2 Research contributions

This research sought to explore the changes in pupil motivation and attitudes towards mathematics as pupils move up through the study secondary school, with the aim of exploring what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10, and what influences pupils' attitudes and motivation in mathematics in the study setting.

This research gives a complex and deep insight into the range of factors such as mathematics anxiety, prior attainment grouping and pupil experiences, which contribute to the decline in motivation and attitude witnessed in the study school. These factors have been presented in a pupil model which allows us to understand the complex experience of the learner and the complexity and interrelationship of the factors.

As a teacher researcher, I have provided a voice for the constraints on staff in the department. I have also raised questions about whether the staff are behaving as victims of a system, hiding behind these constraints, and using them as reasons for not enacting changes in their lessons which would improve their pupils' mathematical experience. The data has illuminated numerous scenarios where the department have lacked agency and autonomy and accepted, without question, a situation which does not meet the needs of their pupils.

This study identifies systemic levers such as large class sizes, unrealistic targets, lack of time and understaffing, as well as practical classroom levers such as increasing real life context, varying lessons, questioning policies and having more autonomy over in class decisions (e.g. setting, classwork tasks, exam paper focus) that may empower the staff to implement the changes to their pedagogy which they themselves identified would help to improve their pupils' experience and stave off the witnessed decline in motivation and attitude.

7.3 Pedagogical implications

As a teacher in the study school I was driven to conduct this research to find out what causes the changes in pupil motivation and attitude towards mathematics that I had witnessed in my own classroom. I wanted to find factors, pertinent to the study school's context which explained these changes and I expected them to be things which would be within the control of the pupil, or at least pupil related. What I did not expect to find was the range of factors that I as a teacher was doing daily and what we as a department and school were doing routinely, which had such a big impact on the motivation and attitude of the pupils. As a teacher in the study school, I was surprised to find myself part of a culture of feeling victims in a system which left us powerless to change, when we had the skills and professionalism to make changes in our own classrooms. This section will explain what this study has caused me to think about in terms of my own pedagogies and relationships with pupils.

As a result of the pupil voice in this research, I endeavour to include more real-life examples of the mathematics that I teach in my lessons. This could be as a wall display which covers different topics or at the start of a topic, or in the lesson, but the voice of the pupils throughout the data was that they craved to see why they were learning the mathematics and how it would benefit them in the future. This could even be set as a homework for them to investigate how a certain topic is used in the real world.

As a teacher I have often felt guilty for giving more attention to a pupil who is most disruptive or who tries to get my attention more and this may be adding to the lack of motivation of the quieter pupils who are struggling on their own. I expect this is a typical tension for teachers but after reading the pupils' opinions in this research I would attempt to speak to the quieter pupils in lessons or to start a 'drop box' or something similar where pupils could drop a question in at the end of a lesson if they were struggling so that I could make sure that I helped them in subsequent lessons.

However, the biggest impact on my pedagogy would be a greater acknowledgement of mathematics anxiety and the huge impact it has on virtually every aspect of mathematics education. This would start with being mindful of pupil relationships when I created my seating plan at the start of the year through to how I gave test results back to pupils at the end of the year, watching out for pupil reactions such as pushing their papers away or seeming to 'give up' after a poor test result. Reading and hearing some of the feelings that the pupils have towards mathematics has been both heart breaking and eye opening and I would hope that they will be in the back of my mind throughout the rest of my teaching career so that I will always try to be aware of how small setbacks, teacher comments, test results, peer remarks etc can play on the pupils' minds and affect their eagerness to learn mathematics in the future.

As a teacher I am aware how quickly set changes are made, often on the back of a set of test results, but I was not aware of the impact that these changes have on the pupils, especially if they are having to move sets more than once. Therefore, at a department level, I would encourage greater care when making set changes, especially to monitor how many times pupils have changed sets to avoid pupils experiencing multiple set changes in one year as it must be very demoralising for a pupil to move up a set and down a set in succession. Perhaps set changes should be tracked across the school life of a pupil to ensure that they are not constantly bobbing between sets, as this must be very unsettling for them and lead to them losing motivation.

At a school level, I would suggest that big events for pupils are tracked so that they are not subjected to too many negative experiences throughout their time at secondary school. For example, the year 7 group in this study who had a long term supply teacher due to staff shortages could be tracked to ensure that wherever possible they do not have any further disruption due to staff shortages, or that any disruption is kept to a minimum.

On a professional level I would give myself a voice to speak up within the department, on behalf of the pupils, about what I felt was constraining me from being able to improve the learner experience, issues such as being too exam focussed, behaviour in lessons, lack of equipment and the speed of the Scheme of Learning. This voice could also question and challenge accepted school policy such as setting, early entry GCSE examinations, class sizes, staffing shortages and unrealistic pupil targets to instigate positive change for the pupils. This professionalism would recognise the power that I have to make changes to the pupils' motivation and attitude, rather than feeling powerless to make a positive difference.

In summary as a teacher in the classroom, I will –

- provide more context for the mathematics the pupils are learning through wall displays, real life examples, context of topics etc.
- be aware of the pupils who may be quietly struggling and use a drop box or similar so that they have an opportunity to ask for and receive help in class
- be more mindful of mathematics anxiety in my dealings with the pupils, giving test results back, peer remarks, teacher comments etc
- remember how much power I have to improve the pupil experience and therefore their motivation and attitude.

As a member of the department, I will strive to –

- ensure greater care is given when organising set changes, including tracking pupils to ensure they do not bob between sets as they go through the school
- give a voice to the pupils by speaking up in department meetings about constraints which are inhibiting staff from making positive changes for the pupils.

As a voice within the school, I endeavour to –

- suggest pupils are tracked to ensure they are not subjected to too many negative experiences e.g., if they have a long-term supply teacher in year 7, then care should be taken to ensure they have consistency in subsequent years
- give the pupils a voice by questioning and challenging accepted school policy such as setting, early entry examinations and unrealistic target grades, which are having a detrimental impact on the pupil experience in the study school.

7.4 Implications of the study

I refer again to the research question and aims of this thesis:

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

The range of factors identified as affecting a pupils' motivation and attitude can be grouped according to whether they have the potential to be altered by the pupil, teacher, school, or general system. Figure 29 gives a pictorial representation of these factors and clearly shows who has the capability to change each factor.

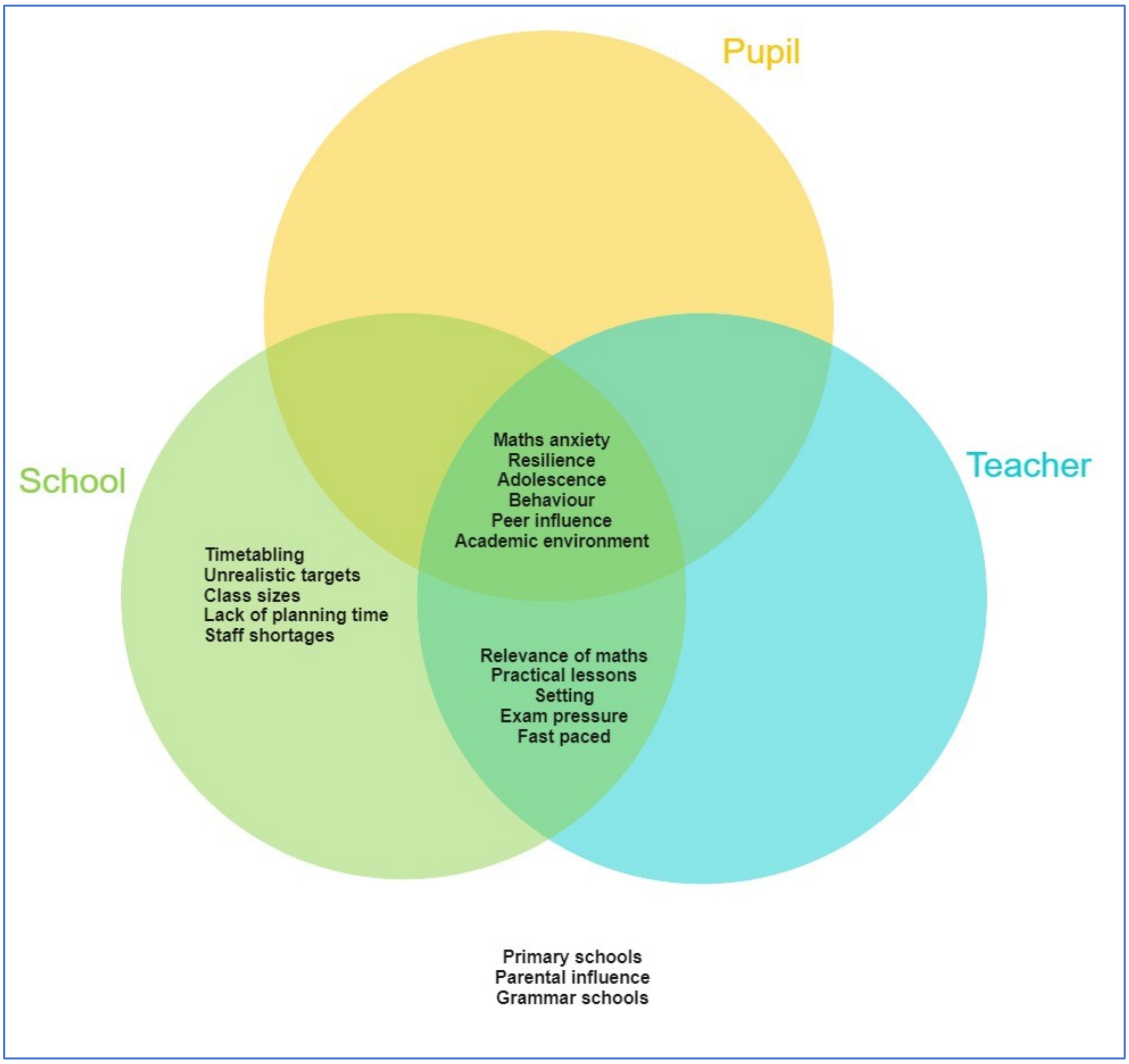


Figure 29 Venn diagram of factors affecting motivation and attitude and who can change them

Figure 29 shows that whilst there are a multitude of factors which influence a pupils' motivation and attitude towards mathematics in the study school (and as mentioned in the *Limitation* section there may be more factors at a personal level for the pupil). There are factors which the pupils, staff, school organisation and wider policy makers have an element of control over, to have a positive impact on the motivation and attitude of the pupils in the study school.

Further tracking may be necessary to monitor any experiences of the pupils which may have a cumulative effect and negatively impact their motivation and attitude towards mathematics. For example, if a pupil moves sets twice in year 7 and has a rotation of supply teachers in year 8, care should be taken to ensure that they have a stable mathematics environment in years 9, 10 and 11.

An unexpected finding of the research was the apparent deterioration of growth mindsets due to the experiences of the pupils throughout their school life; having a growth mindset is not itself a fixed mindset about mindsets but is subject to damage e.g. poor test result or set changes. An implication of this is that further research may be necessary to explore mindsets, focussing on how mindsets can be flexible and change from a growth to a fixed mindset if pupils are not resilient. Further research in this area would enable the construct of mindset to be better understood.

Whilst the aims of this research were to uncover the unique set of factors which influence the motivation and attitude of pupils towards mathematics in the study school, the inclusion of the teacher perspective has illuminated the constraints that staff in the department feel are hindering their ability to positively influence the motivation and attitude of their pupils. The study has also shone a light on how teachers can play the victim and hide behind constraints which they deem beyond their control, knowing the detrimental impact this has on pupils' motivation and attitude towards mathematics.

The implications of this are that there are changes that can be made at each level (from pupil to policy makers) to positively influence the motivation and attitude of pupils and teachers in the study school. To enact these changes, the pupils and staff need to know what factors they can influence, how they can influence them and in the case of the staff, accept that they have the autonomy to make changes in their own classrooms and are professionals who can challenge a system which does not meet the needs of their pupils.

The study school has a responsibility to play their part in improving the pupil experience, by considering logistical factors such as class sizes, timetabling, planning time and staff shortages, whilst outside the school environment, policy makers should be aware of their influence over factors such as ensuring that staff have the correct tools (time, smaller class sizes, resources, CPD etc) available to them to implement the changes in their practice which they recognise would have a positive impact on the motivation and attitude of the pupils in their classes.

In summary –

- there are a wealth of factors which influence a pupils' motivation and attitude towards mathematics in the study school
- factors can be changed by pupils, staff, school organisation and wider policy makers to have a positive impact on the motivation and attitude of the pupils
- further tracking may be necessary to monitor any experiences that the pupils have which may have a cumulative effect and negatively impact their motivation and attitude towards mathematics
- the pupils' experiences appear to lead to a deterioration of growth mindsets
- staff in the study school feel constraints are preventing them from improving the pupil experience
- teachers appear to feel like victims and blame constraints despite an awareness of the impact on pupil's motivation and attitude towards mathematics.

7.5 Limitations of the study

The next section of this chapter covers limitations of the study. As a reminder for the reader there is a flow chart in section *3.3.2 'Pilot study'* which summarises the research carried out in the study school. The aim of this study was to explore changes in pupil motivation and attitudes towards mathematics as pupils move up through one secondary school, however a limitation of this research design is that it only included two year groups as they moved through two academic years. To increase the reliability of the results from this study, it could be extended into a longitudinal study which tracks one year group as they move through the five years of secondary school. This would help to identify changes in motivation and attitude towards mathematics each year as well as tracking any longer-term impacts of organisational issues such as staffing issues. For example, if a class experienced lots of different supply teachers in year 7, does that have an impact on their attainment and feelings towards mathematics all the way through to year 11?

As the research was only repeated once (in 2015) I was only able to include pupils who had completed the questionnaires in 2014 and 2015 in the quantitative data analysis so that I could track any changes. If the study was carried out over the five years of secondary school pupils could be included even if they miss the questionnaire one year as they could be picked up in subsequent years.

When the study was designed, I had intended to select pupils for the focus groups following their responses to the questionnaire, however in practice I did not have enough parental permission slips to select pupils, so I had to include all of the pupils who gave their permission in the focus groups. This meant that I was limited in how I grouped the pupils for the discussion. Wherever possible I only included pupils from the same class in a group, but I was not able to select pupils who might have been more comfortable around each other so that they felt more able to give honest responses.

I experienced similar limitations with the research that I conducted in primary schools because I could only go into the primary schools where the head teacher had given me permission. Despite the head teacher at the study school personally writing to the primary school head teachers to ask them to support my research, many of them did not reply or refused to allow me in to interview their pupils, as they were too busy to fit it in. During the planning phase one school agreed to my research but then nearer the time had to pull out because they were rehearsing for their end of term play. This reliance on other schools supporting the research was frustrating and limiting because I did not have access to all the pupils in year 6. An improvement would be to do the questionnaires and focus groups during the year 6 Induction Day, but this would not allow time to collate parental permission slips. Alternatively, I could conduct the focus groups during their first few days at the study school in year 7 if the study school allowed it.

Getting the questionnaires completed was itself a limitation because I had to rely on other teachers to give them out, ensure that they were completed anonymously and to explain any questions which the pupils did not understand. Although the teachers tried their best, I think it would have been more robust if I, as researcher, could have gone into each classroom and explained the research and the questionnaires, ensuring that they were given out correctly and anonymously in order to standardise how the pupils filled in the questionnaires.

Whilst ensuring that I completed all the research myself would have ensured uniformity, it does highlight another limitation which was the possible bias created by me as teacher in the study school and as researcher. Although this might not have been as prevalent in the questionnaire responses as the pupils completed these with their class teacher, I conducted the focus groups so the pupils might have felt obliged to answer in a certain way and give me the answer that they thought that I wanted to hear. This limitation could be overcome by conducting the research in a school where I did not work so I would only be a researcher to the pupils and not their teacher.

My role of teacher researcher was discussed in *3.4.3 'Power balance and positionality'* but a positive consequence of this position was that as a colleague the department may have been more candid than would otherwise have been the case, as the staff felt comfortable talking to a colleague and not an outsider during the staff interviews.

The order that I chose to analyse the data has shaped what I have produced in this thesis because despite my best efforts, the themes that I generated from analysing the first set of data will have influenced how I looked at the next set of data and so on. Whilst I have found out new pieces of information as I conducted more data analysis, I would unintentionally be looking for the themes which were generated from the first analysis. Every research decision that I have made has contributed to the findings in this study and had I made different research decisions; these findings would look different.

When analysing the questionnaire data, I reflected that I had not asked the pupils anything about their individual lives which may have impacted on their motivation and attitudes towards mathematics e.g. home life, illness, school moves etc. The reason for this was that I wanted to consider the cohort collectively to identify factors which affect whole year groups and not individual pupils. However, an improvement to the questionnaire could be to ask the pupils if there is anything that has happened in their personal life which may have an impact on their motivation and attitude towards mathematics but not ask for the details of what it is. This would allow some analysis on how many pupils experience difficulties in their personal lives which might impact on their school life, without asking them to divulge any personal details. However, this would need consideration around the ethical issues which would arise due to making the pupils more vulnerable.

From the review of literature in Chapter 2 I had included the Personal factor of Mistakes and mathematics and the System factor of Selection, however my data did not provide any information which fell into these categories. This may not be because these categories do not exist in the study school, but rather that my tool did not address it. An improvement to the research tools would be to include questions in the questionnaire and focus groups which cover mistakes in mathematics and selection e.g. the pupils could be asked if the study school was their first choice of school or not. Questions which try to elicit the mindset of the pupils would also allow for greater analysis in this area and would shed light on the impact of pupil mindset on their attitude value and allow for greater investigation into how mindsets can change i.e. having a growth mindset is not a fixed mindset about mindsets.

7.6 Suggestions for further research

I refer a final time to the research question and aims of this thesis:

To explore changes in pupil motivation and attitude towards mathematics as pupils move up through one secondary school.

Embedded within this aim are research questions which are explored through the study of a single case, akin to common descriptions of 'case study' (Stake, 1978; Yazan, 2015; Yin, 2004). I refer throughout to 'study school' to clarify that my research and results are bounded by the single site of my study. This approach was used in order to respond to the overriding aim.

- Within the study school setting, what motivation and attitudes towards mathematics were demonstrated by pupils in year 6 into 7 and year 9 into 10?
- What influences pupils' attitudes and motivation in mathematics in the study school setting?

This section first lists suggestions for areas of further research illuminated in the discussion of the data in Chapter 6 and then discusses ways that the design of the study could be developed in further research.

7.6.1 Further research from the data

The following list summarises suggestions for further research from the data. Further details of the following points can be read in the *Discussion* chapter.

- Investigate how the department enacted set changes i.e., examination results, prior attainment, teacher discussions etc. and how the pupils were told of the set change.
- Probe whether older pupils realise the personal benefits of a mathematics GCSE and what these benefits may be.
- Track pupils who have been affected by staffing shortages and monitor their feelings towards mathematics and whether the disruption has a long-term impact.
- Investigate whether pupils deem work is too easy for them because they are succeeding or because they naively think that the work is too easy for them and how this self-efficacy is related to motivation and attitude.
- Explore the relationship between setting and behaviour and whether pupils with poor behaviour are moved into lower sets.
- Probe the relationship between quiet pupils who get ignored and do not ask for help and their attitude and motivation towards mathematics.
- Explore the reasons behind the change in relevancy of mathematics as pupils get older.
- Ask the pupils to compare how anxious they feel this year compared to last or create a way of comparing how anxious one pupil was against another to quantify and explore mathematics anxiety in the study school.
- Investigate whether pupils feel more anxious in mathematics as the set number increases and why this may be.
- I expected the issue of selectivity to be regularly raised by the pupils without bringing the topic up directly but perhaps this reflects that the staff view selectivity as an issue more than the pupils and could be an area for further research.
- Consider the impact of the number and direction of set changes on the pupils' attitude and motivation towards mathematics.
- Explore what impact the past examination papers have on different prior attainment groups as some may be motivated whilst others demotivated.
- Investigate why older pupils have a change in reaction to being called a 'nerd' or 'boffin'.
- Look into what the pupils are describing when they picture their mathematician and how it changes with age.
- Consider asking staff questions which encourage them to critique department and school policies.

- Investigate whether the department are acting as victims in a system that gives them little autonomy or if they do not have a culture of change and adaptation in the ways they teach in the study school.

7.6.2 Further research design

As this research was a single-site study, further research could be conducted in other secondary schools to see if similar factors contribute to the changes seen in pupil motivation and attitude. Different types of schools could also be used to see if there is any variety in the factors according to school setting. A parallel study in other subject areas would be beneficial to see what factors are specific to mathematics as a subject or mathematics in one school.

As a teacher in the study school I felt that the neighbouring grammar schools were having an impact on the motivation and attitude of the pupils and assumed that this would show in the data. However, other than a question in the focus groups which asked the pupils if this was their first choice of school I did not specifically ask the pupils about their secondary school choices and the impact that the process had on them. As this factor was not apparent in the data, further research into this area would be beneficial. The research methods should be revised to include specific questions to capture information regarding the pupils' feelings around the process of secondary school allocations and what their preferences were. This would enable me to see if my instincts regarding the impact the perceived 'failure' to get into grammar schools has on pupil attitude and motivation are correct.

An area for further research would be the impact of primary schools. Some of the work that is covered in primary school is often overlooked by secondary school teachers so further research in this area could highlight issues at transition where pupils end up re-learning what they have already covered to get all of the pupils to the same level. This is linked to the feelings that the staff had of rushing through the curriculum and not allowing the year 7 pupils time to feel that they did not understand something because they were always having to move on to the next topic.

This research was conducted in 2014 and 2015 and the quantitative data showed that there was not a statistically significant relationship between whether parents helped pupils with their homework and the pupils' attitude value. However, given the Covid-19 pandemic of

2020 and the necessary involvement of parents in their children's learning it would be worth revisiting this aspect of the study to see if parents are now more or less involved with their child's learning and to see if this involvement has a statistically significant impact on attitude value.

As suggested in the *limitation* section this research study could be expanded to track pupils through all years of secondary school, perhaps with a short questionnaire mid-academic year to track in detail any changes in motivation or attitude towards mathematics. This would allow greater analysis between changes in motivation and attitude and possible reasons for them, as data could be collected every six or twelve months over the five years of secondary school. So for example, if a pupil exhibited a decrease in their motivation or attitude towards mathematics, this may be linked to a recent poor mock exam result or set change, as opposed to having to consider what has happened over multiple school years, as in this study.

The aim of this study was to explore the factors which affect the pupils' motivation and attitude towards mathematics in the study school with the purpose of changing the pupil experience so that the pupils were more positive towards mathematics. Therefore the findings from this research need to be shared within the department, the study school and possibly beyond in order to make changes to improve the pupils experience.

As I focus more on the changes in motivation and attitude of the pupils and how my behaviour as a teacher affects this, I will monitor the impact of the pedagogical changes that I intend to make in the classroom and what impact these have on the pupils' learning, engagement and attainment. As a result, I can embed or alter any changes to my pedagogy to improve the attitude and motivation of pupils as they study mathematics and see if this strengthens the self-belief of the pupils so that when they face any challenges (including seeing the neighbouring grammar school at a competition) they have the resilience to believe that they can win.

Works Cited

Abbassi, N., 2016. Adolescent identity formation and the school environment, the translational design of schools: An evidence-based approach to aligning pedagogy and learning environments. pp. 83-103.

Ahmavaara, A. & Houston, D., 2007. The effects of selective schooling and self-concept on adolescents' academic aspiration: An examination of Dweck's self-theory. *British Journal of Educational Psychology,* pp. 613-632.

Ahmed, W., van der Werf, G., Kuyper, H. & Minnaert, A., 2013. Emotions, self-regulated learning, and achievement in mathematics: A growth curve analysis. *Journal of Educatinal Psychology,* Volume 105, pp. 150-161.

Ajzen, I., 1988. *Attitudes, personality and behaviour.* Milton Keynes: Open University.

Alexander, P. A., Kulikowich, J. M. & Jetton, T. L., 1994. The role of subject-matter knowledge and interest in the processing of linear and nonlinear texts. *Review of educational research,* 64(2), pp. 201-252.

Allen, E. & Seaman, C. A., 2007. Likert scales and data analyses. *Quality Progress,* Volume 40, pp. 64-65.

Allport, G. W., 1935. Attitudes. In: *Handbook of Social Psychology.* Worcester: Clark university, pp. 798-839.

Ames, C., 1992. Classrooms: goals, structures, and student motivation. *Journal of Educational Psychology,* Volume 84, pp. 261-271.

Anderman, E. M., Austin, A. C. & Johnson, D. M., 2002. The development of goal orientation. In: *Development of achievement motivation.* San Diego, CA: Academic Press, pp. 197-220.

Anderson, A., Hamilton, R. J. & Hattie, J., 2004. Classroom climate and motivated behaviour in secondary schools. *Learning Environments Research,* Volume 7, pp. 211-225.

Anderson, N. & Peart, S., 2016. Back on track: Exploring how a further education college re-motivates learners to re-sit previously failed qualifications at GCSE. *Research in Post-Compulsory Education,* 21(3), pp. 196-213.

Andersson, A., Valero, P. & Meaney, T., 2015. "I am [not always] a maths hater": Shifting students' identity narritives in context. *Educational Studies in Maths,* Volume 90, pp. 143-161.

Arksey, H. & Knight, P., 1999. *Interviewing for social scientists.* London: Sage.

Artino Jr, A. R., La Rochelle, J. S., Dezee, K. J. & Gehlbach, H., 2014. Developing questionnaires for educational research: AMEE Guide No. 87. *Medical Teacher,* 36(6), pp. 463-474.

Ashcraft, M. H., 2002. Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science,* Volume 11, pp. 181-185.

Ashcraft, M. H. & Faust, M. W., 1994. Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition & Emotion,* 8(2), pp. 97-125.

Ashcraft, M. H. & Kirk, E. P., 2001. The relationships among working memory, math anxiety, and performance. *Journal of Experiemental Psychology: General,* Volume 130, pp. 224-237.

Ashcraft, M. H. & Krause, J. A., 2007. Working memory, math performance and math anxiety. *Psychonomic Bulletin & Review,* Volume 14, pp. 243-248.

Askew, M., Hodgen, J., Hossain, S. & Bretscher, N., 2010. *Values and variables Mathematics education in high-performing countries,* King's College London: Nuffield Foundation.

Atkinson, J. W., 1964. *An introduction to motivation.* Princeton, NJ: Van Nostrand.

Bandura, A., 1997. *Self-Efficacy: The exercise of control.* New York: Freeman.

Bartholomew, H., Darragh, L., Ell, F. & Saunders, J., 2011. 'I'm a natural and I do it for love!': Exploring students' accounts of studying mathematics. *International Journal of Mathematical Education in Science and Technology,* 42(7), pp. 915-924.

Batchelor, S., Gilmore, C. & Inglis, M., 2017. Parents' and children's mathematics anxiety. In: *Understanding emotions in mathematical thinking and learning.* Cambridge: Academic Press, pp. 315-336.

Baxter, P. & Jack, S., 2008. Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report,* 13(4), pp. 544-559.

Bazeley, P., 2009. Analysing qualitative data: More than 'identifying themes'. *The Malaysian Journal of Qualitative Research,* 2(2), pp. 6-21.

Benware, C. A. & Deci, E. L., 1984. Quality of learning with an active versus passive motivational set. *American Educational Research Journal,* Volume 21, pp. 755-765.

Berger, R., 2015. Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative Research,* 15(2), pp. 219-234.

Black, P. J. & Wiliam, D., 1998. Assessment and classroom learning. *Assessment in Education,* Volume 5, pp. 7-73.

Blackwell, L. S., Trzesniewski, K. H. & Dweck, C. S., 2007. Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development,* 78(1), pp. 246-263.

Blanden, J., Goodman, A., Gregg, P. & Machin, S., 2002. *Changes in intergenerational mobility in Britain,* London: London School of Economics and Political Science.

Boaler, J., 1997. Setting, social class and survival of the quickest. *British Educational Research Journal,* 23(5), pp. 575-595.

Boaler, J., 1997. When even the winners are losers: Evaluating the experiences of 'top set' students. *Journal of Curriculum Studies,* 29(2), pp. 165-182.

Boaler, J., 2005. The 'Psychological Prisons' from which they never escaped: The role of ability grouping in reproducing social class inequalities. *FORUM,* 47(2&3), pp. 125-134.

Boaler, J., 2013. Ability and mathematics: The mindset revolution that is reshaping education. *Forum,* 55(1), pp. 143-1525.

Boaler, J., 2015. *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching.* San Francisco, CA: Jossey-Bass .

Boaler, J., Altendorff, L. & Kent, G., 2011. Mathematics and science Inequalities in the United Kingdom: When elitism, sexism and culture collide. *Oxford Review of Education,* pp. 457-484.

Boaler, J., Wiliam, D. & Brown, M., 2000. Students' experiences of ability grouping: Disaffection, polarisation and the construction of failure. *British Educational Research Journal,* 26(5), pp. 631-648.

Bouchey, H. A. & Harter, S., 2005. Reflected appraisals, academic self-perceptions, and math/science performance during early adolescent. *Journal of Educational Psychology,* 97(4), pp. 673-686.

Bowen, G. A., 2008. Naturalistic inquiry and the saturation concept: A research note. *Qualitative Research,* Volume 8, pp. 137-152.

Braun, V. & Clarke, V., 2012. Thematic analysis. In: *The Handbook of Research Methods in Psychology.* Washington, DC: American Psychological Association, pp. 57-71.

Brenner, M. E., 2006. Interviewing in educational research. In: *Handbook of complementary methods in education.* Mahwah, NJ: Lawrence Erlbaum & Associates, pp. 357-370.

Brown, M., Brown, P. & Bibby, T., 2008. "I would rather die": Reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education,* 10(1), pp. 3-18.

Brown, M. L., Macrae, S., Rodd, M. & Wiliam, D., 2005. *Full report of research activities and results: Students' experiences of undergraduate mathematics,* London: King's College London Department of Education and Professional Studies.

Bryman, A., 2007. Barriers to integrating quantiative and qualitative research. *Journal of Mixed Methods Research,* 1(1), pp. 8-22.

Burchinal, M. R., Roberts, J. E., Zeisel, S. A. & Rowley, S. J., 2008. Social risk and protective factors for African American children academic achievement and adjustment during the transition to middle school. *Developmental Psychology,* Volume 44, pp. 286-292.

Burnard, P., 1991. A method of analysing interview transcripts in qualitative research. *Nurse Education Today,* Volume 11, pp. 461-466.

Burnard, P. et al., 2008. Analysing and presenting qualitative data. *British Dental Journal,* 204(8), pp. 429-432.

Burns, R. B., 2000. *Introduction to research methods.* London: Sage.

Butterworth, B., 1999. *The mathematical brain.* London: Macmillan.

Buxton, L., 1981. *Do you panic about maths?.* London: Heinemann.

Cameron, J. & Pierce, W. D., 1994. Reinforcement, reward, and intrinsic motivation: A meta-analysis. *Review of educational research,* 64(3), pp. 363-423.

Carey, E. et al., 2019. *Understanding Mathematics anxiety: Investigating the experiences of UK primary and secondary school students,* University of Cambridge: Centre for Neurosceience in Education.

Carey, E., Hill, F., Devine, A. & Szucs, D., 2015. The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in Psychology,* pp. 1-6.

Charmaz, K., 2014. *Constructing grounded theory.* London: Sage.

Clough, P. & Nutbrown, C., 2012. *A student's guide to methodology.* London: Sage.

Cockcroft, W. H., 1982. *Mathematics counts: Report of the committee of inquiry into the teaching in schools,* London: HMSO.

Cohen, L., Manion, L. & Morrison, K., 2011. *Research methods in education.* Abingdon: Routledge.

Coleman, J. C., 2011. *The nature of adolescence.* London: Routledge.

Connell, J. P., Spencer, M. B. & Aber, J. L., 1994. Educational risk and resilience in African American youth: context, self, and action outcomes in school. *Child Development ,* Volume 65, pp. 493-506.

Connell, J. P. & Wellborn, J. G., 1991. Competence, autonomy, and relatedness: A motivational analysis of self-system processes.. In: *Minnesota Symposia on Child Psychology.* Hillsdale, NJ: Erlbaum, pp. 43-77.

Connolly, P., 2003. *Ethical principles for researching vulnerable groups,* Belfast: Office of the First Minister and Deputy First Minister.

Connolly, P., 2006. The effects of social class and ethnicity on gender differences in GCSE attainment: A secondary analysis of the youth cohort study of England and Wales 1997-2001. *British Educational Research Journal,* 32(1), pp. 3-21.

Covington, M. V., 1992. *Making the grade: A self-worth perspective on motivation and school reform.* New York: Cambridge University Press.

Covington, M. V., 1998. *The will to learn: A guide for motivating young people.* New York: Cambridge University Press.

Covington, M. V. & Omelich, C. L., 1979. Effort: The double-edged sword in school achievement. *Journal of Educational Psychology,* Volume 71, pp. 169-182.

Csikszentmihalyi, M., 1988. The flow experience and its significance for human psychology. In: *Optimal Experience: Psychological Studies of Flow in Consciousness.* Cambridge, MA: Cambridge University Press, pp. 15-35.

Csikszentmihalyi, M. & Massimini, F., 1985. On the psychological selection of bio-cultural information. *New Ideas Psychol,* Volume 3, pp. 15-138.

Currie, C., Roberts, C. & Morgan, A., 2008. *Health behaviour in school-aged children. International report from the 2005/06 study,* Geneva: World Health Organisation.

Dar-Nimrod, I. & Heine, S. J., 2006. Exposure to scientific theories affects women's math performance. *Science,* 314(5798), p. 435.

Davidson, C., 2009. Transcription imperatives for qualitative research. *International Journal of Qualitative Methods,* 8(2), pp. 35-52.

Dawes, R. M., 1972. *Fundamentals of attitude measurement.* London: Wiley.

DeBellis, V. A. & Goldin, G. A., 1997. *The affective domain in mathematical problem solving.* Lahti, Finland, university of Helsinki, pp. 209-216.

DeBellis, V. & Goldin, G., 2006. Affect and meta-affect in mathematical problem solving: A Representational Perspective. *Educational Studies in Mathematics,* 63(2), pp. 131-147.

Deci, E. L., 1975. Notes on the theory and metatheory of intrinsic motivation. *Organizational behavior and human performance,* Volume 15, pp. 130-145.

Deci, E. L., Koestner, R. & Ryan, R. M., 1999. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological bulletin,* 125(6), pp. 627-668.

Deci, E. L. & Ryan, R. M., 1985. *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

Deci, E. & Ryan, R. M. (., 2002. *Handbook of self-determination theory research.* Rochester NY: University of Rochester Press.

Denscombe, M., 2008. Communities of practice: A research paradigm for the mixed methods approach. *Journal of Mixed Methods Research,* 2(3), pp. 270-283.

Denscombe, M., 2014. *The good research guide: For small-scale research projects.* Berkshire: Open University Press.

Di Martino, P. & Zan, R., 2001. *Attitude toward mathematics: Some theoretical issues.* Utrecht, he Netherlands, Freudenthal Institute, University of Utrecht, pp. 209-216.

Di Martino, P. & Zan, R., 2001. *The problematic relationship between beliefs and attitudes.* Kristianstad, Sweden, s.n., pp. 17-24.

Di Martino, P. & Zan, R., 2011. Attitude towards mathematics: A bridge between beliefs and emotions. *Mathematics Education,* Volume 43, pp. 471-482.

Dictionary, O. E., 2020b. *Oxford English Dictionary.* [Online]
Available at: https://www.oxfordlearnersdictionaries.com/definition/english/attitude
[Accessed 21 August 2014].

Diener, C. I. & Dweck, C. S., 1978. An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. *Journal of Personality and Social Psychology,* Volume 36, pp. 451-462.

Dixon, A., 2002. Editorial. *FORUM,* 44(1), p. 1.

Dunne, M. et al., 2007. *Effective teaching and learning for pupils in low attaining groups.* Nottingham: DfES Publications.

Dweck, C., 1999. *Self-theories: Their role in motivation, personality, and development.* Philadelphia: Psychology Press.

Dweck, C., 2006. *Mindset: The new psychology of success.* New York: Random House LLC.

Dweck, C. S., 1975. The role of expectations and attributions in the alleviation of learned helplessness. *Journal of Personality and Social Psychology,* Volume 31, pp. 674-685.

Dweck, C. S., 2007. Is maths a gift? Beliefs that put females at risk. In: *Why Aren't More Women in Science? Top Researchers Debate the Evidence.* Washington DC: American Psychological Association.

Dweck, C. S., 2007. The secret to raising smart kids. *Scientific American Mind,* 18(6), pp. 36-43.

Dweck, C. S., 2008. *Mindsets and math/science achievement,* New York: Carnegie Corporation of New York.

Dweck, C. S. & Bush, E. S., 1976. Sex differences in learned helplessness: Differential debilitation with peer and adult evaluators. *Developmental Psychology,* Volume 12, pp. 147-156.

Dweck, C. S., Mangels, J. A. & Good, C., 2004. Motivational effects on attention, cognition, and performance. In: *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development.* New Jersey: Lawrence Erlbaum Associates, pp. 41-55.

Dweck, C. S. & Reppucci, N. D., 1973. Learned helplessness and reinforcement responsibility in children. *Journal of Personality and Social Psychology,* Volume 25, pp. 109-116.

Dweck, C. S. & Reppucci, N. D., 1973. Learned helplessness and reinforcement responsibility in children. *Journal of Personality and Social Psychology,* Volume 25, pp. 109-116.

Eagly, A. H. & Chaiken, S., 1993. *The psychology of attitudes.* Fort Worth, Texas: Harcourt Brace Jovanovich College, s.n.

Eccles , J., 2004. Schools, academic motivation, and stage-environment fit. In: *Handbook of adolescent psychology.* New York: Wiley.

Eccles, J. et al., 1983. Expectancies, values and academic behaviors. In: *Achievement and Achievement Motivation.* San Francisco: Freeman, pp. 75-146.

Eccles, J. S., 1987. Gender roles and women's achievement-related decitions. *Psychology of Women Quarterly,* Volume 11, pp. 135-72.

Eccles, J. S., 1993. School and family effects on the ontogeny of children's interests, self-perceptions, and activity choice. In: *Nebraska Symposium on Motivation, 1992: Developmental Perspectives on Motiavation.* Lincoln: University of Nebraska Press, pp. 145-208.

Eccles, J. S., 2009. Who am I and what am I going to do with my life?. *Educational Psychologist,* Volume 44., pp. 78-89.

Eccles, J. S., Adler, T. F. & Meece, J. L., 1984. Sex differences in achievement: A test of alternate theories. *Journal of personality and social psychology,* Volume 46, pp. 26-43.

Eccles, J. S., Barber, B. & Jozefowicz, D., 1998. Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of acheivementrelated choices. In: *Sexism and Stereotypes in Modern Society: The Gender Science of Janet Taylor Spence.* Washington, DC: American Psychological Association, pp. 153-192.

Eccles, J. S. & Jacobs, J. E., 1986. Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society,* 11(2), pp. 367-380.

Eccles, J. S. et al., 1993. Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. *American Psychologist,* 48(2), pp. 90-101.

Eccles, J. S. & Roeser, R. W., 2011. Schools as developmental contexts during adolescence. *Journal of Research on Adolescence,* 21(1), pp. 225-241.

Eccles, J. S. & Wigfield, A., 2002. Motivational beliefs, values and goals. *Annual Review of Psychology,* Volume 53, pp. 109-132.

Eccles, J. S., Wigfield, A. & Schiefele, U., 1998. Motivation. In: *Handbook of Child Psychology.* New York: Wiley, pp. 1017-1095.

Eden, C., Heine, A. & Jacobs, A. M., 2013. Mathematics anxiety and its development in the course of formal schooling - A review. *Psychology,* Volume 4, pp. 27-35.

Ennis, C. D. & Chen, S., 2012. Chapter 16: Interviews and focus groups. In: *Research methods in physical education and youth sport.* New York: Routledge, pp. 217-236.

Etzioni, A. (., 1969. *The semi-professions and their organization.* New York: Free Press.

Evans, J., 2000. *Adults' mathematical thinking and emotions: A study of numerate practices.* London: Routledge Falmer.

Evans, J., Hannula, M., Zan, R. & Brown, L., 2006. Affect in mathematics education - Exploring theoretical frameworks. *Educational Studies in Mathematics,* 63(2), p. Special Issue.

Finn, J. D., 2006. *The adult lives of at-risk students,* Washington DC: US Department of Education NCES.

Fischbein, M., 1967. A consideration of beliefs, and their role in attitude measurement. In: *Attitude Theory and Measurement.* New York: Wiley, pp. 257-266.

Fishbein, M. & Ajzen, I., 1975. *Belief, attitude, intention and behaviour.* Reading, MA: Addison-Wesley.

Flick, U., 2002. *An Introduction to qualitative research.* London: Sage.

Fogarty, G. J. et al., 2001. Validation of a questionnaire to measure mathematics confidence, computer confidence, and attitudes to the use of technology for learning mathematics. *Mathematics Education Research Journal,* Volume 13, pp. 154-60.

Ford, M. E., 1992. *Human motivation: Goals, emotions, and personal agency beliefs.* Newbury Park, CA: Sage.

Ford, M. E. & Nichols, C. W., 1987. A taxonomy of human goals and some possible application. In: *Humans as Self-Constructing Living Systems: Putting the Framework to Work.* Hillsdale, NJ: Erlbaum, pp. 289-311.

Foundation, N. S., 2010. *Chapter 2. Higher Education in Science and Engineering.* [Online] Available at: https://wayback.archiveit.org/5902/20160210220943/http://www.nsf.gov/statistics/seind10/c2/c2h.htm [Accessed 9 November 2016].

Fowler, F. J. J., 2009. *Survey research methods.* Thousand Oaks CA: Sage.

Fox, K. & Pope, S., 2005. Gifted and talented mathematicians. In: Lancaster: s.n., pp. 33-38.

Francis, B. et al., 2016. Exploring the relative lack of impact of research on 'Ability Grouping' in England: A discourse analytic account. *Cambridge Journal of Education,* pp. 1-17.

Francis, B. et al., 2019. Teacher'quality' and attainment grouping: The role of within-school teacher deployment in social and educational inequality. *Teaching and Teacher Education,* Volume 77, pp. 183-192.

Francis, J. et al., 2010. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health,* 25(10), pp. 1229-1245.

Friedman, H. H. & Amoo, T., 1999. Rating the rating scales. *Journal of Marketing Management,* 9(3), pp. 114-123.

Gallagher, J., 2014. *Mathematics: Why the brain sees maths as beauty.* [Online] Available at: http://www.bbc.co.uk/news/science-environment-26151062 [Accessed 7 July 2014].

Galton, M., Comber, C. & Pell, T., 2002. The consequences of transition for pupils: Attitudes and attainment. In: *Transfer from the primary classroom: 20 years on.* London: Routledge/Falmer.

Galton, M. & Hargreaves, L., 2002. Transfer: A future agenda. In: *Transfer from the primary classroom: 20 years on.* London: RoutledgeFalmer, pp. 185-202.

Gamoren, A. & Berends, M., 1987. The effects of stratification in secondary schools: Synthesis of survey and ethnographic research. *Review of Educational Research,* Volume 57, pp. 415-435.

Giacobbi Jr, P. R., Poczwardowski, A. & Hager, P. F., 2005. A pragmatic research philosophy for applied sport psychology. *Kinesiology, Sport Studies and Physical Education,* 3(1), pp. 18-31.

Gnambs, T. & Hanfstingl, B., 2016. The decline of academic motivation during adolescence: An accelerated longitudinal cohort analysis on the effect of psychological need satisfaction. *Educational psychology,* 36(9), pp. 1691-1705.

Goetz, T., Frenzel, A. C., Hall, N. C. & Pekrun, R., 2008. Antecedents of academic emotions: Testing the internal/external frame of reference model for academic enjoyment. *Contemporary Educational Psychology,* Volume 33, pp. 9-33.

Good, C., Rattan, A. & Dweck, C. S., 2012. Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology,* 102(4), pp. 700-717.

Gottfried, A. E., 1990. Academic intrinsic motivation in young elementary school children. *Journal of educational psychology,* 82(3), pp. 525-538.

Government, U., 2018. *Revised GCSE and equivalent results in England, 2016 to 2017.* [Online]
Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/676596/SFR01_2018.pdf
[Accessed 15 May 2020].

Graham, S. & Weiner, B., 1996. Theories and principles of motivation. In: *Handbook of educational psychology.* New York: Simon & Schuster Macmillan, pp. 63-84.

Gray, S. L., 2007. Teacher as technician: Semi-professionalism after the 1988 Education Reform Act and its effect on conceptions of pupil identiy. *Policy futures in education,* 5(2), pp. 194-203.

Green , A., 2003. Is UK education exceptionally unequal? Evidence from IALS and PISA surveys. *FORUM,* 45(2), pp. 67-70.

Greenwood, J., 1984. My anxieties about math anxiety. *Mathematics Teacher,* pp. 662-663.

Greig, A. D. & Taylor, J., 1999. *Doing research with children.* London: Sage.

Guay, F. et al., 2010. Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology,* Volume 80, pp. 711-735.

Guo, J., Parker, P. D., Marsh, H. W. & Morin, A. J., 2015. Achievement, motivation, and educational choices: A longitudinal study of expectancy and value using a multiplicative perspective. *Developmental Psychology,* 51(8), pp. 1163-1176.

Gutierrez, R., 2002. Enabling the practice of mathematics teachers in context: Toward a new equity research agenda. *Mathematical Thinking and Learning,* 4(2&3), pp. 145-187.

Halcomb, E. J. & Davidson, P. M., 2006. Is verbatim transcription of interview data always necessary?. *Applied Nursing Research,* Volume 19, pp. 38-42.

Hallam, S. & Ireson, J., 2003. Secondary school teachers' attitudes towards and beliefs about ability grouping. *British Journal of Educational Psychology,* Volume 73, pp. 343-356.

Halloran, J. D., 1967. *Attitude formation and change: Television research committee: Working paper no. 2,* Leicester: Leicester University.

Hammersley, M. & Traianou, A., 2012. *Ethics and educational research, British Educational Research Association.* [Online]
Available at: https://www.bera.ac.uk/researchers-resources/publications/ethics-and-educational-research
[Accessed 8 August 2017].

Hannan, A., 2007. *Interviews in education research.* [Online]
Available at:
https://eclass.aspete.gr/modules/document/file.php/EPPAIK269/UsingInterviewsinEducationResearch.pdf
[Accessed 18 December 2020].

Hannula, M. S., 2002. Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics,* 49(1), pp. 25-46.

Hannula, M. S., 2006. Motivation in mathematics: Goals reflected in emotions. *Educational Studies in Mathematics,* Volume 63, pp. 165-178.

Harter, S., 1990. Causes, correlates and the functional role of global self-worth: A life-span perspective. In: *Perceptions of Competence and Incompetence Across the Life-Span.* New Haven: Yal University Press, pp. 67-98.

Harter, S., 1998. Developmental perspectives. In: *Handbook of Child Psychology.* New York: Wiley, pp. 553-618.

Hart, R., 1992. *Children's participation: From tokenism to citizenship.* Paris: UNICEF.

Hebb, D. O., 1955. Drives and the C.N.S. (Conceptual Nervous System). *The Psychological Review,* 62(4), pp. 243-254.

Hembree, R., 1990. The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education,* Volume 21, pp. 33-46.

Henrion, C., 1997. *Women in mathematics: The addition of difference.* Bloomington and Indianapolis: Indiana University Press.

Hernandez-Martinez, P. & Pampaka, M., 2017. "I did use to like maths...": Emotional changes towards mathematics during secondary school education. In: *Understanding Emotions in Mathematical Thinking and Learning.* Cambridge: Academic Press, pp. 187-220.

Hernandez-Martinez, P. & Vos, P., 2018. "Why do I have to learn this?" A case study on students' experiences of the relevance of mathematical modelling activities. *ZDM Mathematics Education,* Volume 50, pp. 245-257.

Hidi, S. & Harackiewicz, J. M., 2001. Motivating the academically unmotivated: a critical issue for the 21st century. *Review of educational research,* Volume 70, pp. 151-180.

Himmelfarb, S. & Eagly, A. H., 1974. Orientations to the study of attitudes and their change. In: *Readings in Attitude Change.* New York: Wiley, pp. 2-49.

Hoepfl, M. C., 1997. Choosing qualitative research: A primer for technology education researchers. *Journal of Technology Education,* 9(1), pp. 47-63.

Howe, K. R. & Moses, M. S., 1999. Ethics in educational research. *Review of Research in Education,* Volume 24, pp. 21-60.

Hurst, M. & Cordes, S., 2017. When being good at math is not enough: How students' beliefs about the nature of mathematics impact decisions to pursue optional math education. In: *Understanding emotions in mathematical thinking and learning.* Cambridge: Academic Press, pp. 221-241.

Hyde, J. S. et al., 1990. Gender comparisons of mathematics attitudes and affect. *Psychology of Women Quarterly,* Volume 14, pp. 299-324.

Ireson, J. & Hallam, S., 2001. *Ability grouping in education.* London: Paul Chapman.

Ireson, J., Hallam, S. & Hurley, C., 2002. *Ability grouping in the secondary school: Effects on GCSE attainment in English, mathematics and science.* Univeristy of Exeter, University of London Institute of Education.

Jablonka, E., 2013. Boredom in mathematics classrooms from Germany, Hong Kong and the United States. In: *Proceedings of the Eighth Congress of European Research in Mathematics Education.* Middle East Technical University: AntalyaL Service des publications, p. CERME 8.

Jackson, A. & Davies, G., 2000. *Turning points 2000: Educating adolescents in the 21st century,* New York: Teachers' College Press.

Jameson, M. M., 2014. Contextual factors related to math anxiety in second-grade children. *The Journal of Experimental Education,* Volume 82, pp. 518-536.

Jamieson, S., 2004. Likert Scales: How to (ab)use them. *Medical Education,* 38(12), pp. 1217-1218.

Jesson, D., 2006. The performance of pupils and schools in selective and non-selective local authorities. In: *Comprehensive education: Evolution, achievements and new directions.* Northampton: University of Northampton Press.

Joffe, H., 2012. Thematic analysis. In: *Qualitative Research Methods in Mental Health and Psychotherapy: A Guide for Students and Practitioners.* Chichester: Wiley-Blackwell, pp. 209-223.

Johnson, R. B. & Onwuegbuzie, A. J., 2004. Mixed methods research: A paradigm whose time has come. *American Educational Research Association,* 33(7), pp. 14-26.

Johnston, S., 1994. Choosing mathematics: 'You need it even if you don't want to do it'. *Australian Journal of Education,* Volume 38, pp. 233-49.

Johnston-Wilder, S., Brindley, J. & Dent, P., 2014. *A survey of mathematics anxiety and mathematical resilience among existing apprentices,* Coventry: University of Warwick: The Gatsby Charitable Foundation.

Johnston-Wilder, S. & Lee, C., 2008. Does articulation matter when learning mathematics?. *Proceedings of the British Society for Research into Learning Mathematics,* 28(3), pp. 54-59.

Johnston-Wilder, S. & Lee, C., 2010. *Developing mathematical resilience.* Warwick University, s.n.

Johnston-Wilder, S. & Lee, C., 2015. *Developing mathematical resilience in school-students who have experienced repeated failure.* Seville, ICERI 2015.

Johnston-Wilder, S. & Moreton, J., 2018. *Developing mathematical-resilience-promoting practices in teachers.* Seville, ICERI2018.

Katz, D., 1967. The functional approach to the study of attitudes. In: *Attitude theory and measurement.* New York: Wiley, pp. 457-468.

Khandkar, S. H., 2009. *Open coding.* [Online]
Available at: http://pages.cpsc.ucalgary.ca/~saul/wiki/uploads/CPSC681/open-coding.pdf
[Accessed 1 April 2019].

Kislenko, K., 2009. Mathematics is a bit difficult but you need it a lot: Estonian pupils' beliefs about mathematics. In: *Beliefs and attitudes in mathematics education: New research results.* Rotterdam: Sense, pp. 143-164.

Korentz, D., 2017. *The testing charade: Pretending to make schools better.* Chicago, IL: University of Chicago press.

Krapp, A., 2002. Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and instruction,* Volume 12, pp. 383-409.

Kroger, J., 2007. *Identity development: Adolescence through adulthood.* Thousand Oaks, CA: Sage Publications.

Kuhl, J., 1987. Action control: The maintenance of motivational states. In: *Motivation, Intention, and Volition.* Berlin: Springer-Verlag, pp. 279-307.

Kutnick, P. et al., 2005. *An extended review of pupil grouping in schools.* London: DfES.

Kyriacou, C. & Goulding, M., 2005. A systematic review of raising pupil motivation in KS4 mathematics. *Proceedings of the British Society for Research into Learning Mathematics,* 25(3), pp. 81-86.

Laevers, F., 2013. An approach to experiental education. In: *Early childhood education and care: An introduction.* Los Angeles: Sage, pp. 233-251.

Lannegrand-Willems, L. & Bosma, H. A., 2006. Identity development-in-context: The school as an important context for identity development. *IDENTIY: An International Journal of Theory and Research,* 6(1), pp. 85-113.

Larson, R. W., 2000. Toward a psychology of positive youth development. *American Psychologist,* Volume 55, pp. 170-183.

Leaper, C., Farkas, T. & Brown, C. S., 2012. Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and english. *Journal of Youth and Adolescence,* Volume 41, pp. 268-282.

Leder, G. C., Pehkonen, E. & Torner, G., 2002. *Beliefs: A hidden variable in mathematics education?.* Dordrecht: Kluwer Academic Publishers.

Lee, V. & Smith, J., 2001. *Restructuring high schools for equity and excellence,* New York: Teachers' College Press.

Leon, J., Nunez, J. L. & Liew, J., 2015. Self-determination and STEM education: Effects of autonomy, motivation, and self-regulated learning on high school math achievement. *Learning and individual differences,* Volume 43, pp. 156-163.

Leslie, S., Cimpian, A., Meyer, M. & Freeland, E., 2015. Expectations of brilliance underlie gender distributions across academic disciplines. *Science,* 347(6219), pp. 262-265.

Leung, F. K., 2002. Behind the high achievement of East Asian students. *Educational Research and Evaluation,* 8(1), pp. 87-108.

Lewis, A., 1992. Group child interviews as a research tool. *British Educational Research Journal,* 18(4), pp. 413-21.

Lewis, G., 2013. Emotion and disaffection with school mathematics. *Research in Mathematics Education,* 15(1), pp. 70-86.

Licht , B. G., Linden, T., Brown, D. & Sexton, M., 1984. *Sex differences in achievement orientation: A "A" student phenomenon?.* Toronto, Canada.

Licht, B. G. & Dweck, C. S., 1984. Determinants of academic achievement: The interaction of children's achievement orientations with skill area. *Developmental Psychology,* 20(4), pp. 628-636.

Lindskog, M., Winman, A. & Poom, L., 2017. Individual differences in nonverbal number skills predict math anxiety. *Cognition,* Volume 159, pp. 156-162.

Mac Iver, D. J., Stipek, D. J. & Daniels, D. H., 1991. Explaining within-semester changes in student effort in junior high school and senior high school courses. *Journal of educational psychology,* 83(2), pp. 201-211.

MacIver, D. & Reuman, D. A., 1988. *Decision-making in the classroom and early adolescents' valuing of mathematics,* New Orleans: Paper presented at the annual meeting of the American Educational Research Association.

Male, T., 2016. Analysing qualitative data. In: *Doing Research in Education: Theory and Practice.* London: Sage, pp. 177-191.

Maloney, E. A., Ansari, D. & Fugelsang, J. A., 2011. The effect of mathematics anxiety on the processing of numerial magnitude. *The Quarterly Journal of Experimental Psychology,* Volume 64, pp. 10-16.

Maloney, E. A. & Beilock, S. L., 2012. Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences,* Volume 16, pp. 404-406.

Maloney, E. A. et al., 2015. Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science,* Volume 26, pp. 1480-1488.

Maloney, E. A., Risko, E. F., Ansari, D. & Fugelsang, J. A., 2010. Mathematics anxiety affects counting but not subitizing during visual enumeration. *Cognition,* Volume 114, pp. 293-297.

Marks, R., 2014. Educational triage and ability-grouping in primary mathematics: A case-study of the impacts on low-attaining pupils. *Research in Mathematics Education,* 16(1), pp. 38-53.

Martinez-Sierra, G. & Gonzalez, M. d. S. G., 2014. High school students' emotional experiences in mathematics classes. *Research in Mathematics Education,* 16(3), pp. 234-250.

Martino, P. D. & Zan, R., 2011. Attitude towards mathematics: A bridge between beliefs and emotions. *Mathematics Education,* Volume 43, pp. 471-482.

Massimini, F. & Carli, M., 1988. The systematic assessment of flow in daily experience. In: *Optimal experience: Psychological studies of flow in consciousness.* s.l.:Cambridge university press, pp. 266-287.

Masten, A., 2001. Ordinary magic: Resilience processes in development. *American Psychologist,* Volume 56, pp. 227-238.

Matsumoto, D. & Sanders, M., 1988. Emotional experiences during engagement in intrinsically and extrinsically motivated tasks. *Motivation and Emotion,* Volume 12, pp. 353-369.

Ma, X. & Xu, J., 2004. The casual ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. *Journal of Adolescence,* 27(2), pp. 165-179.

McLellan, E., MacQueen, K. & Neidig, J., 2003. Beyond the qualitative interview: Data preparation and transcription. *FIeld Methods,* 15(1), pp. 63-84.

McLeod, D. B., 1992. Research on affect in mathematics education: A reconceptualization. In: *Handbook of research on mathematics teaching and learning.* New York, NY: McMillan, pp. 575-596.

Meece, J. L., Wigfield, A. & Eccles, J. S., 1990. Predictors of math anxiety and its consequences for young adolescents' course enrollment intentions and performances in mathematics. *Journal of Educational Psychology,* Volume 82, pp. 60-70.

Middleton, J. A. & Spanias, P. A., 1999. Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education,* 30(1), pp. 65-88.

Middleton, M., Midgley, C., Gheen, M. & Kumar, R., 2002. Stage/environment fit revisited: A goal theory approach to examining school transitions. In: *Goals, Goal Structures, and Patterns of Adaptive Learning.* Hillsborough, NJ: Lawrence Erlbaum Associates, pp. 109-142.

Midgley, C., Eccles, J. S. & Feldlaufer, H., 1991. Classroom environment and the transition to junior high school. In: *Educational environments: Evaluation, antecedents and consequences.* New York: Pergamon, pp. 113-139.

Midgley, C., Feldlauer, H. & Eccles, J. S., 1989. Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development,* 60(4), pp. 981-992.

Midgley, C., Feldlauger, H. & Eccles, J. S., 1989a. Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *Journal of Educational Psychology,* Volume 81, pp. 247-258.

Morgan, D. & Boychuk Duchsher, J. E., 2004. Grounded theory: Reflections on the emergence vs. forcing debate. *Methodological Issues in Nursing Research,* 48(6), pp. 605-612.

Morgan, D. L., 1996. Focus groups. *Annual Review of Sociology,* 22(1), pp. 129-52.

Morgan, D. L., 1997. *Focus groups as qualitative research.* 2nd ed. Thousand Oaks, California: Sage.

Morrow, V. & Richards, M., 1996. The ethics of social research with children: An overview. *Children & Society,* Volume 10, pp. 90-105.

Mueller, C. M. & Dweck, C. S., 1998. Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology,* 75(1), pp. 33-52.

Muir, T. & Geiger, V., 2016. The affordances of using a flipped classroom approach in the teaching of mathematics: a case study of a grade 10 mathematics class. *Mathematics education research journal,* Volume 28, pp. 149-171.

Munro, A., Holly, L., Rainbird, H. & Leisten , R., 2004. Power at work: Reflections on the research process. *International Journal of Social Research Methodology,* 7(4), pp. 289-304.

Nakkula, M., 2003. Identity and possibility: Adolescent development and the potential of schools. In: *Adolescents at school: Perspectives on youth, identity, and education.* Cambridge, MA: Harvard Education Press.

Nardi, E. & Steward, S., 2003. Is mathematics T.I.R.E.D? A profile of quiet disaffection in the secondary mathematics classroom. *British Educational Research Journal,* Volume 29, pp. 345-367.

National Numeracy, 2014. *What is the issue?.* [Online]
Available at: https://www.nationalnumeracy.org.uk/what-issue
[Accessed 13 April 2020].

Nelson, J., 2015. Navigating grounded theory: A critical and reflective response to the challenges of using grounded theory in an education PhD. *Critical and Reflective Practice in Education,* Volume 4, pp. 18-24.

Newstead, K., 1998. Aspects of children's mathematics anxiety. *Educational Studies in Mathematics,* Volume 36, pp. 53-71.

Nicholls, J. G. et al., 1990. Students' theories of mathematics and their mathematical knowledge: Multiple dimensions of assessment. In: *Assessing Higher Order Thinking in Mathematics.* Washington DC: American Association for the Advancement of Science, pp. 137-154.

Niemiec, C. P. & Ryan, R. M., 2009. Autonomy, competence and relatedness in the classroom: Applying Self-Determination Theory to classroom practice. *Theory and Research in Education,* Volume 7, pp. 133-144.

Norwood, K. S., 1994. The effects of instructional approach on mathematics anxiety and achievement. *School Science and mathematics,* Volume 94, pp. 248-254.

Noyes, A., 2009. Exploring patterns of participation in university-entrance level mathematics in England. *Journal for Research in Mathematics Education,* 11(2), pp. 167-183.

Noyes, A., 2013. The effective mathematics department: Adding value and increasing participation?. *An International Journal of Research, Policy and Practice,* 24(1), pp. 1-17.

Nunez-Pena, M. I. & Suarez-Pellicioni, M., 2014. Less precise representation of numerical magnitude in high math-anxious individuals: An ERP study of the size and distance effects. *Biological Psychology,* Volume 103, pp. 176-183.

Oakes, A., 1985. *Keeping track: How schools structure inequality.* New Haven, CT: Yale University Press.

OCR, 2022. *OCR Qualifications Core Maths.* [Online]
Available at: https://www.ocr.org.uk/qualifications/core-maths/
[Accessed 11 January 2022].

Oliver, D. G., Serovich, J. M. & Mason, T. L., 2005. Constraints and opportunities with interview transcription: Towards reflection in qualitative research. *Social Forces,* 84(2), pp. 1273-1289.

Onwuegbuzie, A. J. & Leech, N. L., 2005. On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology,* 8(5), pp. 375-387.

Oppenheim, A. N., 1992. *Questionnaire design, interviewing and attitude measurement.* London: Pinter.

Oxford English Dictionary, 2020. *Motivation.* [Online]
Available at: https://www.oxfordlearnersdictionaries.com/definition/english/motivation

Pallant, J., 2010. *SPSS Survival Guide.* 4th ed. Berkshire: Open University Press.

Passolunghi, M. C., 2011. Cognitive and emotional factors in children with mathematical learning disabilities. *International Journal of Disability, Development and Education,* 58(1), pp. 61-73.

Pelletier, L. G., Sequin-Levesque, C. & Legault, L., 2002. Pressure from above and pressure from below as determinants of teachers' motivation and teaching behaviors. *Journal of educational psychology,* 94(1), pp. 186-196.

Pennington, D. C., Gillen, K. & Hill, P., 1999. *Social psychology.* London: Arnold.

Pennington, D., Gillen, K. & Hill, P., 2016. *Social psychology.* Abingdon, Oxon: Routledge.

Picker, S. H. & Berry, J. S., 2000. Investigating pupils' images of mathematicians. *Educational Studies in Mathematics,* 43(1), pp. 65-94.

Pintrich, P. R., 2000a. An achievement goal perspective on issues in motivation terminology, theory, and research. *Contemp. Educ. Psychol.,* Volume 25, pp. 92-104.

Pintrich, P. R., 2000b. The role of goal orientation in self-regulated learning. In: *Handbook of Self-Regulation.* San Diego, CA: Academic, pp. 452-502.

Pintrich, P. R., 2003. A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology,* Volume 95, pp. 667-686.

Pintrich, P. R. & Schrauben, B., 1992. Students' motivational beliefs and their cognitive engagement in classroom academic tasks. In: *Student Perceptions in the Classroom.* Hillsdale, NJ: Erlbaum, pp. 149-183.

Platt, J., 1981. On interviewing one's peers. *The British Journal of Sociology,* 32(1), pp. 75-91.

Putwain, D. & Remedios, R., 2014. The scare tactic: Do fear appeals predict motivation and exam scores?. *School Psychology Quarterly,* 29(4), pp. 503-516.

Rattan, A., Good, C. & Dweck, C. S., 2012. "It's ok - not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. *Journal of Experiemental Social Psychology,* Volume 48, pp. 731-737.

Reay, D. & Wiliam, D., 1999. 'I'll be a nothing': Structure, agency and the construction of identity through assessment. *British Educational Research Journal,* 25(3), pp. 343-354.

Reid, M. E., Clunies-Ross, L. R., Goacher, B. & Vile, d., 1982. *Mixed ability teaching: Problems and possibilities.* Windsor: NFER-Nelson.

Roberts, G., 2002. *SET for success: The supply of people with science, technology, engineering and mathematics skills.* London: Department for Education and Science.

Robinson, C., 2017. Growth mindset in the classroom. *Science Scope,* 41(2), pp. 18-21.

Roeser, R. W., Eccles, J. S. & Sameroff, A. J., 2000. School as a context of social-emotional development: A summary of research findings. *Elementary School Journal,* Volume 100, pp. 443-471.

Roeser, R. W., Peck, S. C. & Nasir, N. S., 2006. Self and identity processes in school motivation, learning, and achievement. In: *Handbook of educational psychology.* Mahwah, NJ: Lawrence Erlbaum, pp. 391-424.

Rotter, J. B., 1954. *Social learning and clinical psychology.* New York: Prentice-Hall.

Ruffell, M., Mason, J. & Allen, B., 1998. Studying attitude to mathematics. *Educational Studies in Mathematics,* Volume 35, pp. 1-18.

Ryan, R. M. & Deci, E. L., 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology,* Volume 25, pp. 54-67.

Ryan, R. M. & Deci, E. L., 2017. *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* New York: Guilford Publishing.

Ryan, R. M. & Deci, E. L., 2019. Brick by brick: The origins, development, and future of self-determination theory. In: *Advances in motivation science.* Cambridge, MA: Elsevier Inc, pp. 111-156.

Ryan, R. M. & Deci, E. L., 2020. Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary educational pscyhology,* Volume 61.

Sansone, C. & Harackiewicz, J. M., 2000. *Intrinsic and extrinsic motivation: The search for optimal motivation and performance.* New York: Academic.

Schagen, I. & Schagen, S., 2002. *Using national value-added datasets to explore the effects of school diversity.* s.l., s.n.

Schiefele, U., 1999. Interest and learning from text. *Sci. Stud. Read.,* Volume 3, pp. 257-280.

Schoenfeld, A. H., 1985. *Mathematical problem solving.* New York: Academic Press.

Schunk, D. H., 1990. Goal setting and self-efficacy during self-regulated learning. *Educational Psychologist,* Volume 25, pp. 71-86.

Schunk, D. H., 2005. Commentary on self-regulation in school contexts. *Learning and Instruction,* Volume 15, pp. 173-177.

Schwartz, N. et al., 1991. Rating scales: Numeric values may change the meaning of scale labels. *Public Opinion Quarterly,* 55(4), pp. 570-582.

Seale, C., Gobo, G., Gubrium, J. F. & Silverman, D., 2007. *Qualitative research practice.* London: Sage.

Seligman, M. E. & Maier, S. F., 1967. Failure to escape traumatic shock. *Journal of Experimental Psychology,* Volume 74, pp. 1-9.

Simms, V., 2016. Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. *Research in Mathematics Education,* 18(3), pp. 317-320.

Simpkins, S. D., Davis-Kean, P. E. & Eccles, J. S., 2005. Parents' socializing behavior and children's participation in math, science, and computer out-of-school activities. *Applied Developmental Science,* Volume 9, pp. 14-30.

Skinner, E. A. & Belmont, M. J., 1993. Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of educational psychology,* 85(4), pp. 571-581.

Skipper, Y. & Douglas, K. M., 2016. The impact of a selective entry examination on children's feelings as they approach the transition to secondary school. *British Educational Research Journal,* 42(6), pp. 945-961.

Slavin, R. E., 1990. 1990. *Review of educational research,* 60(3), pp. 471-499.

Smith, C. et al., 2005. *A systematic review of what pupils, aged 11-16 believe impacts on their motivation to learn in the classroom,* London: EPPI-centre, Social Science Research Unit, Institute of Education.

Smith-Woolley, E. et al., 2018. Differences in exam performance between pupils attending selective and non-selective schools mirror the genetic differences between them. *NPJ Science of Learning,* 3(Article 3), pp. 1-7.

Spelke, E. S. & Ellison, K., 2009. Gender, math, and science. In: *The science on women and science.* Washington DC: The AEI Press.

Stake, R. E., 1978. The case study method in social inquiry. *Educational Researcher,* 7(2), pp. 5-8.

Stroet, K., Opdenakker, M.-C. & Minnaert, A., 2016. Fostering early adolescents' motivation: A longitudinal study into the effectiveness of social constructivist, traditional and combined schools for prevocational education. *Educational Psychology,* 36(1), pp. 1-25.

Stuart, V., 2000. Math curse or math anxiety?. *Teaching children mathematics,* 6(5), pp. 330-335.

Stutchbury, K. & Fox, A., 2009. Ethics in educational research: Introducing a methodological tool for effective ethical analysis. *Cambridge Journal of Education,* 39(4), pp. 489-504.

Tabachnick, B. G. & Fidell, L. S., 1996. *Using multivariate statistics.* 3rd ed. New York: HarperCollins.

Tabachnick, B. G. & Fidell, L. S., 2007. *Using multivariate statistics.* 5th ed. Boston: Pearson Education.

Takeuchi, M. A., Towers, J. & Martin, L., 2016. *What contributes to positive feelings towards mathematics?: Examining mathematics autobiographies.* Tucson, AZ, The University of Arizona, pp. 1119-1122.

Taylor, B. et al., 2017. Factors deterring schools from mixed attainment teaching practice. *Pedagogy, Culture & Society,* 25(3), pp. 327-345.

Timonen, V., Foley , G. & Conlon, C., 2018. Challenges when using grounded theory: A pragmatic introduction to doing GT research. *International Journal of Qualitative Methods,* Volume 17, pp. 1-10.

Torff, B. & Tirotta, R., 2010. Interactive whiteboards produce small gains in elementary students' self-reported motivation in mathematics. *Computers & Education,* Volume 54, pp. 379-383.

Towers, J. et al., 2017. Autobiographical accounts of students' experiences learning mathematics: A review. *Canadian journal of science, mathematics and technology education,* 17(3), pp. 152-164.

Towers, J., Takeuchi, M. A. & Martin, L. C., 2018. Examining contextual influences on students' emotional relationships with mathematics in the early years. *Research in Mathematics Education,* 20(2), pp. 146-165.

Triandis, H. C., 1971. *Attitude and attitude change.* New York: Wiley.

UNESCO, 2016. *Closing the gender gap in STEM.* [Online]
Available at: http://unesdoc.unesco.org/images/0024/002457/245717E.pdf
[Accessed 9 November 2016].

Vaismoradi, M., Turunen, H. & Bondas, T., 2013. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing and Health Sciences,* Volume 15, pp. 398-405.

Vaughn, S., Shumm, J. & Sinagub, S., 1996. *Focus group interviews in education and psychology.* Thousand Oaks, California: Sage.

Vogel-Walcutt, J. J., Fiorella, L., Carper, T. & Schatz, S., 2012. The definition, assessment, and mitigation of state boredom within educational settings: A comprehensive review. *Educatinal Psychology Review,* 24(1), pp. 89-111.

Vukovic, R. K., Roberts, S. O. & Green Wright, L., 2013. From parental involvement to children's mathematical performance: The role of mathematics anxiety. *Early Education and Development,* Volume 24, pp. 446-467.

Waller, N. G. et al., 1990. Genetic and environmental influences on religious interests, attitudes, and values: A study of twins reared apart and together. *Psychological Science,* 1(2), pp. 138-142.

Watt, D., 2007. On becoming a qualitative researcher: The value of reflexivity. *The Qualitative Report,* 12(1), pp. 82-101.

Weiner, B., 1985. An attributional theory of achievement motivation and emotion. *Psychology Review,* 92(4), pp. 548-573.

Weiner, B., 1992. *Human motivation: Metaphors, theories, and research.* Newbury Park, CA: Sage.

Wentzel, K. A., 2000. What is it that I'm trying to achieve? Classroom goals from a content perspective. *Contemporary Educational Psychology,* Volume 25, pp. 105-115.

Wentzel, K. R., 1991. Relations between social completence and academic achievement in early adolescence. *Child development,* Volume 62, pp. 1066-1078.

White, R. W., 1959. Motivation reconsidered: The concept of competence. *Psychological Review,* 66(5), pp. 297-333.

Wigfield, A., 1994. Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review,* 6(1), pp. 49-78.

Wigfield, A. & Eccles, J., 1992. The development of achievement task values: A theoretical analysis. *Developmental Review,* Volume 12, pp. 265-310.

Wigfield, A. & Eccles, J. S., 2000. Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology,* Volume 25, pp. 68-81.

Wigfield, A. et al., 2006. Motivation. In: *Handbook of child psychology.* New York, NY: Wiley, pp. 933-1002.

Wigfield, A. et al., 1997. Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of educational psychology,* 89(3), pp. 451-469.

Wiliam, D. & Bartholomew, H., 2004. It's not which school but which set you're in that matters: The influence of ability-grouping practices on student progress in mathematics. *British Educational Research Journal,* 30(2), pp. 279-293.

Winne, P. H. & Marx, R. W., 1989. A cognitive-processing analysis of motivation with classroom tasks. In: *Research on motivation in education.* New York: Academic, pp. 223-237.

Wittgenstein, L., 1996. *Philosophical investigations.* Oxford: Basil Blackwell.

Wolf, A., 2002. *Does education matter? Myths about education and economic growth.* London: Penguin.

Yazan, B., 2015. Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report,* 20(2), pp. 134-152.

Yeager, D. S. & Dweck, C. S., 2012. Mindsets that promote resiliance: When students believe that personal characteristics can be developed. *Educational Psychologist,* 47(4), pp. 302-314.

Yeager, D. S., Trzesniewski, K. H. & Dweck, C. S., 2013. An Implicit Theories of Personality Intervention Reduces Adolescent Aggression in Response to Victimization and Exclusion. *Child Development,* 84(3), pp. 970-988.

Yin, R. K., 2004. Case study methods, revised draft for 3rd edition of complementary methods for research in education. *American Educational Research Association.*

Young, C. B., Wu, S. S. & Menon, V., 2012. The neurodevelopmental basis of math anxiety. *Psychological Science,* Volume 23, pp. 492-501.

Zakaria, E. & Nordin, N. M., 2008. The effects of mathematics anxiety on matriculation students as related to motivation and achievement. *Eurasia Journal of Mathematics, Science & Technology Educaion,* 4(1), pp. 27-30.

Zimmer-Gembeck, M. J. et al., 2006. Relationships at school and stage-environment fit as resources for adolescent engagement and achievement. *Journal of Adolescence,* Volume 29, pp. 911-933.

Zimmerman, B. J., 1989. A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology,* Volume 81, pp. 329-339.

Zimmerman, B. J., 2000a. Attaining self-regulation: A social-cognitive perspective. In: *Handbook of Self-Regulation.* San Diego: Academic, pp. 13-39.

Zimmerman, B. J., 2000. Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology,* Volume 25, pp. 82-91.

Zimmermann, M., Bescherer, C. & Spannagel, C., 2011. A questionnaire for surveying mathematics self-efficacy expectations of future teachers. *Article of German Federal Ministry of Education and Research.*

Appendices

Appendix A Pupil questionnaire

Questionnaire

Code ……………………………………………………………………………………………

Please complete this questionnaire as honestly and fully as you can in order for me to find out how you feel about maths. Your opinions and thoughts are very important to me.

I am happy to participate in Miss Hosking's research and understand that my questionnaire will remain anonymous.

Yes ☐ No ☐

Set ……………………………………………………… Gender - Male ☐ Female ☐

In the following questions please circle the number which represents how you feel:

1. I usually enjoy school	1	2	3	4	5	I do not usually enjoy school
2. I usually enjoy maths lessons	1	2	3	4	5	I do not usually enjoy maths lessons
3. I am very good at maths	1	2	3	4	5	I am not very good at maths
4. I struggle to understand in maths	1	2	3	4	5	I do not struggle to understand in maths
5. I think that I will use maths a lot when I am adult	1	2	3	4	5	I do not think that I will use maths a lot when I am an adult
6. I need maths to get on in life	1	2	3	4	5	I do not need maths to get on in life
7. I need maths to get into college	1	2	3	4	5	I do not need maths to get into college

8. I feel anxious about the work in maths	1	2	3	4	5	I do not feel anxious about the work in maths
9. I think that being clever is more important in maths than working hard	1	2	3	4	5	I think that working hard is more important in maths than being clever
10. Work in maths is too easy for me	1	2	3	4	5	Work in maths is too hard for me
11. My parents/guardians think that it is important to work hard in school	1	2	3	4	5	My parents/guardians do not think that it is important to work hard in school
12. Pleasing my parents is the main reason that I work hard in maths	1	2	3	4	5	Pleasing my parents is not the main reason that I work hard in maths
13. Pleasing my teacher is the main reason that I work hard in maths	1	2	3	4	5	Pleasing my teacher is not the main reason that I work hard in maths
14. My parents/guardians think it is important to pass maths exams	1	2	3	4	5	My parents/guardians do not think it is important to pass maths exams
15. My parents/guardians are pleased with my progress in maths	1	2	3	4	5	My parents/guardians are not pleased with my progress in maths
16. One/both of my parents are good at maths	1	2	3	4	5	Neither of my parents are good at maths.
17. My parents/guardians often help me with my maths homework	1	2	3	4	5	My parents/guardians do not often help me with my maths homework
18. I enjoy doing maths puzzles	1	2	3	4	5	I do not enjoy doing maths puzzles
19. I wouldn't want to be thought of as a 'maths nerd'	1	2	3	4	5	I would not mind to be thought of as a 'maths nerd'
20. People with maths qualifications get paid more	1	2	3	4	5	People with maths qualifications do not get paid more

21. I really enjoy maths when – (in each row, please put a tick in one of the boxes)

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
The problems make me think really hard					
I am the only one who can answer the question					
We work together in groups					
I am the first one to get the answer right					

22. I will probably continue with maths after GCSE. Circle one -

Strongly agree   Agree   No opinion   Disagree   Strongly disagree

Why?………

………

23. If maths was an option now, I would probably choose it. Circle one

Strongly agree   Agree   No opinion   Disagree   Strongly disagree

Why?………

………

24. Put a circle around the <u>one</u> thing your teacher thinks is most important in maths lessons

a) Keeping up with the rest of the class
b) Enjoying maths
c) Doing lots of work
d) Learning lots of rules
e) Thinking deeply about maths

25. Maths lessons would improve if …….. (Circle any that apply)

a) We did less work
b) We had more fun
c) There were fewer tests
d) There was better behaviour in the class
e) It was easier
f) We did more relevant maths
g) other

……

……

26. What does it take to be successful at maths?

……

……

27. Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

……

……

28. If your teacher ordered the pupils in your maths class by their mathematical ability, where would you be? Circle one -

Very high   Top half   In the middle   Bottom half   Very low

29. If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

……

……

30. How many maths teachers have you had this year? Circle one -

1   2   3   4   5+

31. Have you moved sets this year? Circle one –

Yes   No

32. If you moved sets, did you move up or down? Circle one –

Up   Down

33. How do you feel about changing maths set? Please comment

……

……

34. How has this year been for you in maths?

……

35. Compare how you feel about maths now with how you felt in Year 6.
In the following questions please circle the number which represents how you feel:

I like maths more now than I did in Year 6	1	2	3	4	5	I preferred maths more in Year 6
I had more fun in maths in Year 6						I have more fun in maths in Year 7
I was better at maths in Year 6						I am better at maths in Year 7
Maths was more boring in Year 6						Maths is just as boring in Year 7
In Year 6 we knew more about how maths is used in the real world.						I know more in Year 7 about how maths is used in the real world.

Thank you very much for completing this questionnaire.

Appendix B Cartoons used in the focus groups

Please contact author for image

Talk about the picture – how does it make you feel?

How would you feel if you were there?

How would you feel if you can't immediately find the answer to a question?

Please contact author for image

Talk about the picture – how does it make you feel?

Do you ever feel this way?

How would your parents/carers react?

Do other pupils say the same?

Please contact author for image

Some people are glad to give up maths. Others take it after GCSE, why?

If people do well in maths do you think that they feel differently about it?

Do you ever feel anxious about maths? Why?

Please contact author for image

How do you feel about this?

Is there any point in working at maths?

Appendix C Initial letter to parents

Dear Parents and Guardians,

I am currently in my third year of a PhD at The University of Wales Trinity St David in Swansea, researching the change in motivation towards mathematics from primary school to the end of Year 11.

As part of my research I would like to give Year 7 a questionnaire in their maths lessons. I may need to follow up on some of the responses to the questionnaires with a short interview, with your consent. These interviews would only take about five minutes and would be held in your child's maths lessons in groups of 3. A Dictaphone will be used to record the voices during the interview but the interviews will **NOT** be filmed. The interviews will only be played back to me so that I can write them up accurately.

Children's opinions expressed in the questionnaires and interviews will remain confidential. Pseudonyms will be used when the research is written up and it will not be possible to identify individual responses.

If you would not like your child to complete a questionnaire, or if you would like any further information regarding my research please do not hesitate to contact me by e-mailing research@XXXXXXXXXschool.net.

In case your child is selected to be interviewed I would appreciate it if you could complete the consent form below which can be handed into your child's maths teacher.

Thank you for supporting my research.

Yours sincerely,

Charlotte Hosking

XXXXXXXXX School

I ……

parent/guardian of …….

give permission for them to be interviewed in a small group by Miss Hosking.

Signed……………………………………………………………… Date …………………………………………..

Appendix D Ethical approval

Form: PR (E) 1

PROJECT RESEARCH APPROVAL FORM (Ethics)

Have you considered whether there are any problematic 'ethical issues' in your proposed research project? If not, you really should talk to your Course Tutor or Supervisor to discuss if there are any issues you need to address.

If you have already completed an 'Ethics Approval Form' within your Faculty/School, you do not need to complete this form. However, you haven't considered the ethics issues in your proposal, you need to complete this form.

Not all details necessarily apply to your area of study, so you may leave some boxes blank, but do try and complete it as fully as you can. All sections deal with potential ethical issues which need careful consideration before you commence your research, to ensure you deal with them properly (in accordance with the law, for example). You may find it easier to complete the form with assistance from your tutor/supervisor.

Name:	Charlotte Hosking		
Project/Research Title:	Exploring changes in pupil motivation towards mathematics as they move up through secondary school.		
Name of Supervisor:	Dr Howard Tanner		
School/Dept.			
Faculty:	Education		
Proposed Start Date:	**January 2012**	End Date:	**January 2017**

1. Summary of planned research *please indicate briefly below the purpose of your planned project/research, together with your aims, main research questions and research design – you can continue onto a separate sheet if necessary*

The research is intended to analyse the factors influencing attitude towards Mathematics by focussing on two key transition points of Year 6 into Year 7(KS2/3) and Year 9 into Year 10 (KS3/4). I intend to design and trial an attitude questionnaire based on the tripartite model (Cognition, Affect and Behaviour, Eagly and Chaiken, 1993) to explore what motivates pupils to achieve in mathematics.
The research will also explore the development of more indirect measures of attitude and motivation.

These instruments and strategies will be used with Year 6 pupils prior to their entry to secondary school and Year 9 pupils at the end of the school year. The process will be repeated at the end of Year 7 and 10 to compare and contrast their feelings with the previous year. Focus groups of pupils will be interviewed to gain more detailed information. Classroom behaviours will be observed as appropriate.

The research is planned to take four years –

1. Read around the field of motivation and attitude and use this literature to devise the instruments needed in order to carry out the research such as the questionnaires and interview questions. Interviews will be conducted in focus groups in order to glean a collective view of the group as opposed to an individualistic view, as the interviewees interact with each other (Cohen et al., 2011, Research Methods in Education). These should be trialled by the end of the school year in order to check their success and increase the reliability and validity of the questionnaire (Cohen et al., 2011, Research Methods in Education).
2. Carry out the research, questioning years 6/7 and 9/10. Write up the literature review and methodology.
3. Analyse the initial data.
4. Analyse all of the results. Write up and update conclusions.

As a teacher I have a CRB check. I will gain informed written consent from the management at the school and also from the pupils themselves. A system of coding the questionnaires will be used which allows me to track pupils but will hide their names. Parents will be informed of the research through a mass communication letter at the start of the project. Pupils who volunteer to become involved in focus group interviews will be asked to provide written consent letters from their parents or guardians.

Pupils will only be involved in the project if informed consent is freely given, and they will be allowed to withdraw from the research at any stage in the process if they so wish.

The research will follow the ethical guidelines of the British Educational Research Association (BERA, 2011).

BERA (2011) *Ethical Guidelines for Educational Research,* London: BERA.

2. Methodology *you need to be clear about the methodology you intend to use in your study; this could include any number of methods, so either tick those shown below (where appropriate) or put the details in the box marked* *

X	Interviews	x	Participant Observation		Use of personal data
X	Focus groups	x	Questionnaire	x	Literature Review
	Performance		Presentation		Other *(state below)**

*

3. Participants - Does your proposed project/research involve human participants?

X	1. Yes, as a primary source*		2. Yes, as a secondary source*		No- go to section 4

**If you have ticked yes, you are likely to need an Advanced CRB check before undertaking your study*

If yes, indicate who your participants are:

	Early years/Pre-School children		Adults - *give details below*
X	School age children		Vulnerable people - *give details below*
	Young People aged 17-18		
	Unknown at this stage		

4. Other Ethical issues *(tick all that may apply to your research)*

	Administration of drugs incl. alcohol		Deprivation
	Unpleasant stimuli in any manner or form		Active deception or withholding information
	Collection of highly personal information		Payment

5. Are there any ethical concerns other than those listed above?

6. If there are any ethical concerns, please state how you intend to minimise any risk of harm or distress that could be caused

Form: PR (E) 1

You should enclose the research proposal form, together with any materials (e.g. questionnaire, interview schedule) when submitting this form to your tutor/supervisor.

Student Signature _____

______________________________________Date__11.9.12________

Supervisor's Signature: Date: 7.9.12.

☑ **Ethics clearance given at Faculty Level**

☐ **Clearance not given at Faculty level –** *forwarded for discussion at the next meeting of the University Ethics Committee.* **Details below:**

Comments:

Chair's Initials [ ] *Date* 12/9/12.

Details on this form will be always be dealt with in accordance with the terms of the Data Protection Act 1998. The completed form will be retained on the student's file after approval (for audit purposes) and may be forwarded firstly to the Faculty Board and thereafter to the University Ethics Committee for a discussion of the issues highlighted.

Appendix E Staff permission slip

I agree to take part in Charlotte Hosking's research and I understand that anonymity will be protected by the removal of name, gender, length of service and anything else that may link the research to individual teachers. I am also aware that I can read the completed research and can amend any information that may prevent anonymity.

Signed …………………………………………………………………………..

Name …………………………………………………………………………… Date ………………………………..

Appendix F Headteacher's letter to primary schools

30 January 2014

Dear

One of our maths teachers, Charlotte Hosking, is currently working towards a PhD at The University of Wales, Trinity St. David in Swansea. She is tracking the decline in motivation towards mathematics from primary to secondary school. XXXXXX are very supportive of her research and I would be grateful if you would support her in completing her research in your school.

Thank you in anticipation of your help.

Yours sincerely,

XXXXXX

Headteacher

Appendix G Collated qualitative data

This appendix shows the first write-up of the qualitative data and is split into focus group data, cartoon data and questionnaire data. This data was synthesised into the findings detailed in Chapter 4.

Focus group data

The following table shows the number of focus groups across the two year groups:

2014	Number of Focus Groups	2015	Number of Focus Groups
Year 6	11	Year 7	12
Year 9	13	Year 10	7

I decided not to report proportions because it is more difficult to read and was too exact for this kind of analysis. The reasons behind this decision were that just because the students did not say something, does not mean that they did not think it, they tended to follow each other within a focus group which could lead to distorted percentages and having such small numbers of groups, one or two groups are worth a large percentage. However, in order to eliminate any ambiguity surrounding the use of words implying proportion, in this chapter the following terms will reflect the broad proportions listed;

Nearly all = over 75%

A majority = over 50%

Half = 50%

A minority = below 50%

Few = below 25%

Question 1 – What is maths like? What's good about it, what's bad about it, what should it be like?

In response to this question I have constructed three categories that allow me to understand what the students were telling me. These categories are rationale for maths, personal experience of maths and classroom experience of maths.

Rationale for maths

This category contains statements which relate to the students' awareness of the importance of studying maths. This was more prevalent in the responses from the year 6 students than the year 9 with many students recognising that maths is useful in life; "it's good because you use maths quite a lot in life" for "shopping and working out how much stuff is" or "it's useful for jobs and stuff". This response was not present at all in the year 9 focus groups but instead the shift had changed to how maths lessons could be improved by making the content more relevant to real life. Students comment that they "should learn about useful information that you could actually use in life", "a lot of maths I don't feel like I need", "trigonometry, I don't see how it will relate to real life or how you would use it. It's possibly harder to learn". Another student stated a desire for real life context "and with a reason, because sometimes when I do maths and people are like 'why are we doing this, what are we going to do with it in life?' but if we actually have got a real situation that we've got to work out then it's better to do".

There appears to be a change in the students' perception of the relevance of maths as students move through secondary school. Whilst the students have not clearly distinguished between school maths, the way it is taught and maths in general; as the questions were discussing maths lessons, I have interpreted their answers to be describing their maths experience in school. This change in perception about the relevance of maths may be down to a change in the perception of what is classed as 'real life', perhaps because the year 9 students are more aware about becoming adults and the maths that may be useful to them. This change may also be due to the curriculum because in primary school the students will have answered questions about applications of arithmetic in context whereas in secondary school a lot of the maths that they learn is not contextualised for them.

In 2015 the year 7 and 10 students were asked how they felt about maths, what was good about it, what was bad about it and if it had changed from the previous year. The discussion of relevance to real life was not a response that featured in any of the focus groups, but the focus of the question now included how maths has changed throughout the year. In 2015, none of the focus groups gave a response which related to the rationale of why they have to do maths. Their responses fell under the other two categories: personal experience of maths and classroom experience of maths.

Personal experience of maths

Nearly all the descriptions of maths were positive with it being described as fun, challenging and involving thinking. These descriptions were prevalent in year 6 and year 9 whilst words such as interesting and satisfying were only used in year 9. Both years described maths as being fun with a year 6 focus group commenting on maths games being a good thing. However, a few groups in year 6 and year 9 said that maths would be better if it was more fun so that you wanted to do it and looked forward to the lessons. One group suggested the use of maths games to make it more memorable “oh that was fun because we played with that friend, oh yeah I remember how to do that now”. More of these responses were from year 9 but there was an ambiguous response from a year 6 student “it should be fun, I like it”.

Another positive description for maths lessons was that a few students enjoyed it when it was challenging and made them think. This enjoyment of challenge was found in both year groups with one focus group in year 9 recognising the enjoyment in thinking; “if we don’t use a calculator so you actually having to think about it more” and “if you’ve got a worded question you have to work out what you need to do” or if they have a “mental challenge then you have to think about the questions and the answers and really make sure you get everything right”.

One focus group enjoyed the challenge associated with learning new things and a year 6 student enjoyed maths because it got your brain going, however another commented that maths can get annoying when “you spend all break just trying to work out questions”. However, it’s this challenge which year 9 recognised as leaving you feeling satisfied “if you keep trying then it gets easier and then you actually enjoy it because you know how to do it and you actually achieve something”, “I like learning what I didn’t learn before” and “the satisfaction of being able to know how to do this and that in maths”.

In around half of the focus groups in year 6 and a minority of year 9 focus groups there were both positive and negative reactions which shows how varied individual opinions about maths are. There will be many factors which have influenced their opinions, and these also vary enormously e.g. teaching, class behaviour, class, set, room etc. Whilst some students enjoyed the variety in maths, more commented that it was repetitive and that this led to it being boring “if you do the same thing over and over again, it just teaches you the same thing again and again”. This feeling was apparent in both year groups “if it’s something that you might have learnt before or that you're just recapping it might not be as enjoyable as it was then because you've already learnt it so I'm just like oh, I already know this one". More varied lessons were also suggested as an improvement to lessons by both year groups "it's entertaining if we do different things every lesson".

Another personal experience which occurred in around half of the year 6 responses and a few of the year 9 responses was that maths is hard. Maths was described as "hard, I get confused", "I find maths hard a lot of the time" but there were two other focus groups in year 6 who felt that maths was at the right level for them and that they enjoyed it when it was hard. Some focus groups felt that maths would improve if it was easier or if there were easier methods to work things out. The year 9 focus groups also identified with maths being challenging "it is maybe a bit too fast or too complicated" but also made suggestions for how it could be improved "I find maths quite hard and having someone there to help you, I think that would help a lot", "I enjoy maths but the things that I struggle with, I know that I want to keep trying".

A particularly worrying personal experience was how stressful some of the students found maths lessons. This was apparent in both year groups and if it was brought up, dominated the conversation in the focus groups. Predominantly the stress was caused by teachers picking on students to answer questions "I go really nervous, when we go for lessons I get nervous, because I don't know about the question they're going to ask", "I don't like it when they pick on people and don't know the answer and you get really embarrassed", "I get embarrassed easily so it is really not nice", "you say a random answer and they make fun of you" or by the seating arrangements in the classroom (covered in classroom experience below). A focus group in both year groups felt frustrated when they were unable to answer a question "I can't work out a sum and I stay on it for too long and I don't know what the next one is and then I lose time on that one". One student in particular found maths extremely stressful "I feel kind of like nervous every single day, like whenever it's maths; I think it's just me but like that's my weak spot, maths is really hard for me sometimes…" (… is used to show that there is some text missing which is not relevant e.g. ummh).

Some less frequent personal experiences were that maths was boring, it should be more fun and students enjoyed the variety of topics. Some students found it entertaining to keep learning new things. "it should be fun, so you're…. you feel you want to do it and that helps you in the future". Unfortunately, the students were unable to articulate how this could happen, other than to say that it should be more fun, although one student suggested "not just copying off a sheet and filling out answers". A year 6 group was particularly keen on Gecko Maths[4] which is a website which brings Korean teaching methods to American classrooms. The students felt that the "Gecko maths was good…. It's like a group so you can separate jobs doing things, different…..I like maths because it gets your brain going".

Similar positive experiences of maths lessons were noted in 2015 with a few focus groups in year 7 and year 10 describing maths as fun. A year 10 student commented that "I'm terrible at maths but I do like it but I'll never be very good at maths because it's just never going to be a subject that I'm strong at but it's actually quite fun to do and like having to struggle" whilst a year 7 student acknowledged an improvement from primary school "I find it fun because we have different teachers and when we were in year 6 we had the same teacher for all our subjects but in maths we have ***** and I find him really funny". Two groups felt that maths was more fun in secondary school and less boring because you "actually learn stuff" in year 7.

Challenge was a response given by all of the year 7 focus groups and one in year 10 with a year 10 student commenting that "I enjoy maths actually, I've struggled with maths all through my life, but I actually get it. I like maths, I like working stuff out in maths like problem solving". More groups recognised the challenge in year 7 "in primary school it was just adding up stuff and timesing and easy stuff and now you're doing stuff …. Just difficult stuff and I find it better because it's more like a task", "at ***** they challenge you more", "it's got more challenging at our level", "it's more challenging and I like it when it's more challenging because then you have to try your hardest". The responses from the year 7 students imply that there has been an increase in challenge as they have moved into secondary school but that they have enjoyed the challenge because it has been at an appropriate level for them.

Two focus groups in year 7 felt that maths had got harder but neither of them felt that this was a negative thing "yeah, it's got harder but I kind of prefer it", "I didn't really like it at the start but now I like it more because I think it's more better because at the start I think it was a lot more harder but ….. I think it's quite the same for me now". The majority of the

[4] http://geckomath.truman.edu/ In mathematics Korean students have been consistently outperforming American students, so the aim of this project was to bring the successful Korean curriculum to American classrooms. Educators from universities in America have joined Korean teachers in order to discover the successful teaching methods and techniques.

focus groups felt that maths was harder in year 10, “I think it’s got a lot harder obviously because we’re doing our GCSE’s now”, “I think it’s got a lot harder though. I never used to struggle that much until the end of year 9, the start of year 10 sort of age otherwise I’d be going through it fine”, “there’s more complicated stuff you have to memorise” and “it has changed. It’s got harder”. The responses from the year 10 students show an increase in the level of difficult of the subject but also an appreciation for the reasons behind this such as working towards their GCSEs.

Three of the year 10 focus groups commented on how they were more independent “there is much more independent work”, “you’re more in control of what you do” and “I like the fact that you can talk in groups and ask other people for help instead of just asking the teacher all the time”. This personal experience was not noted at all in the year 7 responses but one year 10 student explained this difference because “in years 7, 8 and 9 you have someone like you’re doing this, you’re doing that, whereas now….especially when you’re near your exam they just kind of say do what you need to do rather than do what’s on the board”.

Some less frequent personal experiences (1 focus group) in year 7 was an increase in confidence with mathematics whilst in year 10 they felt that the maths was more “compact” because they knew what they were working towards and they “got it” more than they did before.

In summary the students’ personal experience of maths in both year 6 and 9 was mostly positive with descriptions of maths being fun, challenging and involving thinking. Year 9 described maths as being interesting and satisfying. Both year groups enjoyed the challenge that maths offered as well as the variety of learning new things. In around half of the focus groups there was a mixture of both positive and negative responses about maths which shows how varied the student opinions were. One negative experience was the repetitive nature of maths which led to it being boring. Around half of year 6 and a quarter of year 9 groups found maths hard, although some students felt that the level of difficulty was appropriate for them. A few groups in both years found maths stressful, predominantly as a result of not being able to answer a question that the teacher may ask in the lesson. This caused them to be embarrassed and to feel nervous going to maths lessons.

Similar positive experiences were noted by year 7 and 10 students, with maths being described as more fun in secondary school. An increase in challenge was mentioned by both groups but not as a negative point as many recognised that the challenge was at an appropriate level for them. Both year groups felt that maths had increased in difficulty but again, this was not a negative. The year 10 students appreciated that they were now working towards their GCSE exam.

Classroom experience

The final category of responses described the classroom environment. One year 9 focus group reported that maths had "a lot of things to remember" and it was "hard to remember because there is quite a lot to remember" so suggested that different methods of teaching may make topics more memorable. Some other less popular responses were that games were mentioned as both a good part of maths lessons but also as a way to improve lessons. Silence was a point of contention within one group with girls disliking silent classrooms but the boy in the group having the "exact opposite opinion to these two" because he liked working on his own and in silence. A year 9 focus group found tests very stressful "in tests I completely panic…I'm surprised that I don't like sweat". This group felt that they did better in class than in tests and recognised that being judged on classwork as well as tests would be fairer. There was a similar response in a year 6 focus group who found working on paper stressful "you get stressed when it's on a piece of paper and you can't do it and then you just don't want to move onto the next question. It's just there. But if you are doing it out loud and in an activity, it doesn't matter as much and it's not quite as, you don't feel as bad if you don't get it right". This group suggested that more activities would be better in lessons because it would avoid getting so stressed.

Four focus groups in year 9 and one in year 6 found the seating arrangements in lessons stressful. To put this into context, the year 9 students had spent three years being taught in sets which were made up of other tutor groups in their 'half year' (so there were two top sets, two second sets etc). As they go into year 10 the whole year is put together and streamed between Maths, English and Science to create two groups (a higher 'half' and lower 'half'). The higher 'half' will contain sets 1-5 and the lower 'half' sets 6-8.

This change was clearly worrying the year 9 students as four groups commented on how who they sit by affects their lessons. "I feel kind of intimidated when I sit next to someone who I don't normally sit next to", "I feel like I can't concentrate at all because I'm always like worried about what they are thinking of me…..if I put my hand up I feel like the person is judging me because I don't understand". Many groups in year 9 felt that maths would be improved if they could choose who they sit next to because "having someone there to help you, I think that would help a lot".

More group work was suggested by focus groups in both years as a possible way of improving maths lessons because group work "makes it easier" as you "haven't got one brain to work off, you've got like others to pool off" so you can "get the work done quicker". Not all the students were as positive about working in groups, with one student recognising that "you don't really know them, you don't know if they like maths and you don't want them to make you like doing it all…..because some people in groups they don't want to work with other people they don't know".

Some less frequent improvements to maths lessons were more investigations and practical activities "because when you just sit there and copy out textbooks it gets a bit boring and then you shut off and you don't want to learn" so "activities (are) more interesting because you just get bored when you just have a piece of paper to work on". This love of practical, investigative learning was apparent in both year groups with one year 6 focus group suggesting learning outside instead of sitting in a classroom.

Other less frequent responses were that maths should have easier methods, be more varied and interesting and that the teacher should be there to help more often.

In 2015 there was only one focus group in year 10 which made reference to which class they were in "I think it has changed, personally for me because I wasn't with you guys, wait, last year we weren't mixed with the other half were we?" and in response to that another student said, "no that's true I think that makes it so much better now though". However, three focus groups in year 7 commented on their class because they may not have experienced setting before "we didn't have sets but now we have sets and it's a lot easier because now I'm with other people doing the same amount of work", "I think it's pretty good just how it is at the moment because there's like groups so you feel you're not worse than anyone else in a way", "in primary we weren't really in sets at all so everyone had different levels but now, we're all kind of the same level in a class so ….. nowadays you feel a lot more confident knowing that other people don't feel confident as well". Setting is obviously a big change for the year 7 students but those who have commented on it have felt that it has helped them.

A few year 7 focus groups felt that maths was more exciting than before “they do more exciting things to do, compared to primary when it was just like average maths all the time, it’s like much more better here”. Other focus groups noted the variety of activities and the practicals which they did as being enjoyable.

There was no reference to this in the responses from the year 10 students, instead the majority of them discussed working towards their GCSE exams “we are actually doing some sort of real work and been given a bit of context”, “I think that we had to shove a lot of it in together, quite quickly for our summer exam”. Perhaps the most concerning exam related responses were “instead of learning you learn the paper instead of learning questions so it’s helpful” and “you learn like the layout more than actually learning the maths which is quite helpful”. One year 10 student felt that “it’s like, it’d been better if we’d been taught about papers throughout all of it because all we learn in maths is for our exams but we’re learning lessons instead of exam learning”.

A reference to teachers was made by one group in each year, with the year 10 group appreciating that they only have one teacher teaching them instead of two in the previous year and the year 7 student felt that “I find it more fun now because my old maths teacher because I had my same teacher for everything I kind of got a bit bored because it’s the same teacher all over again so I didn’t enjoy maths as much as I do now”. One group in year 7 enjoyed being able to answer questions because at primary school “you didn’t really get to answer any questions because ….. they’d ask the people who put their hands up …. whereas in secondary school they give a chance to everyone”.

Some less frequent responses in year 7 were that some students felt that their confidence had improved and one student enjoyed having more maths lessons than they did in primary school and another group felt that they had more help. In year 10 they felt that maths was better because it was more compact, and they got to work in groups a bit more.

Very few focus groups discussed how maths could be improved but the two suggestions were to include more group work and more projects and fun stuff. Both ideas were year 7 ideas. The year 10 students did not comment on how maths could be improved.

In summary some year 9 students felt that there was a lot of things to remember in maths and felt that more varied methods of teaching may help to make topics more memorable. Maths lessons in silence was a controversial idea with some students feeling that they worked better in these conditions and others disliking silence. It was felt that maths lessons would improve if they involved more games with some year 9 focus groups finding tests very stressful. A year 6 student felt that writing on paper was stressful because they felt bad if they got it wrong.

Who the students sat by in lesson caused them stress, especially for the year 9 students who were facing streaming across the year when they moved into year 10. Some students noted how they felt intimidated when they sat next to someone different and felt that they were being judged if they did not know the answer.

The use of group work and more practical investigations were listed as the main ways that maths lessons could be improved because sitting and copying out of textbooks was boring and some students felt like they shut off.

In 2015 only one focus group in year 10 mentioned the class they were in, whereas three focus groups in year 7 mentioned it because presumably they have not experienced setting before. The year 7 students felt that maths was more exciting than before whilst the year 10 students acknowledged that they were working towards their GCSEs. One student noted that they were now "learning the paper instead of learning questions so it's helpful". I have interpreted this comment to mean that instead of covering a topic in class and answering questions out of a textbook the student will have spent time answering exam questions and perhaps the teacher has emphasised exam technique in lessons i.e. the focus of the lessons will be towards the exams; which the student feels is helpful in order for them to pass their exam.

One group in both years mentioned their maths teacher with the year 7 group appreciating having different teachers for different subjects and the year 10 student preferring only having one maths teacher as opposed to many in the previous year.

Some less popular responses in year 7 were that some students felt that their confidence had improved and another preferred having more maths lessons than they did in primary school.

Question 2 – Could you picture for me a good mathematician and then describe them to me?

When this question was asked to both year 6 and 9 students the responses between the students were not dissimilar. If any differences occur these will be noted, otherwise the descriptions were given by both year groups. I have put the descriptions into three categories; personal appearance, individuals and characteristics.

Personal appearance

The mathematician was described as smart and tidy, "it's the way you dress, there's a lot of factors to looking clever". The use of smart could be used to describe their appearance or their intelligence but unless it was clearly used to describe intelligence, I have assumed that it describes a person's appearance. In contrast to this two focus groups thought that they would have "mad hair". Most groups pictured a mathematician with glasses with a few groups seeing them wearing a lab or scientist coat. Focus groups in both years described their mathematician as looking like a "scientist". More groups in year 6 felt that a mathematician would have accessories such as a calculator, books or a pencil. This was also suggested by a few groups in year 9.

Five of the year 9 focus groups pictured their mathematician to be "old" whereas the year 6 groups did not comment on age. If gender was discussed groups in both years described their mathematician as being male but other hidden gender descriptions were present such as using the pronoun "he" or describing them as having a beard or wearing a suit and tie. This was prevalent in both year groups but was more common in year 9.

Individuals

These are very typical descriptions of a scientist/mathematician, but many students were very aware that a mathematician could be anyone or a "normal person" that they "do not need to wear like smart clothes and stuff". This was mentioned by five focus groups in each year. This was perhaps best summarised by a year 6 student "I don't think a good mathematician would look any different, they'd just be normal people", "they don't have glasses, unless they have to have them". This group went on to acknowledge "they're not different they just look like normal people", "it's just that they work much harder". This work ethic will be discussed in the next section.

Some students gave a name of someone who came into their mind such as their brother or a student in their class. A few year 6 students gave the name of their teacher in primary school or said a teacher in the secondary school. Four groups in year 10 also alluded to their mathematician being a teacher "like a teacher, a maths teacher". This was also discussed in a year 6 focus group "be like a teacher wearing fun clothes".

Characteristics

A popular response in both years was to describe their mathematician as wanting to learn and working hard; "it needs to be someone that….tries as hard as they can", "revises and always gets the work done", "does maths every single day" and they need to "work much harder" than normal people. A less popular response was that a good mathematician "doesn't give up as soon as a question comes" but that they should "always like learning from mistakes that they make and like trying to correct them and to keep trying and never give up".

Three year 9 focus groups felt that a mathematician should be good at maths and enjoy it and get "good grades" whilst focus groups in both year groups described their mathematician as being clever and knowing quite a lot about maths". They are also "usually quick at solving out stuff" and be "really quickly on the times tables".

In keeping with the idea that a mathematician could be a teacher some groups in year 9 described them as being good listeners and communicators "a person what obviously knows maths but also can express it in not a geeky way", "communicate in a simple and interesting way". A year 6 student recognised listening skills but not as a teacher, describing them as being "someone who would listen to your instructions and understand them well".

A description which surprised me was that a mathematician should always try "new things to try and work to a better level". They should be "quite imaginative" because they "have got to come up with a good formula" so they need to "think outside the box". These ideas were discussed in year 9 focus groups only which may be related to their GCSE examination preparation.

The same question was asked to year 7 and 10 in 2015 and the responses were very similar to 2014. Again, there were not any clear differences between the year 7 and year 10 descriptions. These can be categorised into the three categories as before: personal appearance, individuals and characteristics.

The responses within these categories were very similar with accessories such as glasses, suits and beards being mentioned. More year 10 groups felt that a good mathematician worked hard than year 9 groups in the previous year. This was true in year 7 as well with one student saying, “I don’t think that there’s really a person that can be good at maths, I think that you can choose to be good at maths, you just have to work hard”.

Two new responses were given by year 7 and that is that their mathematicians were confident and that you could “have a joke around with him”. These were not mentioned in the year 6 focus groups but perhaps reflect a change in the students’ feelings towards maths since starting secondary school.

Question 3 – What would your friends say if you came top in a maths test and how would you feel?

There were not any clear differences between the responses of year 6 and year 9 to this question, so unless stated the responses discussed were given by both year groups.

All students had very positive feelings about coming first in a maths test. “You’d probably feel really chuffed and really like happy with yourself” and “I would be happy about it because I would have tried my best to get that”. Students commented that they would feel proud of themselves in both years 6 and 9 “you’d feel proud of your achievement” and “proud that I’ve accomplished something”. Some other positive descriptions are that students would feel “amazed” or “excited” that they had come top and that they would feel “good” about themselves.

One student in year 6 felt that they would be “excited and that I know I could do it another time”. A similar sentiment was expressed by another year 6 student who felt that coming top would “make me want to do more of it. You came top of the test and you want to get compliments, or you want to do more of it because you just worked out, you now know ‘I can do this’, I want to do more, I want to have more, do it more”. One year 6 student sadly noted that “I don’t really know because I never get anything high because I’m really bad at maths”. A year 9 student also commented on how low grades affect her “I remember at primary school doing lots of mental maths things and everyone used to be like 20 out of 20 and there would be just me with like 6 and oh I remember just always crying because I used to hate it so much and it's just like when you get like a low grade it like feels so like the end of the world and you can't stop thinking about it all day".

Some other personal feelings which were mentioned less frequently, were that some students would feel relieved that they did well, surprised that they had come first or that they would feel like a winner. A response that I did not expect to see is that a few groups in both years commented how they would be mindful to not boast to their friends "you don't go flaunting it", "you're like gutted that they've not done as well as you" and "I'd go to them and be like 'don't worry, just revise next time and make sure you do it' and I'd just tell them 'if you need any help, then I'll help you'". A year 6 student responded, "if they didn't get a great score, they'd just say it is a good score but they tried their hardest and they got the best that they can and they shouldn't feel bad". Students in both years were clearly aware of how their peers would feel if they do not do well in a test and were mindful to think of the feeling of others' in that situation.

The responses to how the students' friends would react can be split into positive and negative reactions. Again, there was little difference between the response of the two years but if any were seen these will be noted.

Some of the positive reactions were that the students' friends would be happy for them and say well done. This was an overwhelming response across the two years, however most of these descriptions were followed by a negative comment such as "I think they'd say 'well done' but secretly they would be thinking 'I wish I had done better'" or "I think it depends on the different people and what they are like as well. So if it's like they're the same ability as you then they'll congratulate you but other people do call you like names" and "some of my friends would say well done and some would say boffin and why did you bother revising and stuff like that".

Nearly all year 9 and a few year 6 groups recognised that their friends would feel jealous of them "if you got top in a maths test, maybe they would call you things such as boffin but I think it's because they are quite jealous they wouldn't understand what it's like to be top maybe, if they are very insecure because they don't have anything else to say apart from negative things". The feeling of jealousy was mentioned by virtually all groups in year 9 but by only one group in year 6. Only four groups in year 6 felt that there would be a negative reaction to them coming top whereas every group bar one on year 10 were able to describe a negative comment that they may receive.

The most common negative word was boffin; "some people call you boffin and stuff like that because you had a good mark but you could have worked really hard for that and then like they couldn't have and that's why they got a low mark", "I'd be happy but they'd call me a boffin but I wouldn't really care, I just wouldn't care if I was amazing but they called me a boffin". Other negative words were geek and nerd but most of the students felt that the positive feelings they would get from coming top outweighed the negative comments, except one year 9 student who noted that "it is an accomplishment so you feel like happy that you've done it but I don't know, when you get like put down in a way, that kind of stops you from keeping that going and driving on in maths". Another year 9 boy summed his feelings up as "you'd only get called a boffin for like two days and they realise that they'll be working at McDonalds and you're like a millionaire they won't care".

Two year 9 groups felt that they may have the "micky" taken out of them but again this was explained by their friends feeling jealous. Some less common descriptions were that their friends would feel surprised that they had done well or "if they got a good grade, they might be really happy for you in themselves but if they got a low grade they might be quite embarrassed that you got a high grade and they didn't or good marks or something because they had like hoped they would get better marks than you". Some felt that their friends would be proud of them and a year 6 student described their classroom situation "XXXX she's not very good at maths and say, she was to get top, everyone would sort be bullying her, like XXXX should have come first".

In 2015 years 7 and 10 were asked the same question but with an extra part which was "would you have felt differently last year?" There were similar positive responses as the previous year such as feeling proud and "I'd be buzzing, I'd be so happy", "I'd love to be a geek, I'd love it. To be smart would just be amazing". A year 7 student acknowledged that the work had got harder, so they would be even more pleased with themselves; "really happy especially as the maths we're doing now it's better to get a top grade here than it is in primary school because it's a lot easier in primary school then it is here". This idea was seen in other groups "I would feel like a bit better if I got a really high grade in this school than I did in my old school because my old school the work was a bit easier than it is in this school", including year 10 "I'd be a lot more proud of my myself because this year it actually matter like it did matter last year but this year is our actual GCSEs and getting top, if you came top you'd have an A* and that would just mean a lot and I'd be quite proud of myself".

Students in both years would feel surprised and amazed if they came top. There were more responses of this nature than the previous year which may be due to the increase in difficulty of the work. One year 6 group was worried about their friends and recognised that they should not boast about their score "we would make them feel better if someone got a bad grade and praise them if they've got a higher grade".

There were similar positive comments from their friends such as excited for me, happy for me and that they would say well done. The negative comments from their peers were also similar with boffin, nerd, and geek being common replies. Three groups in year 7 noted these words which was more than in year 6. Again, most students were able to balance the negative words with a reason behind it. This response was from a year 7 student "I think that getting a good grade in maths is a lot better than not because people will make fun of you for getting a bad grade but they will think highly of you if you get a good grade, even if they call you boffin and stuff" and similar from a year 10 student "I think throughout year 7 and 8 maybe there's like if you came top you'd be a boffin and well I got that a lot and then yeah a boffin mainly, but now it's not obviously you've got GCSEs so it's not like, there's not as much 'boffin', it's like I wish I could be as good as him. They say it as like 'well done'". This was repeated in another year 10 group "yeah I think people do judge, not so much now because it's GCSE and that but a lot in year 7, 8 and 9 you get people who judge and if someone gets a higher mark you get called names of people…" "it's kind of gone away" "yeah, people kind of are more focused on themselves rather than other people". When asked what had brought about the change, one student replied, "the realisation that this is it, if you mess around now, it's going to affect you forever". There appeared to be a focus on GCSEs from the year 10 responses which gave them a new appreciation for a high mark.

Question 4 – What do you think maths is going to be like in Key Stage 4? Do you think you are going to enjoy it more or less and why?

The responses for this question differed more than the previous two questions between years 6 and 9. In response to this question I have constructed three categories that allow me to understand what the students were telling me. These categories are the same as in question 1; rationale for maths, personal experience of maths and classroom experience of maths.

Rationale for maths

There was only one response which fell into this category and this was from a year 9 focus group where the students felt that maths would be more relevant to real life “we’ll be doing more things to do with real life because like you learn things like Pythagoras’ Theorem I guess it’s important if you’ve got a certain job and stuff but like it’s really hard and it’s kind of aggravating that you might not have to, don’t need to learn it at all even though you spend so long like figuring it out and stuff”. The rationale for maths was not discussed in any other groups.

Personal experience of maths

Three groups in year 6 and four groups in year 9 felt that they would enjoy maths more in the following year. Some reasons for this given by year 9 students are that “I don’t want to be relearning what I’ve already done. I want to bring that to the next stage and feel a bit of satisfaction then when I actually get it”. Focusing on GCSEs was another response “it would be better because …. It is closer to our GCSEs obviously everyone, more people should be more concentrated, so it should be better because there will be less distraction”, this was agreed by another student in that group “it will be better because it will be more organised and you’ll concentrate more because this is proper now”.

Reasons given by year 6 for enjoying it more were that there were “more things to do and more experienced teachers” and that the students were looking forward to feeling challenged “I have always been a bit like good at maths and I usually can do pretty much all the work so I’d want it to get harder”, “I think it might be more fun because I like hard questions” and “I think I’ll like it more because I like the feeling of being in a testing atmosphere …. It feels nicer to just being in a test, concentrating and enjoying the test really”.

This feeling of being challenged was apparent across both year groups when they considered how maths would change as they went into the next year. Many year 6 students felt that they wanted to be challenged and enjoyed maths more when they were “I think it’s going to be funner because you’re doing more complex things”, “you’re not stuck doing lower stuff in primary school, you're into secondary stuff". One group were particularly positive about being challenged "we think it'll be much funner in secondary school because it'll be quite challenging and then you'll have to get up to a higher stage and then when you get to that stage, you'll feel much prouder and you'll be working up and up until you get a really good job".

Year 9 students felt that maths would be worthwhile because they were "getting something that you're getting out of it". This feeling was reiterated by other year 9 students "there's no point not pushing us because then we won't succeed", "they could make it fun and easy, but you'd get nothing out of it". One student recognised that they would have to work harder to achieve the same grades "I think I'll enjoy it just as much as now but I know that I'm probably going to have to work even harder now and yeah, it's going to be more of a challenge in Key Stage 4 and it's going to be hard like to maintain my grades and go higher … there's going to be more mistakes made so I'm going to have to learn from them and get better for the actual test". Another year 9 student reacted differently to the anticipated challenge "it's more challenging because then it's like harder so you shouldn't feel bad about yourself if it's too difficult".

A similar number of groups felt that they would enjoy maths the same in the following year as felt they would enjoy it more. These students did not feel that maths would be any different in the future and so their feelings would remain the same "there are some things that I don't really like and some things I do like" and "it'll probably be kind similar to how I feel at the moment because I kinda like understanding what I'm doing but then again it is nice having a challenge and then when you come through that challenge and then totally get it you're like yeah". There were less groups in year 6 that felt that they would feel the same about maths but the two students who mentioned it felt that "it's going to be alright because it's not going to be like a huge, huge step like so so hard like we think it's going to be because it's only going to be a little bit harder because we've been practicing here for secondary school" and "at this school didn't really like it as well, at the next school I don't really think I'll like it".

In around half of the year 9 focus groups there were students who felt that they would enjoy maths less in the following year, overwhelmingly the reason given for this was that the students felt that it was going to get harder as they worked towards their GCSEs; "I think it's going to be less enjoyable, you're going to have to like try harder in lessons and revise more if you want to get high grades" and "I think I'm going to enjoy it less, I might enjoy it like at the start but when it gets to GCSE, when it's like really serious maths, you can't do as much fun stuff because you actually have to learn a lot more". The few groups in year 6 who felt that they would enjoy maths less also attributed this to the work being harder and one student did not like the length of the lessons "it's going to be fifty minutes of constant maths every day which I don't really like. Which isn't really my thing".

The recognition of maths becoming harder was evident in all bar two focus groups across the two year groups. Some of the year 6 students felt that they were ready for the challenge "it will be slightly harder but easier because as we know a lot about maths, it will be hard work but we will find it slightly easier" and that they would be supported in secondary school "I think it's going to be harder of course but it can be easier because they would understand more people our age because they have a big school with lots of people our age". One year 9 boy also felt that it would get easier "because they'll put people in the right groups so they'll help more people". The arrangement of classes will be discussed in the *Classroom Experience* section below.

This idea of stress and pressure was alluded to by other year 9 students who felt that maths was going to become more serious the following year, although this was then interpreted both positively and negatively. One student thought that the lessons would be less fun because they were now working towards their GCSEs whilst another felt that at least they were "actually getting something at the end of it, not just a higher set or something".

In summary around a quarter of the groups in both years felt that they would enjoy maths more in the following year with some reasons given by year 9 students that they would not be repeating what they already know but would be focussing on their GCSE exams. The year 6 students were looking forward to being challenged and to having more experienced teachers (in their opinion).

The feeling of being challenged was evident in both year groups with year 6 feeling relishing being challenged more than they currently were as maths would be more fun than it was in primary school. The year 9 students felt that maths would be more worthwhile because they would be getting something out of it although they recognised that they would have to work harder to achieve the same grade. One student felt that they should not feel bad about themselves if it becomes too difficult because the work is harder.

A similar number of focus groups felt that they would enjoy maths the same in the following year as would enjoy it more. These students felt that maths would not be any different in the future, so their feelings would remain the same. Two students in year 6 felt that although they were about to take a big step, they had been practicing in primary school so they were ready for it.

Around half of the year 9 focus groups felt that they would enjoy maths less in the following year, with the overwhelming reason being that it was going to get harder as they worked towards their GCSEs. This feeling of maths getting harder was also felt in year 6 as a few groups felt that they would enjoy maths less as it got more difficult. This feeling of maths becoming harder was mentioned in all except two focus groups across the two year groups, although some of the year 6 students did feel ready for the challenge. One year 9 boy felt that maths would become easier because he would be put into the correct set.

One student in year 9 felt that maths was going to be stressful, however this was interpreted both positively because they were actually working towards something and negatively because the lessons would be less fun.

Classroom experience

The arrangement of classes came up in four focus groups in year 9 and two in year 6. Some year 9 students felt that they would get more help with the new groups “it will be a smaller group, so the teacher will be able to help you out more”, “the teacher will be able to concentrate on one child rather than have 30 children and different ones wanting to speak to her”. The other two groups were very anxious about what set they would end up in, mixing with the whole year group and where their friends would be “I think it’s hard for somebody to say that they are in the bottom group, when their best friend is right at the top or something”. One group in particular found the setting very stressful “I’m with people I don’t know and I’d probably get put in the bottom one with my exam grade and I feel like, I don’t know, I feel like I’d do a bit worse because I don’t really know the people in my class and I won’t feel confident because I just don’t know, I’m kind of scared for next year’s group”. The students in this group felt that if you were in a set that you did not want to be in then it would “put you down and you don’t learn anything”. The idea of making new friends was on the minds of the year 6 students as well. Some students felt that trying to make new friends would distract them from their work whilst others felt that there would be more people around them to help them.

This feeling of stress and fear came across in a focus group in year 6 and year 9. Year 6 feared a new school "I'm scared basically, not scared scared but scared that it's going to be really hard and I'm not going to be able to do it". Others in that group were also worried "I think I will enjoy it but sometimes I get panicky because I think it's going to be harder", "I feel pressured because the teachers are more strict and if you don't know an answer then they might start shouting at you" and "I feel like I'm not going to be smart enough for the work and I'm going to feel dumb and everyone's going to pick on you".

The feeling of fear was mentioned in the year 9 focus group in relation to how the year group would be mixed together and set. "I'm scared of being in the bottom set because I'm scared that I am not learning anything because you know there is teachers who teach bottom set and you don't learn anything".

An idea which came up in three focus groups in year 9 and one in year 6 was the idea of repetition in maths "I don't want to be relearning what I've already done" and "it could be less fun because you have done lots of maths already and it is just kind of repeating things but it is getting harder". One year 6 student felt that they would go back over topics in secondary school "you don't do much like times tables anymore because you are in year 6 and you are expected to know a lot of it, so it will be good to step back into XXXX and start doing more work that you haven't done for a while and I think it will be kind of scary to start off with because you'll think of like how other people will have done and how you should be".

In 2015 the year 7 and 10 class were asked "how have your feelings changed towards maths from this year to last year, if they have changed at all?" As in 2014 the responses have been categorised into personal and classroom experience.

Personal experience

Eight focus groups in year 7 and three in year 10 felt that they enjoyed maths more than they did the previous year for a variety of reasons; "I prefer maths now because I'm not in the higher set anymore", "I used to hate it …. But it's like all changed now". The year 7 students felt that maths was more enjoyable "I think it's a lot more enjoyable being in sets", "I find it easier because when I was in primary school they didn't like tell you what you were exactly doing they just gave you a sheet or something" and "you get to learn loads more than you did in year 6".

Most groups in year 7 and one group in year 10 felt that maths had become more fun "because we do a lot of games and drawings and things which I prefer to tests and things like that", "I actually want to come to school because I find maths really fun", "I remember stuff because we do more funner activities" and "it's funner now than primary school because primary school was pretty easy maths".

The idea of maths being challenging was also prevalent in year 7 responses; "it's a good hard that you like it's not hard that it's oh, I don't want to do that, it's hard that oh yeah, I'll give it a go". The work being at the correct level was also recognised "it's like challenging so we have to work towards it but it's just above our level that we have to do", "they push you a bit better here than at primary" and "you learn loads more than you did in year 6 we were limited of what we learned but now you've got different topics and want to learn".

Groups in both years felt that maths had become more interesting and felt more positive about it. Year 10 students noted that "everyone was I hate maths and things like that, apart from the people who actually did like it but now we just kind of get used to it and it is important", "probably why I enjoy it more because I've been doing better" and "a few years ago I used to dread maths, it's one of those subjects I don't mind going to it. I don't dislike it, I don't love it but I don't mind it".

The feelings towards maths of some groups had not changed. A year 10 student felt that they had "always enjoyed it really" whilst some year 7 students felt that "it's about the same". One year 7 focus group felt that they enjoyed maths less at secondary school "maths is quite fun at the moment but I enjoyed it more during primary but it's still fun now but at primary it was just a bit more fun because you got to do more like kind of activities and not just like mostly work".

Year 10 students also recognised that they had to work harder in maths "when we were younger, we didn't sort of find maths that important … but now we sort of see that it is very important not just for uni but even just day to day life you need maths. We've also seen that we're working on getting a good qualification rather than just a C". The students acknowledged the need to increase their efforts "you actually have to knuckle down and pay attention, less messing around", I've put in a lot more effort" and "I think it's more important".

A few groups in year 7 and one in year 10 felt that they had increased in confidence in maths, with one year 7 student saying that "I feel like I'm the same as other people so I can do better and work harder". A year 10 student felt "a lot more confident than in year 7. A few years ago, I used to like dread maths". Another student in year 10 attributed their increased enjoyment of maths to putting in a lot more effort and feeling more confident in the lessons.

Classroom experience

A few year 7 focus groups felt that maths was explained better to them at secondary school than it was at primary school because they were "given sheets and they don't even help you because that's what happens with our primary school". One focus group spent a long time explaining how having a range of supply teachers was affecting their feelings towards maths "it's not really the maths that makes me feel nervous, it's the teachers and how they respond to you".

Two groups in year 7 felt that they benefitted from being taught in sets "knowing that you've got everyone around the same level" and "I felt more confident in that group because when it came to the tests because I'm not very good at maths being on the spot because I panic and I don't do as much as I could so that's why I moved down". One year 10 student also mentioned sets but felt that they had benefitted from moving out of a higher set "which is annoying for me because I like doing harder maths but we do get to choose what we do and when we do it in maths so I choose the hardest thing I can do and then work backwards compared to last year I had to do the normal stuff that everyone else was doing so I had no challenge really. I just sat there being bored for half the lesson".

How did you feel before you joined XXXX School and how do you feel now?

In 2015 the focus groups were asked this extra question to establish if the school was their first choice and how they felt before joining. This question was asked as a result of the 2014 focus groups in order to establish if the students had chosen this school or if they had wanted to go to another school e.g. tried to get into a grammar school and failed the test or tried to get into a neighbouring comprehensive school.

In response to this question I have constructed two categories that allow me to understand what the students were telling me. These categories are personal feelings (positive and negative) and environmental aspects.

Personal feelings

All the year 7 focus groups said that they were scared or nervous before they started. Some reasons for this were that “the school’s like massive and we came from a tiny primary school”, “I didn’t know what to expect”, “I didn’t know anybody, no one from our old school went here” and “I knew a bit around but not like quite a lot”. Three year 10 groups remembered feeling nervous “I was terrified of coming here, there were like 12 of us in year 6”.

One student in year 7 admitted that “it wasn’t my first-choice school”. They had chosen to start in a different comprehensive school but left after three weeks because “I just kind of got bullied” and “I didn’t enjoy it as much”. Another student said, “my first choice was XXXX *(grammar)* but I’m glad that I did come here in the end”. The other students in this focus group agreed with this student “I was tempted to go to XXXX *(grammar)* but then all of my friends came here and I wouldn’t have known many people at XXXX *(grammar)* so yeah, I’m glad I came here” and “same with me like only I think 5 people I think it was went to different schools and then all the rest went to XXXX *(comprehensive)* or came here so I wanted to come here”. A year ten student admitted “I wanted to go to XXXX *(grammar)* because they have nice uniforms” but they went on to say, “I’ve got a friend who goes to XXXX *(grammar)* and she hates it”.

More positive personal feelings were that three focus groups in year 7 were excited to start the school “I was excited because I was going from a small school to a big school and you start at the bottom again, rather than top”. One year 10 student said that they were “excited to come here”. One group in each year group felt confident to start at a new school “I felt confident coming to XXXX because I knew the place already in terms of the school and in terms of work, I was doing quite well at primary school, so I thought that I’d be fine here at secondary school”.

All the students felt settled in the school and any negative thoughts before joining had turned to positive ones. In year 7 “I like it more this year than I did last year because it’s more, they’ve comforted us this year about like telling us how to do it and what we need to improve on and not just making us do it, they help us but last year they didn't really help as much", "alright because you know what's like there and stuff". Year 10 students felt that you get used to it "now I'm just used to it and it's completely normal", "now I love it, I love school" and "you get a bit more freedom than in primary school".

Some students in both year groups felt that it was not as bad as they had imagined. A year 10 student felt that "but now you actually get here, and you get used to it and like because you're getting smarter it's not actually as hard, it's just like you feel like it's the same".

Environmental aspects

Bullying was mentioned by one group in year 10 "obviously before you come you think obviously about bullying and you don't actually know what secondary school is actually like and you see sort of TV programmes about people being bullied and things like that. Because I was quite nervous that I would get bullied before I came", and one group in year 7 "I was quite scared of the older kids because out of school I've had some confrontation".

One group in each year group mentioned that secondary school would be hard work. In year 10, "I thought it was going to be a lot harder work" and in year 7 "I was a bit nervous about how much homework we would get", which was agreed by another student "I felt really nervous at the start, I thought that we were going to get loads and loads of really hard work and loads of hard homework".

A year 7 group admitted that they did not get as much homework as they thought they would "but we don't get that much homework". Another student agreed "we didn't actually get that much homework or hard work".

A focus group in each year made a reference to maths being fast paced. A year 10 student felt that they "enjoyed maths more at primary school than I do now" because "it was more laid back in primary school compared to now, it's more full on….like when you go from KS3 to KS4 there's a big jump, not in the learning but in the amount of work that you do". Another student in this focus group was more confident "I find it better now that I know what I'm doing". They went on to admit that in years 7,8 and 9 you could get away with not doing your work but now they could not.

Another year 10 group mentioned "I feel like I've improved in maths" which was agreed by another student "yeah, maths was something I struggled with in primary school, but I feel I've got better, especially in like algebra and stuff…I think I've learnt more this year than any other year in school". Year 7 students also commented on maths "I was worried that I was going to be really low in the maths sets but I think I surprised myself with how well I work" and "I didn't really like maths in primary school, it was always too hard and they were going too fast but like it's better in secondary school because they've got different levels for your ability".

In summary all of the students felt happy to be at the school, even if it was not their first choice. Despite feeling nervous and anxious before they joined the school, they soon felt settled and enjoyed coming to school. If maths was mentioned, it was in a positive light with students feeling pleased that they were either in a higher maths set or making more progress than they had imagined.

Cartoon data

<u>Cartoon 1</u>

Please contact author for image

Talk about the picture – how does it make you feel?

How would you feel if you were there?

How would you feel if you can't immediately find the answer to a question?

In response to this question I have constructed three categories that allow me to understand what the students were telling me. These categories are personal feelings, classroom environment and actions. When this question was asked to year 6, 7, 9 and 10 students the responses between the students were not dissimilar. If any differences occur these will be noted, otherwise the descriptions were given by students in all year groups.

Personal feelings

Two focus groups in each year group contained students who would feel frustrated if they were a student in the picture and could not work out the answer. This varied from personal frustration that "I'm not good enough" to frustrations with the teacher; "really annoyed that I'd been put on the spot and the teacher isn't helping the pupil" and "some teachers when you put your hand up they don't answer you, it just gets really frustrating so this picture just kind of reminds me of like not really listening to the students".

The majority of year 7 and year 10 groups would feel worried, nervous or frightened if they were in the classroom. Similar proportions were seen in the 2014 data. The students felt nervous that they "wouldn't get it right" and that "everyone would be looking at you". Two groups in each year group felt that they would feel stressed if they were in the classroom because "everyone's watching", "I don't like talking in front of a big group of people". Some students would actively try to avoid being selected "try not look at the teacher to try to avoid the question".

Two groups in year 9 and 7 felt that they would be embarrassed; for similar reasons as mentioned above "I'd feel put on the spot, embarrassed, because the whole class would be looking at you and laughing at you like I can't believe you can't do that and making you feel bad about yourself" and "she'd just pick us out if we didn't put our hand up and she didn't know if we were ready and we would sit there and be red and be embarrassed because we didn't know what to say or how to react to it because and then you've got everyone else laughing at you and then taking the mick out of you".

Some less common personal feelings were that some students would have previously bottled up their feelings whilst another would feel that they would struggle in that situation. A few groups in the year 9 written responses were that students would feel confused if they were in that classroom. One year 10 student felt that they had increased in confidence and that "having more confidence in maths makes it easier to learn questions that you don't know whereas because you feel more confidence in maths you're more confident with yourself in answering questions".

Classroom environment

A year 9 and 10 group both commented on the layout of the classroom, suggesting that "it's better to work in groups….maybe just 2 or 3 of the same ability as you" because "if you're stuck there is always someone there to help you".

Another comment made by both year groups was that the teacher was not listening or interacting with the class, which as seen above leaves the students feeling frustrated and nervous.

One year 7 student felt that if the content related to real life they would "understand it more and I wouldn't have to ask for help because I'd think of the subject or the matter that they put it into, the context and then I can just relate back to that".

Actions

The majority of focus groups would ask for help from either the teacher or each other "I'd say does anyone have any ideas and I'd learn from other people if I didn't know myself I'd make sure I found out", "I'd just ask, it's better to ask then not know and just stand there". A year 7 student felt that "last year I bottled it up but now I ask quite a lot".

One year 7 focus group suggested that they would "look around the room" or "other people whisper it to you and tell you….I'd listen to what they said or I would just guess an answer and be like Miss I'm not too sure but I'd guess an answer or if I'd make up an answer and go back at the end and say Miss I don't know the question, could I have a bit more help to improve in what I can do". This idea of being told the answer was mentioned again in two other year 7 groups "when you get picked people always shout the answer at you, it's annoying because when you're trying to try to do it and everyone's shouting the answers at you it's just really annoying" and "people are whispering it to their friends".

One year 9 group would "give up", whereas one year 6 and three year 7 focus groups suggested they would "think about it carefully", "think of ways to find out how to do the sums" or "I'd spend a bit longer" on the question. The idea of thinking was not mentioned in year 10, but one group said that "if someone asked me a question I'd just leave it". This was also suggested in a year 7 focus group "if I was there and I didn't know it I would actually leave it to someone else for a little bit and then when it came into my head I'd put my hand up" or "pass it to someone else or estimate a guess".

One year 7 group suggested just having a go at the question “instead of thinking oh I don’t know it so I won’t put my hand up, just have a go at it and if you get it wrong it won’t matter”. Another student in the same group recognised a change since primary school “I think in primary if we were in a test and we didn’t know we would just leave the answer but now I think that we see that we should just have a go because we may guess right”.

Cartoon 2

Please contact author for image

Talk about the picture – how does it make you feel?

Do you ever feel this way?

How would your parents/carers react?

Do other pupils say the same?

In response to this question I have constructed three categories that allow me to understand what the students were telling me. These categories are personal feelings, classroom environment and parental views. When this question was asked to year 6, 7, 9 and 10 pupils the responses between the students were not dissimilar. If any differences occur these will be noted, otherwise the descriptions were given by students in all year groups.

Personal feelings

Students in all year groups recognised that maths was an important subject which would be useful in life “it’s school, you need to get a good education, get the right qualifications when you’re older so it’s not really a big thing because you’ve got to have lessons”, “you have to have maths in your life because you won’t get a job or anything”. Although this was a common answer in the younger groups, it was mentioned by nearly all the year 10 groups.

Three groups in each year felt that they enjoyed maths and so the number of lessons did not matter to them “it’s not really that bad for me though because I like maths so I would probably be like ‘yeah we’ve got maths 4 times a week’”, “I don’t agree with it because maths is one of my favourite lessons that I do here, I just really like it, I’m really excited about it because it’s well fun”.

One student in year 7 did not enjoy maths “annoyed because I don’t really enjoy maths that much but then I do”, although the year 9 students wrote “don’t understand – don’t enjoy” and “not everyone enjoys it”, acknowledging that if students do not enjoy maths they may feel differently about the number of lessons they have a week.

One year 7 group found the number of lessons “confusing because if you revise for one because you want to get really good at it but the next day you move on to something else that would be frustrating”. Another group thought that maths was better now that they had more lessons “I like it better, we had one maths lesson a week and now we have 3 or 4 and I like it better now because we’ve got more lessons and we can improve and we can show how much we’ve learnt compared to last year and we know what we’ve done different”. A year 10 group also felt that maths had improved but for a different reason “I really like maths now but I didn’t like maths last year because I didn’t like the people I was sat next to they were so horrible the smarter people would not have a go at you but XXX you and I didn’t like that”.

Some less popular responses were that you cannot do anything about it so you have to get on with it, that you learn more by having more lessons and that you get used to it.

Classroom environment

One year 9 group wrote “only if we had fun lessons” which may imply that if their lessons were fun they did not mind having them four times a week.

One year 7 group felt that “you need maths quite a lot although people find it boring it’s still really important”. Another year 7 student felt that maths would “probably be repetitive so it’d kind of get on your nerves sometimes because normally I feel like it doesn’t really bother me that much”. Another group commented that the maths lessons were well spread so it was not too bad.

Parental views

If any groups mentioned what their parents would say it was to give a positive, encouraging response. Three groups in year 9 wrote “get on with it as it’s important”, “parents think it’s good” and “parents would say get on with it”. This was reaffirmed in year 7 “they would try and change my opinion because maths, you enjoy it if you’re having fun but if you did like it you wouldn’t be saying it’s unfair”, “do the best I can and don’t give up on it” and again in year 10 “they’ll say I need to have it to get a job”.

<u>Cartoon 3</u>

Please contact author for image

Some people are glad to give up maths. Others take it after GCSE, why?

If people do well in maths do you think that they feel differently about it?

Do you ever feel anxious about maths? Why?

The responses to this question were all related to how the students felt or how they viewed maths. When this question was asked to year 6, 7, 9 and 10 students the responses between the students were not dissimilar. If any differences occur these will be noted, otherwise the descriptions were given by students in all year groups.

Feelings

Around half of the focus groups felt that if you achieved in maths you enjoyed it more; “when I get a good grade in maths I feel happy and it motivates me a bit”, “if they do good and they’re in a higher group I reckon they get more confident and they’re doing well and they carry on working hard” and “some people believe they’re good at it and some people believe that they can get places in life by just trying their best but others if they can’t do it they believe they’re rubbish if they’re in bottom group or they don’t try as well and they say they’re not going to take it when they’re older”. The final example summed up the next group of response which is that students do not enjoy maths if they do not achieve in it, “if you barely get a C or maybe a D you’re probably going to think I’ve got no chance, there’s no point carrying on if I can barely pass GCSE” and “if you’re doing badly in it and you’re struggling then you tend to not enjoy it”. This was given by 2 focus groups in both year groups.

Feelings of stress were mentioned by between a third and half of all year groups; “it can be frustrating when you don’t get a good grade”, “I just push my papers away so I don’t see it”, “if I really don’t know something I feel kind of anxious” and again, as in the first cartoon, “when the teacher asks me a question or if there’s a really hard sum on the paper”. Two year 7 groups felt nervous in maths lessons “I like to put my hand up and ask but at the start of the year and sometimes a bit now I was a bit scared to put my hand up for help because I thought I was the only one in the room that doesn’t understand” and “I feel anxious and feel like doing that is when I make silly mistakes”.

One year 7 group suggested that “if you weren’t good at maths obviously just try again until you think you’ve done the best” whilst another suggested that “just because you don’t get the score that you wanted to doesn’t mean that you have to give up, you can still keep trying”.

A third of the year 7 and one year 10 group felt more confident towards maths “I think the better you do in maths the more confident you become so then that’ll probably put you away from the thought of giving it up because if you’re good at it you don’t really want to give it up as long as you enjoy it”.

One group in year 7 and year 10 felt that the teacher affected whether students continued with maths or not “some people have a bad opinion of it and it depends on who’s teaching it”, “I think that if you have a good teacher and the class is good and the pupils are nice and willing to learn then it’ll be fine but I think it just gives you a boost and you feel much better”.

Views of maths

There was only one response which fell into this category and that was how important and useful maths is in their futures. Between a quarter and a half of groups recognised that some students may take maths beyond GCSE because it would help with their career; “they realise that they need it in life”, maths is important, I wouldn’t give up on it. I’d make sure I had done it eventually”, “if we’re going to do a certain job we can use it” and “maths is very important in jobs and everything because if you don't have maths there's not really a right range of jobs you can get".

Cartoon 4

Please contact author for image

How do you feel about this?

Is there any point in working at maths?

The responses to this question have been categorised as positive and negative. When this question was asked to year 6, 7, 9 and 10 students the responses between the students were not dissimilar. If any differences occur these will be noted, otherwise the descriptions were given by students in all year groups.

Positive responses

The overwhelming response given by all bar three groups in all the year groups is that there is a point to revising "if I revise I might learn some more and gather some more information that we weren't taught that might be in the test", "if you don't bother trying then you're not going to get any better", "you're going to get a better grade after revising than not revising". Every student felt that you had nothing to lose by revising and you may improve "even if you're achieving an E in maths if you revise then you're going to get better at it, it's basically definite, if you revise properly and you revise stuff you don't know then there's no way you can go down in maths you're either going to stay the same or go up you can't go down if you revise".

Two groups in year 7 felt that the person in the picture did not do well because he had not revised “I think that he’s no good because he hasn’t revised because if he did revise he would become good at it, I think he’s just got himself a bit worked up because he hasn’t revised and then he’s not good at it”.

One student in year 10 felt that they had improved when they tried “the papers we did at the start I didn’t put much effort in because I thought it was pointless but I found that when I did put the effort in and took time to do them properly I got quite good grades”. A year 7 student felt that “people say stuff about maths like oh it’s so boring and stuff but it’s only because they can’t be bothered to try but when you do try I think people find it more fun”.

Nearly half the year 10 groups recognised that maths was an important subject “you need maths in your life anyway so you should be good at it” and “you have to do it until you get a C so there is a point doing it first time around so then you don’t have to revise over and over again”.

Negative responses

Two groups in year 7 and one in year 10 felt that they used to feel like the man in the picture but their feelings had changed “I used to feel like that in primary school because we get an end of year test like we do now but I normally feel like that because in primary school I was really bad at maths but I did it and I still got a bad grade but I sometimes feel like that but I normally just do it and it actually turns out quite well but I revise anyway, even though I think that, just in case” and “I used to feel like that quite a lot but the more you practise something the better you’ll get at it, it’s different if you’re sitting there like I’m not going to try because I’m just going to fail. You have to actually try, you can’t just say that you’re going to give up if you haven’t started”.

One year 9 group wrote that “revising is hard in maths” whilst another wrote “maths brain”, perhaps referencing that some people had more of a maths brain, so revising was easier for them.

One year 7 student recognised that they had improved now “I used to think I’m no good at maths but now I think I’m really good at it because I used to revise quite a bit and I don’t as much because I know a bit more”.

Questionnaire data

I decided not to report proportions because it is more difficult to read and was too exact for this kind of analysis. The reasons behind this decision were that just because the students did not write something, does not mean that they do not think it and having such small numbers in the sample, one questionnaire is worth 10%. However, in order to eliminate any ambiguity surrounding the use of words implying proportion, the following terms will reflect the broad proportions listed

Nearly all = over 75%

A majority = over 50%

Half = 50%

A minority = below 50%

Few = below 25%

To help me understand what the students were trying to tell me I constructed categories for certain questions from all the answers given to that question in the sample from both the year 6 and year 9 students. Not all categories are present for all groups.

Year 6 Boys

I will probably continue with maths after GCSE. Circle one –
Strongly agree Agree No opinion Disagree Strongly disagree

Why?

Answer	Number of Responses
Strongly agree	3
Agree	3
No opinion	5
Disagree	0
Strongly disagree	0

Two of the 'no opinion' and two of the 'agree' responses left the 'why' section blank.

The categories are personal effect, future uncertainty and subject value.

Personal effect

Two of the ‘strongly agree’ responses were as a result of enjoying maths “maths is a joy to my life and it’s something I like to do” and feeling confident in their ability “because I like it and I’m good at maths”.

Future uncertainty

The three ‘no opinion’ responses were all linked to being unsure what they wanted to do in the future “I don’t know what I want to do after GCSE”, “because I don’t know yet” and “because it depends on what job I get when I’m older”.

Subject value

The third ‘strongly agree’ response was due to maths being useful to them in the future “when I go shopping, work and partys [sic]”.

Another student who agreed with this statement felt that maths was something that they could improve on “because you need to keep practising”.

If maths was an option now, I would probably choose it. Circle one –
Strongly agree Agree No opinion Disagree Strongly disagree

Why?

Answer	Number of Responses
Strongly agree	2
Agree	5
No opinion	2
Disagree	2
Strongly disagree	0

One of the ‘no opinion’ and one of the ‘agree’ responses left the ‘why’ section blank.

The categories are personal effect, future uncertainty and subject value.

Personal effect

Three students agreed that they would choose maths because they enjoyed it "I have always liked math", "I like it so I would continue". One student felt that they would continue with maths because they were good at it "I'm good at it so I'll get a good grade.

Two students would not choose maths because they did not enjoy it "I would pick something different and more fun" and "because I don't like maths".

Future uncertainty

The link between maths and job was mentioned by two students "I think that maths would get me a good job so I would choose it" and "it will help with my job" and one student felt that they would choose maths because it "would help me with life".

Subject value

One student responded 'no opinion' because "there are more subjects" which perhaps means that there are other subjects which they would rather take instead of maths.

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

Only one boy explained his answer to this question and he chose option (d).

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Behaviours

Behaviours covers actions which somebody can do e.g. work hard, listen etc. All the year 6 boys suggested that a behaviour made somebody successful at maths. Two boys suggested listening, whilst one suggested asking a friend or teacher if you got stuck.

Nearly all the suggestions were to work hard and to not give up; "to work really hard and keep to the task", "revision and hard work", "good concentration and stick ability". One student suggested that you need to "do what it says on the board in front of you". One anomalous response was "to be very careful".

The other two categories were not mentioned by the Year 6 boys.

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

The categories are classroom environment, personal experience and activity type.

There were 5 blanks to this question from the year 6 boys.

Classroom environment

This category was only mentioned by one year 6 boy recalled playing games in the ICT suite and one student who recalled sweets; "we used sweets and ate them at the end. It helped me understand how to use fractions".

Personal experience

One student's favourite lesson was because it was easy "I found it easy doing collum [sic] addition. I learnt how to do it in a few minutes" whereas two students enjoyed a challenge "learning times tables because it is a challenge and fractions because there [sic] hard to learn and it takes a while".

Activity type

One boy enjoyed the competitive aspect of Gecko Maths "Gheggo[sic] maths as it is a bit like a competition against the time. One student enjoyed maths games and another boy recalled "it was my favourite lesson because of a murder mystery, it was a puzzle and hard".

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

The categories are teacher behaviour, activity and personal experience.

Three boys left this question blank. The year 6 boys did not have any comments which would sit in the teacher behaviour category.

Activity

One boy suggested using computers and one suggested maths games on iPads in order to make the class more enthusiastic about maths. Half of the year 6 boys suggested playing games to improve maths lessons; “play lots of fun games that are relevant to maths”.

One boy suggested to use more murder mystery puzzles and another suggested going outside into the playground to make maths more fun.

One boy suggested times tables (I am interpreting their response as times tables as opposed to timetables) as making students more enthusiastic, “I would make them know more about time table”.

Personal experience

Nearly all the year 6 boys suggested making lessons more fun; “make maths lessons more fun so they want to do it more”. One student suggested making maths “more fun. Not as hard for some people”.

<u>Year 6 Girls</u>

I will probably continue with maths after GCSE. Circle one – *Strongly agree Agree No opinion Disagree Strongly disagree* *Why?*

Answer	**Number of Responses**
Strongly agree	1
Agree	4
No opinion	4
Disagree	1
Strongly disagree	0
Blank	1

One of the ‘no opinion’ and one of the ‘agree’ responses left the ‘why’ section blank.

The categories are personal effect , future uncertainty and subject value.

Personal effect

Two 'agree' responses felt that they enjoyed maths, whereas one 'no opinion' response did not enjoy maths but recognised that it "is an important life skill".

Future uncertainty

Two year 6 girls responded with 'no opinion' because they were unsure about their future "cause [sic] no one knows what the future holds".

The most popular response to this question was that maths was useful "you will need maths in your general life", "it can help me do stuff", "it is an everyday life skill" and "you need maths every day in life". All those students felt that they would continue with maths after GCSE with one going on to write that "whatever job you have you need to be good at maths".

Subject value

A student that felt that they would not continue with maths after GCSE felt that they did not "see the point if you've learnt everything" which shows the value which they place on maths as a subject.

One student recognised that although she did not enjoy maths, it was an "important life skill".

If maths was an option now, I would probably choose it. Circle one – *Strongly agree Agree No opinion Disagree Strongly disagree* *Why?*

Answer	Number of Responses
Strongly agree	2
Agree	3
No opinion	0
Disagree	1
Strongly disagree	1
Blank	2

One of the ‘no opinion’ left the ‘why’ section blank.

The categories are personal effect, future uncertainty and subject value.

Personal effect

The enjoyment of maths was only mentioned by one year 6 girl who felt that she would choose maths “because I work hard in maths and enjoy maths”, however another girl felt that she worked hard but still would not choose to do maths “maths is not my strong point, I try my hardest, but I don’t like it”. Another student strongly disagreed to choosing to do maths if it was an option “because I don’t like maths much”.

Future uncertainty

One year 6 girl strongly agreed that she would choose maths because she felt that she would “learn about things you need in XXX life”.

Subject value

Four girls agreed or strongly agreed that they would choose maths because they felt that it was important “I strongly agree as it’s a very important subject”. One girl would continue with maths “because I don’t want to be dum [sic]” which I have interpreted as meaning that people who take maths are thought to be intelligent, and one girl appeared to enjoy the challenge of maths “to see if I can do harder levels”.

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

Three girls explained their answer to this question. One girl chose option (d) 'there was better behaviour in the class' and explained "so you can concentrate better and get on better".

Two girls chose option (b) 'we had more fun', going on to say that "people would enjoy it more" and "it would be more interesting then".

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Behaviours

Nearly all the year 6 girls felt that you needed to work hard to be successful at maths "working hard and trying your best", "to think", "to do your best and never give up" and "try hard, don't let it get to you if you don't know what your [sic] doing".

Two girls suggested that you need to enjoy maths to be successful at it, whilst one felt that you should "always ask a teacher for help" and another that to be successful you need to "train yourself more and then your there".

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

In response to this question I have constructed three categories that allow me to understand what the students were telling me (across all the year groups). These categories are classroom environment, personal experience and activity type.

There were 4 blanks to this question from the year 6 girls.

Classroom environment

How the students were arranged was mentioned by two year 6 girls. One enjoyed working independently “it was my favourite lesson because we used different skills. Also you could work independently or on your own”, whilst another preferred “I like to work as a team which helps me enjoy it”. One student commented on the behaviour of the class “pupils were well behaved”.

Personal experience

One student enjoyed an easy lesson “because it was easy. All you had to do was do easy sums and check them”.

Two girls enjoyed ‘fun’ lessons; “the teachers made it as fun as possible” but did not explain how it was fun.

Activity type

One student enjoyed starting the “learning ladder” whilst another enjoyed a lesson where “we did nothing because we had to just listen”.

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

The categories are teacher behaviour, activity and personal experience.

Two girls left this question blank.

Teacher behaviour

One year 6 girl suggested putting the class into groups so that they enjoy maths more “if you don’t enjoy maths maybe they should work as a group”. Another proposed making maths “fun and strict”. One year 6 girl responded to “talk to them and give them a questionnaire” perhaps to ask how they would like to learn maths, or maybe because she was completing a questionnaire for me.

Activity

One girl suggested games to “help them learn” and another prizes; “give out prizes for children that get questions right and the children with good behaviour”. Another year 6 girl recommended a variety of things in order to enthuse the class.

Personal experience

Half of the year 6 girls would make lessons more fun; "make it more fun and not make them think: 'oh not maths again!'". One girl suggested to "show them why maths would help in the future, prove that it can be fun".

Year 9 Boys

I will probably continue with maths after GCSE. Circle one – *Strongly agree   Agree   No opinion   Disagree   Strongly disagree* *Why?*

Answer	Number of Responses
Strongly agree	3
Agree	3
No opinion	5
Disagree	0
Strongly disagree	0
Blank	1

The categories are personal effect, future uncertainty and subject value.

Personal effect

Two of the 'strongly agree' responses were as a result of enjoying maths "because I enjoy maths a lot".

Future uncertainty

One student agreed that they would continue with maths after GCSE but recognised that they would "like to travel before I go to university etc so I'm not entirely sure yet but probably".

Two students knew that maths would be important for the job that they wanted to do "because I think that the job I will eventually get will involve maths" and "for the job I am aiming for maths is really important".

Subject value

The majority of responses showed that the students felt that maths was an important subject "it is essential to have maths knowledge", "it is very important for my future" and "I think it is the most important subject along with English". All of these students agreed or strongly agreed that they would continue with maths, except one who answered, 'no opinion' "because it is essential to have maths knowledge but I don't think you need to know or learn everything".

If maths was an option now, I would probably choose it. Circle one –				
Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly disagree*

Answer	Number of Responses
Strongly agree	6
Agree	2
No opinion	1
Disagree	0
Strongly disagree	0
Blank	1

The categories are personal effect, future uncertainty and subject value.

Personal effect

The enjoyment of maths was mentioned by two year 9 boys who felt that they would choose maths "because it is fun to do" and "I enjoy maths". One student put 'no opinion', explaining that "I want to have essential maths knowledge but I don't want to learn everything to do with maths".

Future uncertainty

Jobs were the reason that two boys gave for choosing maths "because it is important to help get a job" and "you need maths for a lot of jobs". One student felt that maths was "important to have throughout life".

Subject value

Nearly all the year 9 boys felt that they would choose maths because it was important; "it is one of the most important subjects", "because it is a key subject that improves your skills in every subject" and "it's a very important subject for my subject".

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

Two boys responded to this question. One boy chose option (b) 'we had more fun', explaining that "most of the work in the lesson is VERY boring" and another chose options (b) and (c) 'we had more fun' and 'there were fewer tests', adding that they would enjoy "more group work".

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Behaviours

Nearly all the year 9 boys felt that you needed to work hard and concentrate; "try to do your best", "hard work, effort" and "it takes hard work and positive behaviour to succeed at maths".

One boy suggested that to be successful you would need to do "a bit of independent revision to make sure you remember what you have learnt", which was similar to another response which was to "try and remember formula" and another suggested that one should listen to the teacher.

One boy suggested that to be successful you need "hard work, effort and fun" which I have interpreted as meaning that you find maths fun.

Personal attributes

Two year 9 boys suggested that to be successful at maths you needed to be "quick at picking up different things" and have "a brain that understands how maths works".

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

The categories are classroom environment, personal experience and activity type.

There was 1 blank to this question from the year 9 boys. Two boys wrote that they did not have a favourite lesson; "I have never had a favourite maths lesson ever".

Classroom environment

Two year 9 boys preferred lessons when they worked in groups and one boy listed "food" as a reason for it being his favourite.

Personal experience

Primary school was listed as fun by one student "primary school, because the lessons were fun". Two students explained that their favourite maths lessons were not too hard; "when we did area of shapes because no one knew how to do it, only I knew".

Activity type

Christmas lessons was a favourite for one year 9 boy, whilst another enjoyed a problem sheet with lots of objects on, when he worked in a team. One boy remembered playing hangman as his favourite lesson.

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

The categories are teacher behaviour, activity and personal experience.

One boy wrote "food an" but then crossed it out.

Teacher behaviour

One year 9 boy suggested a practical change to "allow us to listen to headphones, but if there are any arguments they have to take them out". Two students described specific teacher behaviours; "I would be very enthusiastic myself and remove any students who don't co-operate" and "be able to have more time to do problems and allow the class to interact with me when I'm at the front".

Activity

A third of the boys suggested more practical lessons; “do more practical things instead of class work”, “I would create my practical activities that involve a lot of maths” and “do more practical work that would still deliver the same message to if we did written work”.

One year 9 boy suggested to do more maths related games.

Personal experience

One boy would “do more fun things that are related to maths but that are educational” in order to make students more enthusiastic about maths.

<u>Year 9 Girls</u>

I will probably continue with maths after GCSE. Circle one – *Strongly agree   Agree   No opinion   Disagree   Strongly disagree*

Answer	Number of Responses
Strongly agree	0
Agree	2
No opinion	5
Disagree	2
Strongly disagree	0

The categories are personal effect, future uncertainty and subject value.

Personal effect

None of the year 9 girls mentioned enjoying maths but nearly half of them commented that they did not enjoy maths “I don’t enjoy maths most of the time and I only want to use it when I have to”. These students all circled ‘no opinion’ or ‘disagree’.

Two students did not feel very confident in maths “I find it hard and don’t like working out equations etc” and “I’m not sure because I don’t feel confident in maths and I don’t really enjoy it”.

Future uncertainty

Three of the students were not sure whether they would continue with maths because "I'm not really sure what I want to do in the future".

Two students mentioned the link between choosing mathematics and their choice of job "I don't know because the job I want doesn't use much maths" and "I wouldn't want a job which involves further maths equations".

Subject value

Three students felt that maths was an important subject; "maths is such an important subject and it's really important to be good at it and know what to do", "because it's a good subject to keep near by [sic]" and one student felt unsure because of the importance of maths and their ability "I may continue with maths to get higher qualifications, however I may not because I don't think I'm very good at it".

If maths was an option now, I would probably choose it. Circle one –				
Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly disagree*
Why?				

Answer	Number of Responses
Strongly agree	1
Agree	3
No opinion	2
Disagree	2
Strongly disagree	1

The categories are personal effect, future uncertainty and subject value.

Personal effect

Enjoying maths was not mentioned by any of the year 9 girls in the sample, however not enjoying it or finding maths hard was the reason for three students not to continue with maths; "I don't understand most of maths", "because I find maths really hard so I wouldn't chose [sic] it" and "I don't really enjoy it".

Future uncertainty

One student strongly agreed that they would choose maths because "you need maths in life for most things" and another felt that they would choose maths "because some jobs need maths".

Subject value

Half of the responses to this question felt that maths was an important subject "because it is an important part of my education, it's important to take maths as an option". Two girls gave mixed responses, recognising that maths was important but not wanting to take it further "I think it's important to learn maths for further on in life but I don't really enjoy it" and "I know that it is important so I would probably take it for the benefit of my qualifications, but if it didn't count for anything then I wouldn't choose it".

Maths lessons would improve if .... (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

Three girls responded to this question. One girl chose the 'other' option and requested more group work. One girl chose options (b), (e) and (f), 'we had more fun', 'it was easier' and 'we did more relevant maths'; explaining that "it would be better if we didn't do algebra, we don't need algebra in life".

Options (b) and (e), 'we had more fun' and 'it was easier', were chosen by another year 9 girl who simply wrote "times tables" in the explanation space.

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Behaviours

Around half of the year 9 girls felt that you needed to work hard and concentrate; "motivation to be bothered with all the sheets they give us in maths (killing trees)", "hard work" and "concentrate in lessons".

Three students suggested regular practise "practise to get better", "lots of revision of formula and equations" and one suggested getting help "if you don't understand get help".

Personal attributes

Three year 9 girls suggested that you needed to be able to "do" maths to be successful; "to be clever", "to listen and understand everything which is said" and "to be able to do it".

External factors

Two girls felt that you needed to enjoy maths to be successful at it. One girl suggested "knowing your times tables helps a lot in maths".

One girl wrote that she did not understand the question.

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

The categories are classroom environment, personal experience and activity type.

There was 1 blank answer to this question from the year 9 girls.

Classroom environment

A change from the normal lesson routine was mentioned by three year 9 girls as being their favourite lesson; "in primary we went outside for the lesson", "when we all sat in a circle and learned about loci" and "I like making visual aids with different investigations because its easier to learn the formula".

Two students described working in groups or teams as being their favourite lesson.

Personal experience

Two year 9 girls appeared to enjoy the feeling of achievement in their favourite lesson; "my favourite lesson was making the giants clothing because it was fun and I learnt without knowing it” and “when we did a code cracking treasure hunt cause we got to work in teams and I could do the work”.

Activity type

One student enjoyed a puzzle in their favourite lesson “when we did a puzzle and coloured the answers in the right colour”, but they may have enjoyed the colouring more than the puzzle. Another student mentioned working with paper “making shapes with paper and making paper shape nets”.

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

The categories are teacher behaviour, activity and personal experience.

Teacher behaviour

Two year 9 girls suggested working in groups as a way to enthuse a class; “get them moving around and interacting with other pupils”.

Activity

Practical activities were suggested by two year 9 girls; “do lots of hands on tasks like building shapes and things” and “have more practical things and let people choose their mathematical activity”.

Maths games was again an idea; “I would play more maths games with them but also make sure they learn new things and also so they understand the work”.

One girl would use revision as a tool; “I would go to the library and encourage the class to make a PowerPoint in groups about a topic they’ve chosen in maths, with facts”.

Personal experience

Half of the girls suggested making lessons more fun; “more fun things that children would enjoy more than boring maths”, “make it more interesting and fun” and “use maths in fun ways”.

Appendix H Saturation sample data

In this section I detail the findings of the second 10% sample with the intention to see if there were any different responses. This sample was again stratified by gender and year because of the differences in gender, suggested by the literature and because the study is based on changes in motivation and attitude as the pupils move through secondary school, so the sample needed to reflect the population. Set was not included in the stratification because the year 6 pupils were not in sets in primary school and I wanted the method of sample selection to be the same across the study.

As theoretical saturation is achieved when no new ideas are present in the sample and when the categories are clearly described and fully dimensional (Morgan & Boychuk Duchsher, 2004; Timonen, et al., 2018), I am only going to summarise responses which were different from, or additional to, the original 10% sample. The findings will be reported by question for each gender and year group separately.

<u>Year 6 boys</u>

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Behaviour

Behaviours covers actions which somebody can do, and one boy used words which were not present in the first 10% sample. He said that to be successful in mathematics takes "courage and determination because you must try hard to get better grades for life after you buy a home". Although the word determination was similar to the descriptions seen in the sample such as trying hard and working to the best of your ability, I had not seen the word "courage" used before, which perhaps implies having to face mathematics bravely.

<u>Year 7 boys</u>

If you moved sets, did you move up or down? Circle one – *Up* *Down* *How do you feel about changing maths set? Please comment*

One year 7 boy felt “really anoyed [sic] because I thought I was good”. Although this was a similar response to those pupils who said that they felt “upset” by changing set in the original sample, the word “annoyed” had not been used before.

Another boy said that he was “happy, but a bit nervous”, although the word “happy” had been in the first sample, feeling nervous had not been mentioned before.

<u>Year 9 boys</u>

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

Personal attributes

One boy wrote “I think mostly logic but also being a quick thinker and being able to apply methods”. Being a quick thinker, and good at mathematics had been mentioned before but not logic specifically.

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

One boy responded with “we got to sit where we wanted to and work at a slower pace”. Although working in groups had been mentioned before, the request to work at a slower pace was not present in the initial 10% sample.

<u>Year 9 girls</u>

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

One girl felt that her lessons would improve if “we get to sit next to someone who you could enjoy mathematics with, (friend) not someone who takes the calculator and is selfish”. Where the pupils were positioned had been mentioned before but not the grievance regarding the sharing of calculators.

What does it take to be successful at maths?

The categories are behaviours, personal attributes and external factors.

This same girl responded with “a believable mind, you need to believe that you are going to succeed and if so then you will”. The belief that you can succeed is a personal attribute because it is linked to a person’s character but the notion of having belief in yourself had not occurred in the initial 10% sample.

Think about your favourite ever maths lesson. Write 2-3 sentences to describe it. Why was it your favourite?

The categories are classroom environment, personal experience and activity type.

Again, the same girl gave a new response “because the teacher explained everything very well and she wouldn’t see you as stupid or dumb. She taught us and controlled the class”. Although the behaviour of the class had been mentioned in the first sample, how the teacher made a pupil feel was not present before. These feelings that the pupil has would come under the personal experience category.

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

Two girls wrote about the enthusiasm of the teacher “be enthusiastic and not see students as dumb” and “I would come across as enthusiastic about everything so my pupils would want to participate and enjoy my lessons more”. Although teacher behaviours had been present in the first 10% sample, being enthusiastic was not mentioned. These responses would go in the category of teacher behaviour.

Year 10 girls

Maths lessons would improve if …….. (Circle any that apply)			
a) We did less work	*b) We had more fun*	*c) There were fewer tests*	*d) There was better behaviour in the class*
e) It was easier	*f) We did more relevant maths*	*g) Other*	

One year 10 girl wrote "we had a single teacher and didn't keep moving around so organisation". This was the first time that the lack of a constant teacher had been mentioned, in the response to this and any other question.

If your teacher ordered the pupils in your maths class by their mathematical ability, where would you be? Circle one -				
Very high	*Top half*	*In the middle*	*Bottom half*	*Very low*
Why do you think that?				

One year 10 girl put top half and explained "most of the people in our class don't want to learn". The behaviour of the other pupils in the class had not been mentioned in response to this question before as most responses had been in relation to personal feelings or ability and not the behaviour of others.

If you could be the maths teacher in your class for a week, what would be the things you would do to make the class more enthusiastic about maths?

In response to this question I constructed three categories that allowed me to understand what the students were telling me (across all the year groups). These categories were teacher behaviour, activity and personal experience.

One girl responded with "relieve the pressure and be willing to help even if it take [sic] a long time". The notion of relieving the pressure that the pupils were feeling had not occurred in the initial 10% sample taken and would come under the *teacher behaviour* category.

If you moved sets, did you move up or down? Circle one –

Up *Down*

How do you feel about changing maths set? Please comment

One girl who had moved up a set felt that she was 'bottom of the set', another girl who put a question mark where she should circle up or down wrote "it makes me feel unstable" whilst another girl who circled that she had moved up and down described feeling "very emotionally unstable with the constant movement and don't know where my ability stands".

All three of these responses show that set changes have affected the confidence of the girls and left them feeling emotionally insecure in mathematics. Although the idea of feeling upset due to a set change has come up before, it has not been described so emotionally.

How has this year been for you in maths?

In response to this question I constructed four categories that allowed me to understand what the students were telling me (across all the year groups). These categories were positive feelings, negative feelings, learning related experiences and classroom experiences.

One girl described the year as "stressful coming up to exams – I think they could have done better preparation". Although pupils had described their year as hard or frustrating, the word stressful had not been used before. This would sit in the *negative feelings* category.

6 out of the 9 responses in this sample mentioned their teacher in response to this question. One girl felt that her year had been fine but "my teacher can't control the class so we don't learn anything but I have found it alright", but the other 5 responses all mentioned the dislike for the number of teachers that they have had in the year. As previously explained due to staffing issues certain sets were rotated every fortnight so that they did not have a supply teacher for too long. As each pupil has a slightly different view of the situation, I have included all 5 of these responses for completeness:

> *confusing as we had a system of changing teachers every two weeks and learnt new topics everytime that were crammed into that space of time*

not good, I have had so many different teachers and classes that it has been difficult to focus on the actual task

not good. It has been too difficult and the different movement of classes has been stressful and disorganised and I cannot gather all in the info from each class

Mr XXXX (Teaching Assistant) has helped me improve but having so many teachers has been hard

confusing as we have had lots of different teachers and when we were put into one set everyone had done different parts in mathematics. So when we did some mathematics lessons some people had no clue about the section whereas others did so we just moved on without people understanding.

Whilst all these responses would come under the *classroom experiences* category, because this second 10% sample did show up ideas which were not present in the initial 10% sample, in particular relating to specific teachers and staffing patterns, I could not stop analysing the data. The new ideas found in the second sample were mostly surrounding the variety of teachers that some classes had experienced in that year so for the further sample, 10% of year 10 students were selected, stratified by gender and set to ensure that the feelings of all classes were analysed. Table 36 Year 10 pupils in the third saturation sampleshows Year 10 pupils in the third saturation sample the number of pupils in each gender in each set and how many were selected for the sample.

Set	Number of questionnaires in set	Number of questionnaires in sample
10J1 Boys	15	2
10J1 Girls	9	1
10J2 Boys	10	1
10J2 Girls	8	1
10J3 Boys	12	1
10J3 Girls	1	0
10J4 Boys	9	1
10J4 Girls	13	1
10J5 Boys	6	1
10J5 Girls	9	1
10J6 Boys	10	1
10J6 Girls	4	0
10K1 Boys	8	1
10K1 Girls	9	1
10K2 Boys	6	1

10K2 Girls	1	0
10K3 Boys	5	1
10K3 Girls	0	0

Table 36 Year 10 pupils in the third saturation sample

<u>Year 10 girls</u>

If you moved sets, did you move up or down? Circle one –

Up *Down*

How do you feel about changing maths set? Please comment

One girl wrote that she did not mind her current set but "I do feel cheated that I can't get any higher than a C in my GCSE". This was the first time that I had read about a pupils' feelings regarding taking the foundation paper in their exam.

<u>Year 10 boys</u>

I will probably continue with maths after GCSE. Circle one –

Strongly agree *Agree* *No opinion* *Disagree* *Strongly disagree*

Why?

One boy circled disagree, explaining that "I am not being helped when I struggle". All the responses to his questionnaire expressed his feelings that he was not being sufficiently supported in lessons and he explained this further in the final question.

How has this year been for you in maths?

In response to this question I constructed four categories that allowed me to understand what the students were telling me (across all the year groups). These categories were positive feelings, negative feelings, learning related experiences and classroom experiences.

To this the same boy responded

> *terrible! I have not improved what so ever, if I was actually helped when I was unsure of what to do I may have learnt something. However, my teacher finds it humerous [sic] to give sarcastic answers and/or ignore me when I ask for help.*

This would sit in the *negative feelings* category as it is how the boy feels as a result of his teacher's perceived behaviour.

As new ideas were still present in this sample, I took a further 5% sample of the year 10 data, stratified by gender and set. The following table shows the number of pupils in each gender in each set and how many were selected for the sample.

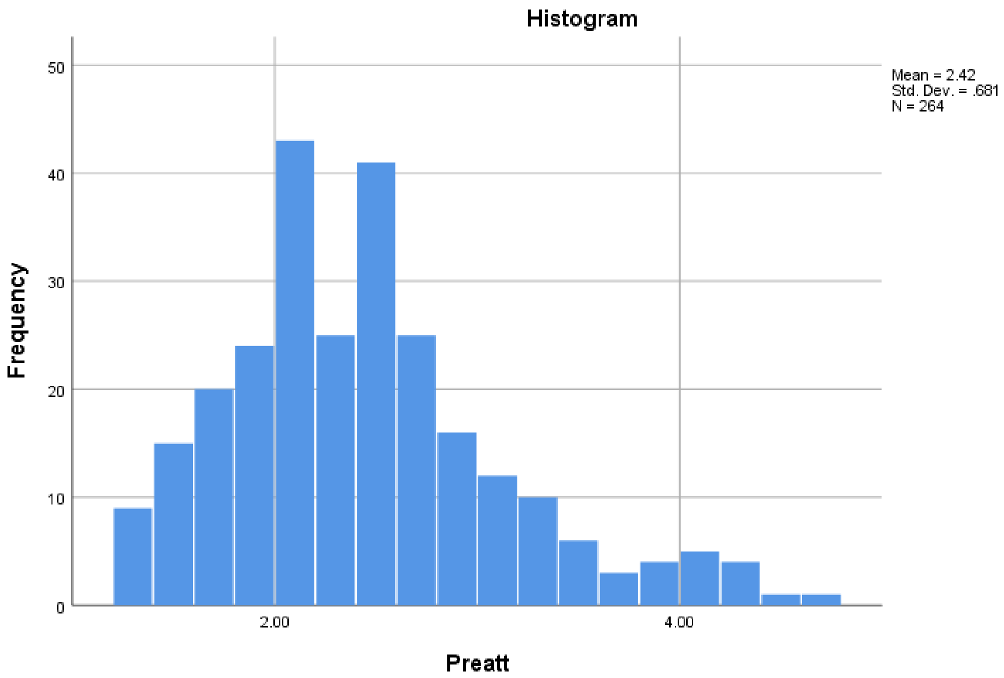
Set	Number of questionnaires in set	Number of questionnaires in sample
10J1 Boys	15	1
10J1 Girls	9	0
10J2 Boys	10	1
10J2 Girls	8	0
10J3 Boys	12	1
10J3 Girls	1	0
10J4 Boys	9	0
10J4 Girls	13	1
10J5 Boys	6	0
10J5 Girls	9	0
10J6 Boys	10	1
10J6 Girls	4	0
10K1 Boys	8	0
10K1 Girls	9	0
10K2 Boys	6	0
10K2 Girls	1	0
10K3 Boys	5	0
10K3 Girls	0	0

Table 37 Year 10 pupils in the fourth saturation sample

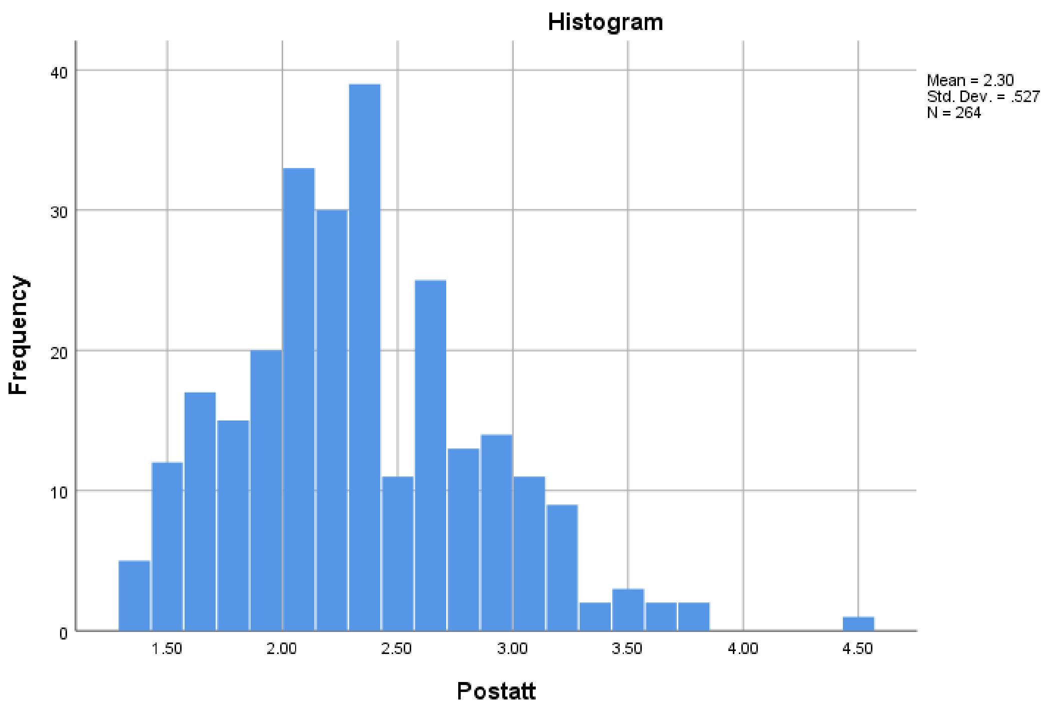
After an initial 10% sample stratified by year and gender, a second 10% sample also stratified by year and gender, a third sample of 10% of year 10, stratified by gender and set and a final 5% sample of year 10, also stratified by gender and set; no new codes were identified, and as similar responses were being repeated, I am confident that the data I have analysed is now saturated (Nelson, 2015).

Appendix I Histograms of pre and post attitude value

The following histograms show the shape of the distributions for pre and post attitude values –



Histogram 1 Distribution of the pre attitude value



Histogram 2 Distribution of the post attitude value

The first histogram is reasonably normally distributed for pre attitude value but not for the post attitude value as there appears to be more than one peak in the data.

Appendix J Not statistically significant quantitative data analysis

This question was analysed as part of the quantitative data but has not added anything statistically significant to the findings.

Question 17

My parents/guardians often help me with my maths homework	*1 2 3 4 5*	*My parents/guardians do not often help me with my maths homework*

The data were analysed with a Kruskal-Wallis Test for each year group. In year 6 there was not a statistical difference in the pre attitude value across the Question scale, χ2 (4, *n* = 120) = 6.69, *p* = 0.15. Table 38 shows the mean rank for the Question scale and shows that overall, there was not much variation in the pupils' attitude towards mathematics depending on if their parents helped them with their homework.

	N	Mean Rank
1	31	62.31
2	31	50.60
3	26	62.50
4	22	59.57
5	10	82.45

Table 38 Mean rank for the Question scale for whether their parents help them with homework in year 6

In year 7 there was not a statistical difference in the post attitude value across the Question scale, χ^2 (4, *n* = 123) = 9.288, *p* = 0.05. Table 39 shows the mean rank for the Question scale and shows that the pupils' attitude value does not vary greatly depending on whether their parents helped them with their homework or not.

	N	Mean Rank
1	12	64.58
2	35	52.94
3	34	64.49
4	26	56.21
5	16	84.00

Table 39 Mean rank for the Question scale for whether their parents help them with homework in year 7

In year 9 there was not a statistically significant difference in the pre attitude values across the Question scale, χ^2 (4, n = 140) = 2.20, p = 0.7. Table 40 shows the mean rank for the Question scale and shows the little variation in the pupils' pre attitude value across the Question scale.

	N	Mean Rank
1	15	76.20
2	23	66.43
3	41	65.20
4	28	78.00
5	33	70.97

Table 40 Mean rank for the Question scale for whether their parents help them with homework in year 9

In year 10 there was not a statistical difference in the post attitude value across the Question scale, χ^2 (3, n = 138) = 2.76, p = 0.60. Table 41 shows the mean rank for the Question scale and shows that the pupils' attitude values do not vary greatly across the Question scale.

	N	Mean Rank
1	8	52.75
2	25	63.80
3	31	71.65
4	32	69.06
5	42	74.83

Table 41 Mean rank for the Question scale for whether their parents help them with homework in year 10

Overall, for all years, there was not a statistically significant difference between the attitude value and whether the pupils felt that their parents helped them with their homework [5].

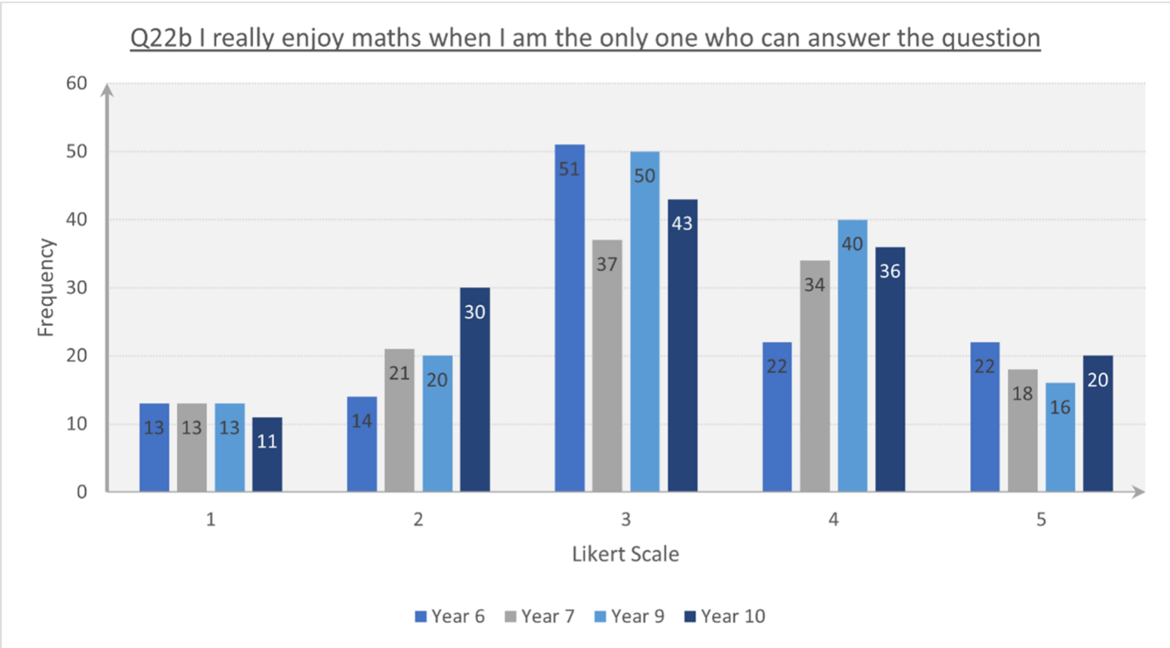
[5] This research was conducted in 2014-2015. The results to this question may well be very different after the events of the pandemic in 2020.

Appendix K Quantitative data – charts

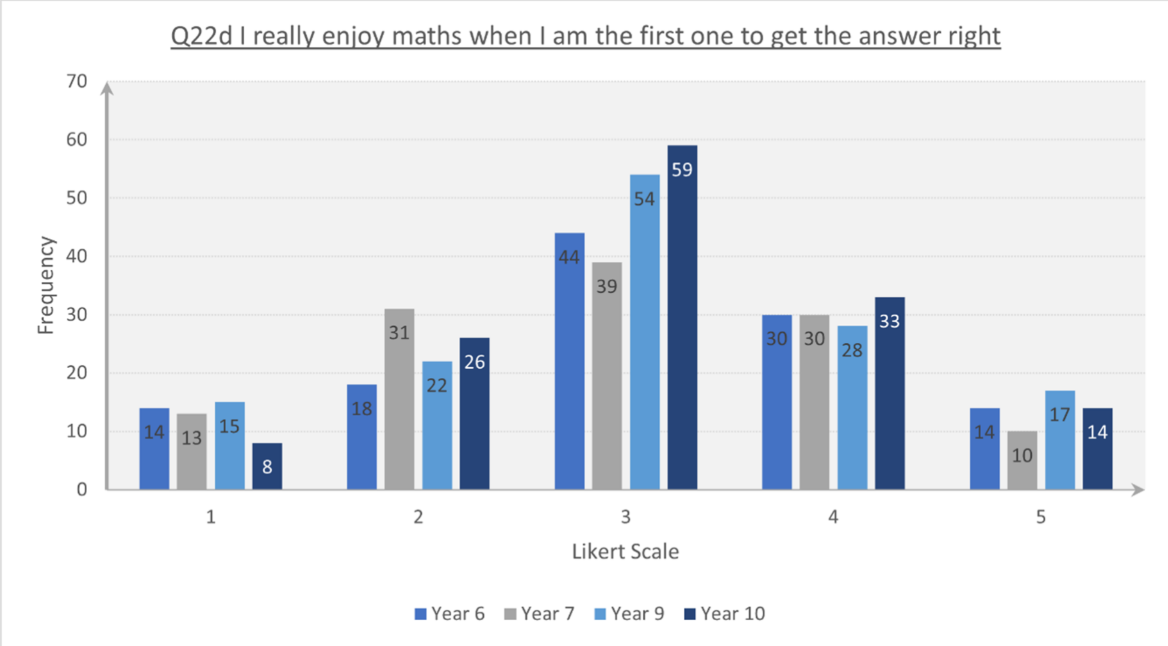
Question 22

I really enjoy maths when – (in each row, please put a tick in one of the boxes)

	Strongly agree	*Agree*	*No opinion*	*Disagree*	*Strongly disagree*
a) The problems make me think really hard					
b) I am the only one who can answer the question					
c) We work together in groups					
d) I am the first one to get the answer right					



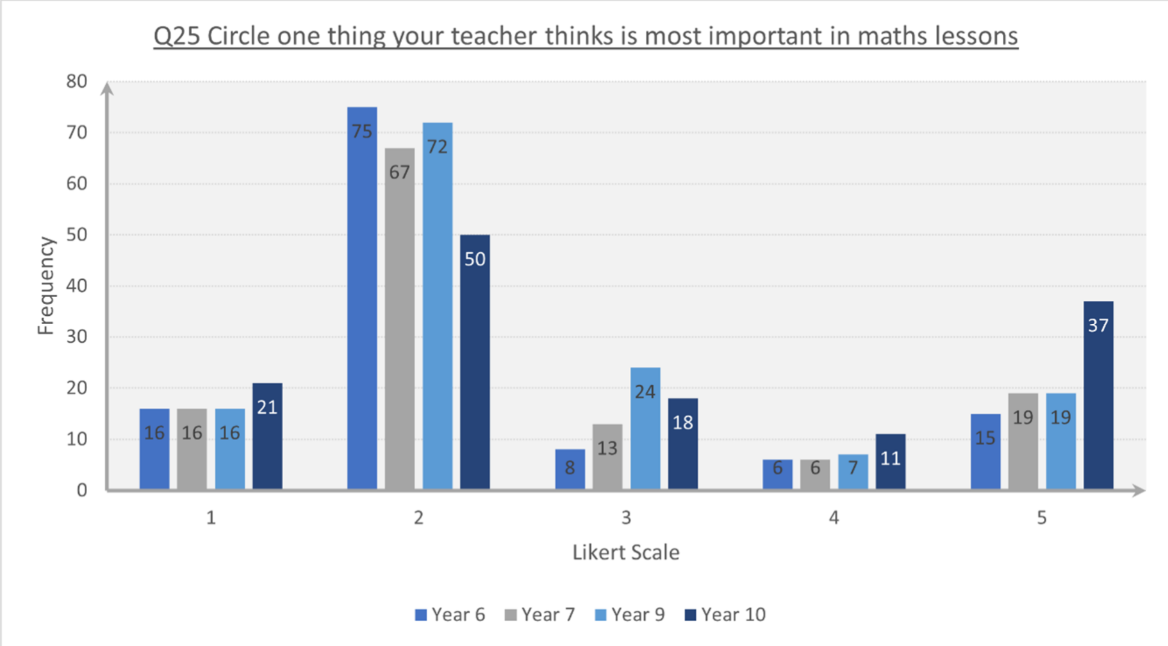
The bar chart for question 22b shows the modal response for all years was no opinion with disagree being a popular response for years 7,9 and 10.



The bar chart for question 22d show that the modal response for all years was no opinion and again, disagree was a popular response.

Question 25

Put a circle around the one thing your teacher thinks is most important in maths lessons
a) Keeping up with the rest of the class   *b) Enjoying maths*
c) Doing lots of work   *d) Learning lots of rules*
e) Thinking deeply about maths



The modal response for all years was 'enjoying maths'. The other options received similar numbers of responses, although for year 10 'thinking deeply about maths' was the second most frequent result.

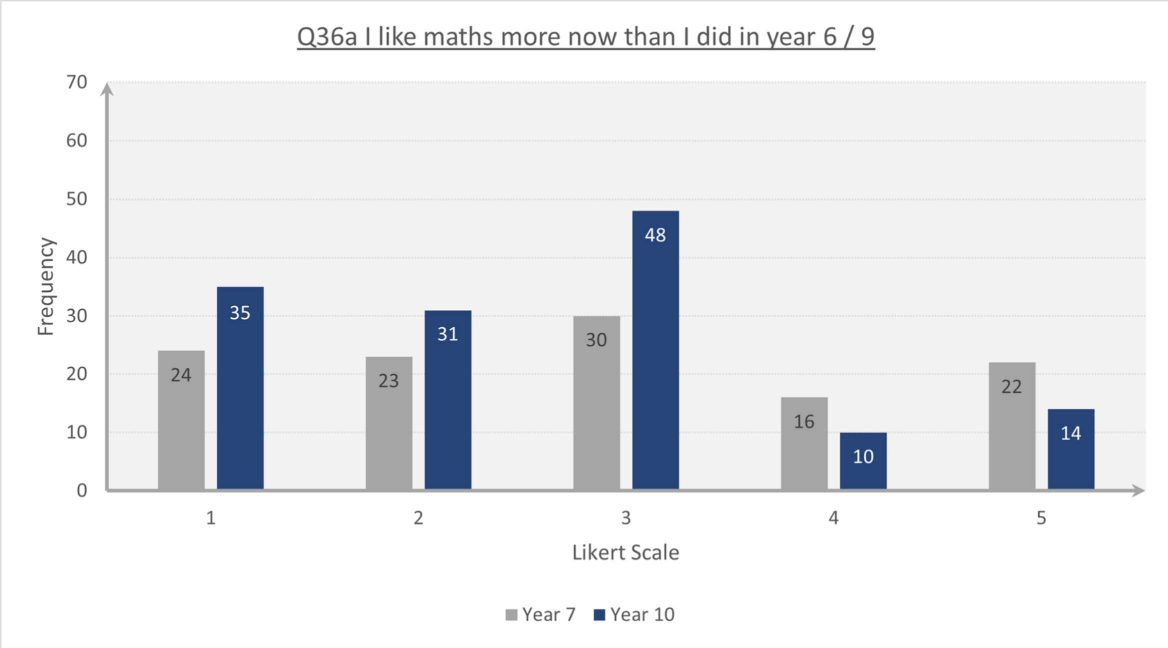
Question 36

Compare how you feel about maths now with how you felt in Year 6.

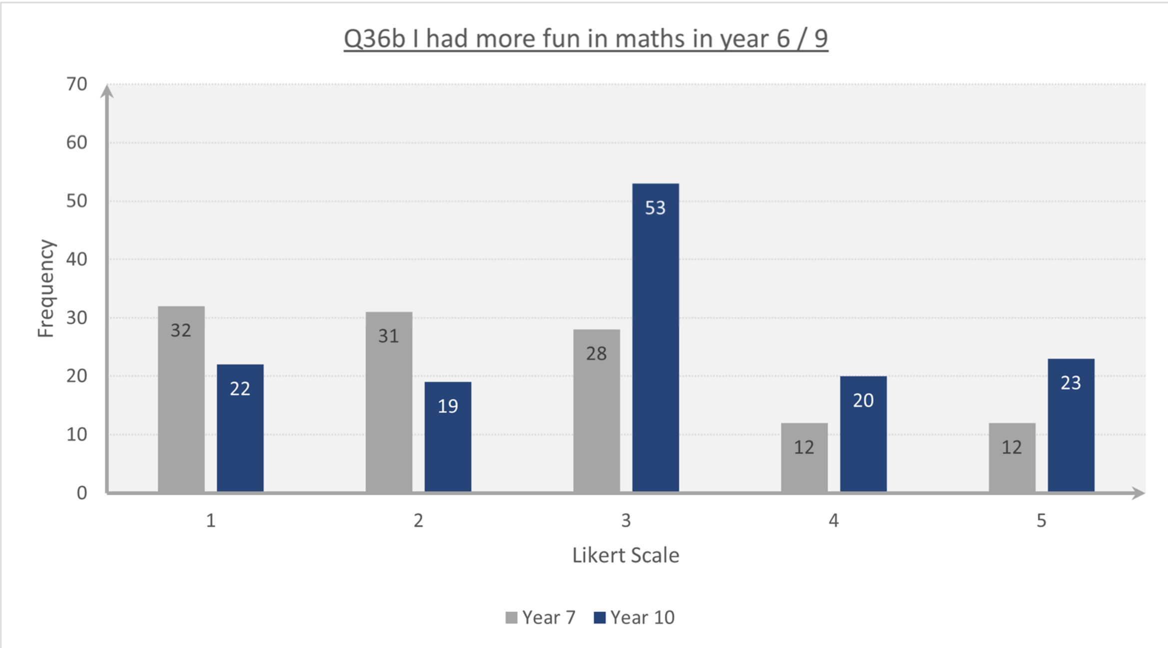
In the following questions please circle the number which represents how you feel:

I like maths more now than I did in Year 6	*1*	*2*	*3*	*4*	*5*	*I preferred maths more in Year 6*
I had more fun in maths in Year 6						*I have more fun in maths in Year 7*
I was better at maths in Year 6						*I am better at maths in Year 7*
Maths was more boring in Year 6						*Maths is just as boring in Year 7*
In Year 6 we knew more about how maths is used in the real world.						*I know more in Year 7 about how maths is used in the real world.*

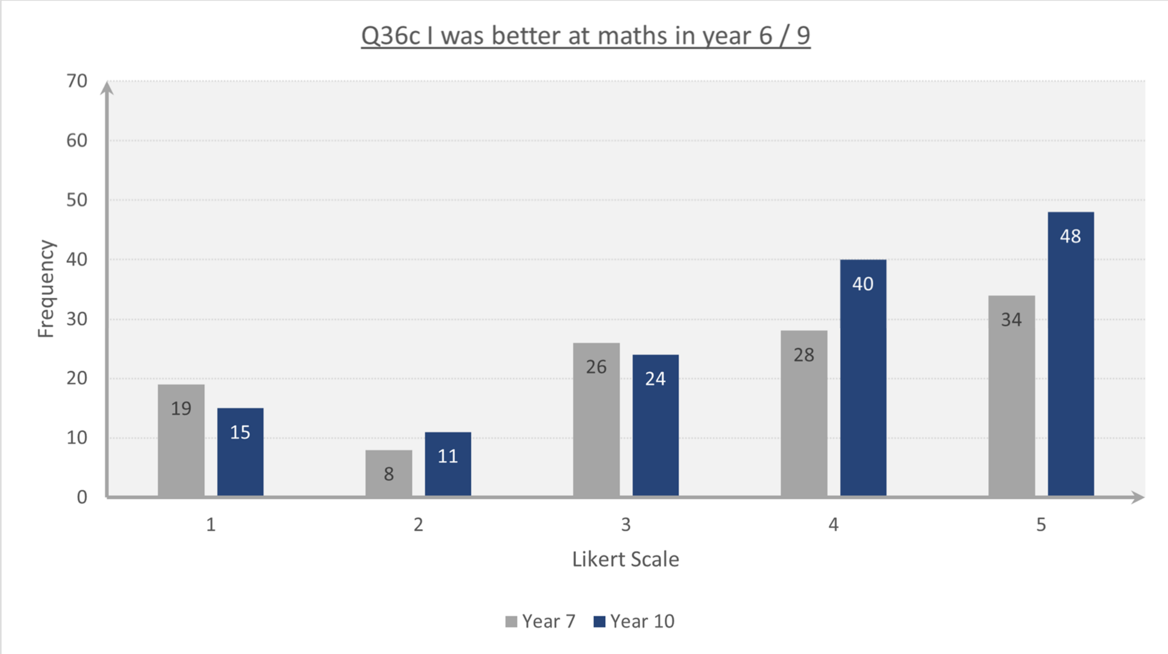
The year 10 class had the same question only it was comparing year 9 to year 10.



Both years' modal result to question 36a was neutral in response to this question, although the year 7 responses were more evenly distributed across the five options. Both years appear to enjoy maths more this year to last.



In response to question 36b, again the most popular response in year 10 was neutral to this question, but the year 7 seem to have had more fun in mathematics in year 6 than in year 7.

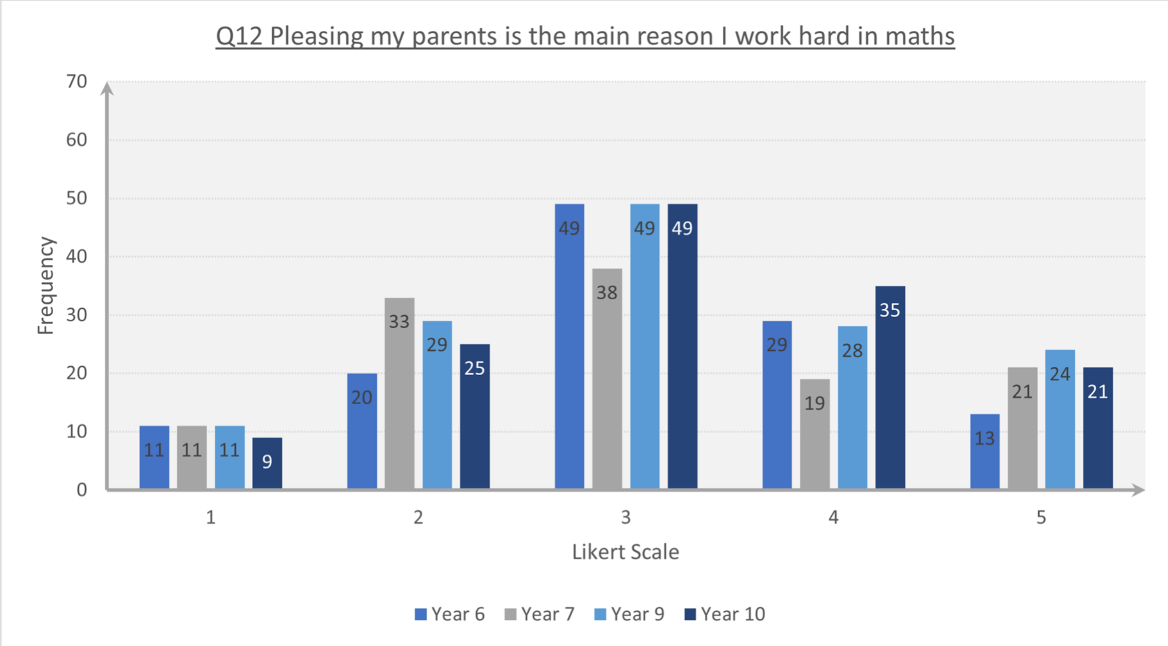


The responses to question 36c show that overall, both years feel that they were better in mathematics this year than the previous year.

Overall, from this group of questions the pupils appear to enjoy maths when it makes them think and years 7,9 and 10 prefer to work in groups. Year 7s feel that maths would improve if there was better behaviour in the class but year 10 feel that it would improve if they had more fun. Despite year 7 and 10 pupils feeling that they are better mathematicians than the previous year, a large proportion of year 10 pupils felt that maths was just as boring in year 10 as year 9.

Question 12

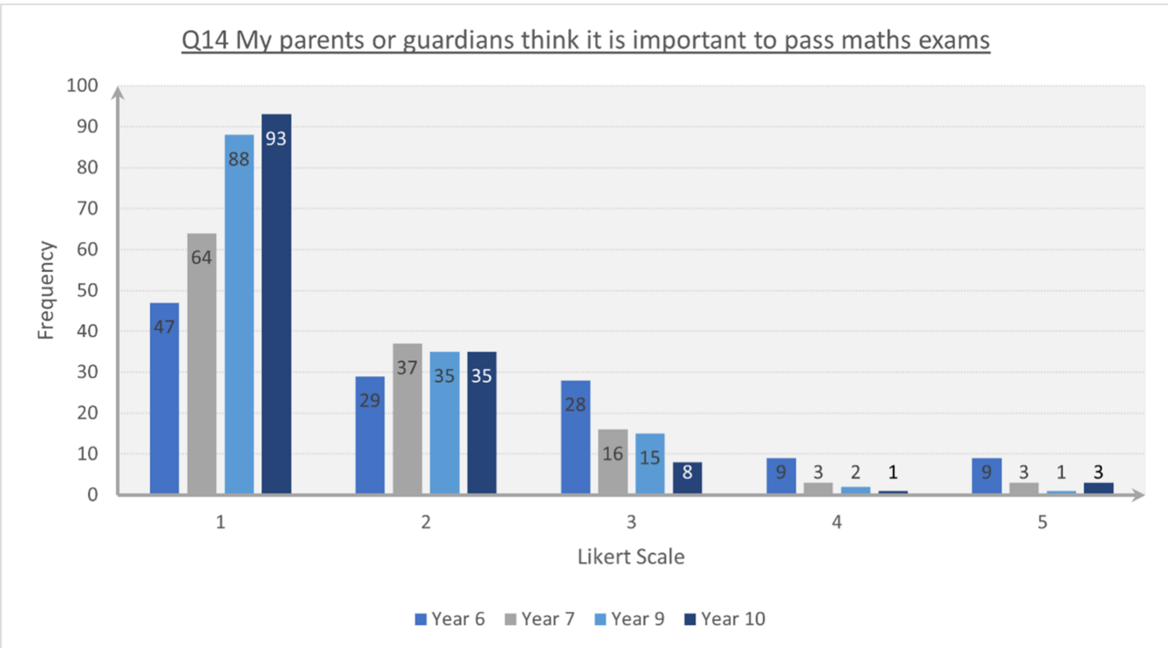
Pleasing my parents is the main reason that I work hard in maths	*1*	*2*	*3*	*4*	*5*	*Pleasing my parents is not the main reason that I work hard in maths*



The graphs show that the responses do not vary greatly over the four year groups with the modal response being neutral on the scale.

Question 14

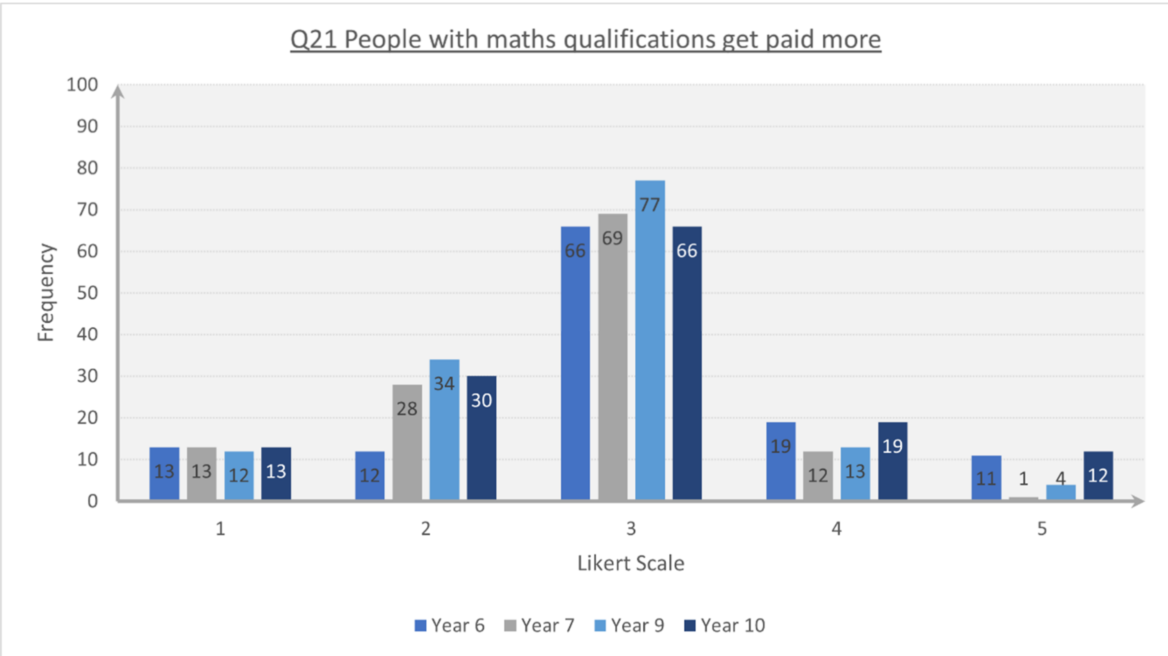
1. My parents/guardians think it is important to pass maths exams	*1*	*2*	*3*	*4*	*5*	*My parents/guardians do not think it is important to pass maths exams*



As would be expected, for all year groups most parents felt that it was important to pass exams, with this being a more frequent response in years 9 and 10.

Question 21

1. People with maths qualifications get paid more	*1*	*2*	*3*	*4*	*5*	*People with maths qualifications do not get paid more*



The modal response to this question was clearly that the pupils were not sure if people with mathematics qualifications get paid more. The responses from all of the year groups showed a spread across all of the five options, however year 7 only had one response with a 5, 'people with mathematics qualifications do not get paid more'.