The Aetiology of Maths Anxiety:

Identifying the Influential Factors of Year 4 Pupils' Attitudes to Mathematics attending Schools in North West England

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Dedicated to Sam Whitehouse, the dear friend who inspired me to pursue my interest in education, who supported me in the very early stages to make this research happen, and who is sadly no longer with us to see this thesis.

You are the reason I will never give up and why Bat Out of Hell is the official soundtrack to this PhD journey.

Abstract

This study took place during relatively recent times where it was culturally acceptable to say that we are not strong in mathematics in wider society, and some of us establish that lacking ability as part of our identity. Whilst adults in the UK are known to lack numerical skills and have poor attitudes to mathematics, children in primary schools are needed to fulfil the demand of future STEM graduates that the UK is not expected to meet, posing serious future economic risk. Primary schools situate within an increasingly intensified culture of assessment, impacting the practice of teachers and the pupils' understanding of mathematics as a result.

This quantitative study identifies factors of attitudes to mathematics in Year 4 pupils in primary schools located in North West England. The study worked with 10 primary schools, 19 teachers, and 508 pupils, using self-completion questionnaires to measure pupils' attitudes, aspects of identity, self-confidence, motivation and perceived value of mathematics. Pupils' teachers who agreed to take part also answered an attitudinal questionnaire measuring their attitudes to mathematics and confidence in teaching. The research also measured the deprivation levels of the schools, along with other standard mathematical performance measures.

The current research consists of an innovative newly designed measure, 'Attitudes 2 Mathematics'. Specifically, this PhD provides evidence to suggest that pupils' attitudes to mathematics are not only dependent on their own identity and self-confidence, but also by the attitudes of their teachers and the school attended. The findings of this study contribute to the knowledge of: measurements of attitudes to mathematics through new creative means of eliciting responses in questionnaires, such as using Emojis and drawings that can be quantified, and a model that measures and assesses the impacts of multiple factors on pupils' developing those attitudes.

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Introduction

Introduction to the Chapter

This chapter introduces the focus of the study, specifically attitudes to mathematics, and the so-called 'problem' of attitudes to mathematics in the UK. The chapter discusses the potential impact of negative attitudes to mathematics on individuals specifically and society more generally of. In addition, the chapter will introduces the study's theoretical framework that draws on social science research to identify the core components of an individual's attitudes to mathematics, along with educational and sociological research to identify the influential factors that can influence attitudes. The methodological framework is also discussed, which involved adapting previously validated measures (Hunt et al, 2011) and adding an additional shorter measure of pupils' attitudes to mathematics. Finally, this chapter will provide a brief description of the study's findings, strengths and limitations, which echo the need for a model that measures pupils' attitudes to mathematics and measures the influence of external factors that may shape these attitudes. The analytical model used in this study takes into account both the complex nature and influence of school environments and the role of non-school influences.

This research identifies that pupils' attitudes to mathematics are formed at an early age, and that these formations differ according to the characteristics of the pupil, their parental support, teacher and the school attended. The need to address this complexity is highlighted in previous studies (Collins, 2000; McCall, 2005; Menheere and Hooge, 2010; Mutodi and Ngirande, 2014; McMaster, 2017; Jay et al, 2018), but very few have examined this issue quantitatively and with a relatively large sample. This study concludes by identifying the complex nature of attitudinal formation in young children in relation to mathematics and the need for further research to fully understand the interaction between in-school and external factors, so that we can develop suitable interventions to ensure that all children develop and maintain positive attitudes to mathematics.

Numeracy and Mathematics: Different from One Another, Dependent on One Another

Numeracy is often used synonymously with mathematics, but it is actually much more than that. Whilst possessing the ability to be mathematically functional is valued as one of the most important factors for success in education and careers (Noyes, 2007); having basic numeracy skills is just as important. Whilst high proficiency in mathematics is required for STEM related careers, numeracy concerns skills that we need for our everyday lives (Chinn, 2012b). An example of such skills is managing finances (National Numeracy, 2019b), and these basic skills can also help us progress in other careers (Scarpello, 2007; Hillman, 2014; Marshall et al, 2016) and therefore contribute to the growth of our economy (Pro-Bono Economics, 2014). However, a significant number of pupils who have been found to perform at the expected level of grade C (or equivalent) in GCCE mathematics have been criticised for not being able to use these skills effectively (OFSTED, 2018). Additionally, fewer pupils opt to study mathematics when it is no longer compulsory (Hillman, 2014). This poses significant economic risk to individuals with their lack of career choices (Macdonald, 2014) as well as an economic risk nationally.

There must therefore be recognition of how positive mathematical experiences are needed to establish positive attitudes to mathematics. An example of the wider impact of poor mathematics skills is how the UK is are expected to not meet the demand of STEM graduates roles (Wilson, 2009; UK Commission for Employment and Skills, 2013; 2015). Furthermore, the rise of the digital age means that an estimate of 90% of graduate roles will involve working with numerical data (Race Online, 2012 in National Numeracy, 2019c), posing the need to assess how we establish a competitive workforce that has the required skills to contribute and earn. Low levels of numeracy are common in the UK (Pro-Bono Economics, 2014), as are negative attitudes to mathematics (Royal Society, 2019), and evidence indicates that this is due to negative experiences with mathematics (Scarpello, 2007; Marshall et al, 2016). Whilst numeracy skills are arguably different, they do associate with attitudes to mathematics. Furthermore, the term, ‘Mathematics’ is often concerned with anything that relates to numbers. This problematic use of the term continues to separate individuals from seeing themselves as mathematical or not mathematical (Williams et al, 2008), which further affects our basic numeracy skills (Chinn, 2012a; Curtain-Phillips, 2016) through this negative association. This research has been undertaken at a time where numeracy and mathematics are not generally viewed as two separate terms. This PhD will therefore be using both phrases interchangeably as it recognises that in order to improve both our mathematical and numerical skills, our attitudes to mathematics must improve.

Numeracy and the UK

The UK is in the midst of a so-called 'Numeracy Crisis' (National Numeracy, 2016a) as a result of poor attitudes to mathematics and poor performance in mathematics in schools. Numeracy however, includes skills just used in classroom, but that allow people to use numbers and solve problems in their everyday lives (National Numeracy, 2019b). Low levels of numerical skills amongst the population costs the UK an estimate of £20.2 Billion per year (Pro Bono Economics, 2014). This is linked to poor experiences of mathematics in school (Scarpello, 2007; Marshall et al, 2016), where teachers often have a weak grasp of mathematical knowledge and may lack confidence in 'doing maths' (Vorderman et al, 2011). However, pupils' attitudes to mathematics are not solely influenced by experiences in the classroom and require a deeper understanding. Pupils' first experiences of mathematics can help shape their learner identity: not only how the learner reacts to early experiences but also how their parents validate or challenge the learner's reactions (Eccles, 1993; McMaster, 2017). This provides an indication of how mathematics should be valued by pupils in order to meet the expectation set by parents based on those first experiences.

Experiences of mathematics and the reactions of parents establishes the core of a learner identity known as self-efficacy. Self-efficacy is a crucial component of education as it is defined as the judgement of one's ability to organise and execute given types of performances (Bandura, 1977:21), and operates within a wide range of socio cultural influences (Bandura, 1977). Self-efficacy has also been found to positively relate to the frequency of parental engagement in extracurricular activities (Fan and Williams, 2010). A person's perception of their mathematical ability is therefore dependent on their previous mathematical experiences. These experiences may occur at home or in the classroom, and further develop through the influence of parents and teachers reactions (Eccles, 1993), and go on to shape our numerical ability through our attitudes to mathematics (Chinn, 2012a).

We therefore need to recognise the importance of positive mathematical experiences rather than continue to view being innumerate as something to be deemed acceptable (Sharp, 2017; Royal Society, 2019). In order to do this, our attitudes to mathematics must change (National Numeracy, 2016a).

Mathematical Dispositions and their Relationship with Attitudes

Experiences of mathematics help establish mathematical dispositions (Tapia and Marsh, 2004; Damon, 2007; National Numeracy, 2016a), which are crucial to developing mathematical proficiency and ultimately, achievement in mathematics and numeracy (Zaskis, 2011; Feldhaus, 2014; National Numeracy, 2016a). This research recognises and uses the term, 'disposition' as learning and coping strategies that become habits of the mind (Katz, 1993). Furthermore, whilst this research recognises the importance of mathematical dispositions, it does not claim to measure dispositions, which will be discussed in greater detail in the methodology section. This research recognises that an attitude can be a distinct outcome of a disposition, as through encounters with a particular subject, dispositions establish and act as the power or tendency towards a particular outcome (Webber, 2013). Therefore, positive encounters encourage positive dispositions, which would therefore more likely lead to positive attitudes as the outcome. The focus of this study is the outcome of dispositions, the attitudes. Furthermore, this research recognises mathematical dispositions as a distinct type of disposition (Feldhaus, 2014) that would therefore influence attitudes to mathematics. Finally, the focus on attitudes as the outcome of dispositions, means positive attitudes are the result of positive dispositions.

Positive attitudes are argued to consist of four key components: Enjoyment, Confidence, Value and Motivation (Tapia and Marsh, 2004). To attain the four components, each must be met through the experiences the pupil has with mathematics, which depend on mathematical tasks and how they are presented, the support provided from both parents and teachers, and the identity of the pupil. Tapia and Marsh (2004) inspired the theoretical framework of this study, where attitudes to mathematics are regarded as something that cannot be simply measured by a series of questions, but are measured through various techniques that aim to capture the four components in different manners. Additionally, the theoretical framework of this study aims to apply a sociological theoretical framework onto the psychological model that holds the four components. In other words, this research identifies how a multitude of social factors influence attitudes in different ways, highlighting the need to approach such a subject methodologically with a framework that takes into account this complex hierarchy of factors. This framework influenced the adoption of a methodological approach that constructed and applied a Multilevel Model to encapsulates the theory discussed, by applying a series of measures that collaboratively capture the influences of pupils' attitudes to mathematics.

Positive Mathematical Dispositions cannot simply be experienced by ensuring the task presented to the pupil is fun (Bandura, 1977; Tapia and Marsh, 2004; Kalder and Lesik, 2011). Instead, there is need to recognise how a wide range of factors associate with the attitude of the pupil, including identity (Macdonald, 2014), parental support (Fan and Williams, 2010), teacher perception (Beilock et al, 2010) and school characteristics (Hussain, 2016; Reay, 2017). From the pupil's perception, to the school's approach to mathematics; a positive mathematical disposition is dependent on a range of factors that contribute to how a pupil perceives their mathematical ability, and therefore the ability to achieve mathematical tasks. The complexity of mathematical dispositions, highlights the complexity in attitudes to mathematics and how they are established. We can therefore not expect pupil attitudes mathematics to change, without considering how pupils' attitudes to mathematics are associated with the many external factors that concern schools, teacher's attitudes, parental involvement, pupil identity and perception of ability.

The Need to Identify How Attitudes to Mathematics are Dependent on more than just a good teacher

In order to address the so called 'numeracy crisis' (National Numeracy, 2016a), there must first be an identification of the factors associated with attitudes to mathematics. By identifying these factors, we can only then begin to attempt to build an understanding of how these factors are associated, whilst recognising the complex framework that establishes these factors. The concept of self-efficacy (Bandura, 1977) highlights how our perceived abilities are dependent on a range of socio-cultural factors. The same acknowledgement can be made with attitudes in order to build an understanding of how attitudes are established, and how our self-efficacy is altered as a result. By building that understanding, can it then be a reasonable assumption that the 'crisis' can be addressed through well informed solutions that recognise and understand those factors first identified. The UK's poor attitudes to mathematics is a complex problem. A solution cannot be found without first identifying possible reasons and this can only be done by acknowledging the complexity that is being studied. This doctoral research aims to identify possible reasons through a critical discussion of the impact of attitudes to mathematics, both positive and negative.

The Problem with Maths: A National Issue

Poor attitudes to mathematics are very common in the UK (Nuffield Foundation, 2014; National Numeracy, 2016a; Royal Society, 2019). This is highlighted through people making clear choices not to study the subject, or STEM subjects, after the age of 16 (Scarpello, 2007; Pampaka et al, 2012; Hillman, 2014; Marshall, et al, 2016) and often suffering from maths anxiety as a result of poor educational experiences (Scarpello, 2007; Sun and Pyzdrowski, 2009; Hillman, 2014; Curtain-Phillips, 2016). Such anxiety is not new, with the UK and other western nations expressing concern with national numerical abilities, student performances and student inclinations to 'drop' mathematics post-16 (Williams et al, 2008). Poor encounters with mathematics result in negative mathematical dispositions, which are habits of the mind (Katz, 1993) that reinforce particular outcomes (Webber, 2013). A disposition can be thought of as continuously active and appears as the outcome when the countervailing pressure is weaker than the disposition itself (Mumford and Anjum, 2011). These experiences lead to a lack of confidence and result in low levels of numeracy skills, which concern the ability to solve problems involving numbers that most of us encounter in everyday life (Chinn, 2012b; National Numeracy, 2016a).

The national impact of negative attitudes are more acute than ever (National Numeracy, 2019c) with an increasing demand for Numeracy and STEM related skills (UK Commission for Employment and Skills, 2013; 2015) and the projected failure to meet such demand posing significant economic risk (Macdonald, 2014). However, poor educational experiences are not the only issue a cultural dimension in the UK that shapes our attitude to mathematics. CP Snow's, "The Two Cultures" (1959) highlights how the polarisation of intellectuals appears to be a long-standing issue for decades and consists of a conception that a skillset in science/mathematics and a skillset in literacy are mutually exclusive (Snow, 1959). Macdonald's (2014) notion of non-STEM identities echoes Snow, with individuals identifying their lack of STEM skills as a part of who they are and sharing that identity with others holding the same perception (Wenger, 1998). Furthermore, the root of the polarisation is argued to be the result of literary intellectuals regarding science as an inferior branch of learning that cultured individuals need not concern with (Whelan, 2009). This view is problematic in the current economic climate, with an increased demand for individuals with numerical and data driven skills (McMaster, 2017).

The Polarising Nature of Mathematical Ability

On either side of the exclusion that separates literary intellectuals from scientists is the distorted view of one another (Snow, 1959). This view often consists of scientists perceived as dirty and optimistic without the acknowledgement of the human condition, whereas scientists perceive the literary as lacking foresight and un-intellectual, both of which are recognised as dangerous misinterpretations of one another (Snow, 1959; Whelan, 2009). Despite the rise of more critical and deconstructionist studies of science, this popular duality still exists amongst individuals (James, 2016). An important aspect to consider is how this argument still evidently applies to perceptions today, with the cultural acceptance amongst the UK of being innumerate (Kowsun, 2008 in National Numeracy, 2016a; Royal Society, 2019) to the extent that it can be seen as a 'badge of honour' (Sharp, 2017). Equally, the UK has had a long-standing national bias towards literacy (Nuffield Foundation, 2010). An applicable example can be found in James's (2016) discussion of a scientist when discussing his profession, "see's the first sign of panic and disengagement and changing the topic of conversation to literature or music" (James, 2016:107). This arguably reflects the pride in ignorance, literacy intellectuals hold over scientific content (Whelan, 2009), which echoes the same pride in ignorance identified by Snow (1959). Furthermore, those who identify their lacking in numerical skills with or without the literary skillset often contain non-STEM identities (Macdonald, 2014) and therefore establish attitudes in working towards their identity (Smith and Hogg, 2008). Studies on such identities have identified that people can see themselves distinctively as 'non-mathematical' (Williams et al, 2008). This common cultural acceptance of innumeracy reflects the UK's negative attitudes to mathematics (National Numeracy, 2016a), which need to change in order to address the problems the

UK's problems with numeracy (Chinn, 2012c; UK Commission for Employment and Skills, 2015; Curtain-Phillips, 2016). The issue with changing attitudes however, is the association between attitudes and identity (Wenger, 1998; Smith and Hogg, 2008).

"Something you are, not something you have": The Result of Polarised Learner Identity

Identity is an important aspect of learning as it affects our self-efficacy, which effects our perceived ability to perform tasks (Bandura, 1977). This is said to originate and differ according to the influence of parents and encompasses their own identity and perceived skillset, as first identified in Eccles' Expectancy Value Theory (1993), which still appears to be the case (McMaster, 2017). This identity is further validated and established in early school experiences through interaction with teachers (Beilock et al, 2010). This specific discussion can not only be applied to mathematics, but other aspects of learning too (Noyes, 2007) as it concerns the establishment of learning dispositions (NCTM, 1989; Damon, 2007). Furthermore, school experiences are a significant contributor to identity through which pupils receive the reactions of teachers. Howard Becker's labelling theory (1963) and studies such as Willis (1978) reveal the significant negative impacts of poor experiences with teachers where the perception of pupil identity is at the root of the experience of educational segregation and marginalisation. However, discussing mathematics specifically, the establishment of non-STEM identities (Macdonald, 2014) is the result of poor experiences and how those experiences are responded to from both the child having that experience and the parents and teacher reacting to that experience. These identities cause significant impact beyond education, such as a lack of options after education (Noyes, 2007; Scarpello 2007; Hillman, 2014) and even more serious issues, such as debt (Chinn, 2012a; Curtain-Phillips, 2016).

Unlike other life skills (such as literacy), negative attitudes towards mathematics are culturally acceptable in the UK (Kowsun, 2008 in National Numeracy, 2016a; Epstein et al, 2010; National Numeracy, 2016; Sharp, 2017; Royal Society, 2019). This is as a result of negative educational experiences of mathematics that go on to shape the belief that maths is something we can or cannot do, rather than believing in mathematics as an obtainable skill. "Unfortunately for millions of adults and children in the UK, 'I can't do maths' has become a self-fulfilling prophecy" (National Numeracy 2016a:3). The UK is recognised as poor at numeracy throughout the educational life course (Hillman, 2014; Vorderman et al, 2011; National Numeracy, 2012; Royal Society, 2019) leading to negative impacts in adult life (Chinn, 2012; Curtain-Phillips, 2016; Marshall et al, 2016). It is estimated that 17 million adults, 49% of the UK working population, have the mathematics ability of a nominal ten year old (National Numeracy, 2012) and a child's mathematical career is said to be decided by the age of 11 at the end of primary school (Vorderman et al, 2011). Low levels of numeracy are said to cost the UK £20.2 billion per year (Pro Bono Economics, 2014) with adults struggling to manage their personal finances as a result (Curtain-Phillips, 2016).

The discussion surrounding the UK's problems with mathematics concerns the national attitudes towards mathematics. Further evidence shows the extent to which this continues to be the case with the lack of desire for people to study mathematics in higher education (Hillman, 2014) and the fact that less than five percent of primary school teachers have mathematics degrees (Vorderman et al, 2011). This issue is not new, with Snow (1959) identifying that Britain forced important educational choices at an unusually early age, and snobbery dictated that the brightest children would be pushed towards traditional literary culture and others to Science and Engineering (Whelan, 2009). It can therefore be argued that this national bias towards literacy (Nuffield, Foundation, 2010) is an embedded national issue. Evidence of the impact can be seen in how England, Wales and Northern Ireland fall in the lowest percentage bracket of students studying maths post-16 at less than 20% (Hillman, 2014). Recognition of this national issue has provided suggestions for solutions, such as learning from other countries' curricula or having schools adopting or creating their own programmes (Vorderman et al, 2011). The issues however, cannot be solved by simply adopting the curricula of other countries that depend on the cultural influence of that country (Mathematical Association, 2011). The strength of the cultural influence must be taken into account, given it has arguably driven educational choices and divides for almost a century (Whelan, 2009) and the UK culture has a long-standing bias towards literacy (Snow, 1959; Whelan, 2009; Nuffield Foundation, 2010).

Making Maths a Priority

Maths is recognised as the most likely determinant for future study or employment (Noyes, 2007) and STEM is now nationally prioritised due to the lack of STEM skills needed to meet UK economic demand (Wilson, 2009; UK Commission for Employment and Skills, 2013; 2015). The projected number of STEM qualified people is not expected to fulfil industry needs as employees retire, risking serious risk to UK economic growth (Macdonald, 2014). As a result, the government has committed to fostering STEM related innovation in the UK in order to meet the long term needs set out in the STEM sector (National Audit Office, 2018). This includes a more accessible STEM support across all phases of education (DfES 2006 in Tripney et al 2010). Studies such as the Vorderman Report (2011) and Hillman (2014) highlight how 85% of pupils decide to no longer study mathematics after the age of 16, which is sufficiently less than most other industrialised nations. Whilst STEM (including mathematics) have become prioritised, it is important to also consider why so many students actively choose to no longer study the subject at their first opportunity (Archer et al, 2013; Marshall et al 2016), which is often due to poor educational experiences.

The Need for Policy to Support UK's Numeracy

Whilst there has been a long standing awareness regarding the UK's problem with mathematics and numeracy, Carol Vorderman's (2011) report identified key issues, as did Hillman's (2014) study, regarding those who select mathematics as a subject of study after the compulsory age. The response from Government, to such reports, that identified the lack of specialism in primary education for mathematics and the lack of desire to study the subject in further or higher education has been to seek a 'solution' from those nations with high levels of mathematics skills. For example, the Department of Education (2016b) agreed to fund £41 million into 8000 schools, over four years, to develop a curriculum based on 'maths mastery' that Singapore had reportedly managed to create (Cartwright, 2017). Whilst it is useful to compare countries, it ignores the wider social and educational context in which that system of maths learning occurred and ignores the British educational context (Vorderman et al, 2011; Mathematical Association, 2011) and its cultural bias towards literacy (Snow, 1959' Nuffield Foundation, 2010). Furthermore, whilst it is important to recognise the role of teaching, the drive to improve educational standards through a commitment to improving grades is not necessarily the answer. Teachers' pedagogy could be considered an important influence to a pupil's attitude given its impact on educational experiences. However, a commitment to helping pupils achieve high grades can result in a lack of creativity, and prevents 'deep' understanding in pupils (Jackson, 2005; Pampaka and Williams, 2016). The negative cultural views of mathematics nationally must also be recognised as an influential factor in the maths curriculum (Sharp, 2017; Royal Society, 2019). Identifying how attitudes are established are therefore just as important as reviewing an educational curriculum.

Whilst a commitment to improving the curriculum is a positive response from Government, additional effort is evidently required. Furthermore, it could be argued that changing attitudes would be more beneficial (National Numeracy, 2016a) as it would encourage more STEM participation. There does not need to be a sole focus on the curriculum exclusively. Instead, it would be more beneficial to identify how and where attitudes differ within the UK educational system. Given the issue of pupils avoiding mathematics once it is no longer compulsory (Scarpello, 2007; Pampaka et al, 2012; Archer et al, 2013; Hillman, 2014; Marshall et al 2016) and the need to be numerate as a life skills (Chinn, 2012; National Numeracy, 2019b), this can be regarded a national issue that applies to both children and adults. The need for such research has been highlighted in the discussion for a need to consider maths anxiety when trying to increase achievement in mathematics (Foley et al, 2017). This poses the need to identify what could influence different attitudes to mathematics. This study aims to begin that identification and to do so in earlier years of education as opposed to focusing on adults, as the majority of studies on the subject do (Richardson and Suinn, 1972; Tapia and Marsh, 2004; Hunt et al 2011; Yanez-Marquina and Villardon, 2016). This would arguably be more beneficial in developing long-term strategies that build positive attitudes to mathematics in order to encourage young people to study mathematics and STEM related subjects after the compulsory schooling age (Foley et al, 2017).

The evident impacts of poor numeracy, such as struggling with debt (Curtain-Phillips, 2016), have led to additional initiatives aimed at adults to gain the skills they thought they were too old to attain (National Numeracy, 2016). These initiatives come from charities like National Numeracy (2019a) and their challenge for adults along with the BBC's (in National Numeracy, 2019d) launch of resources targeted at adults to revisit their learning and change their mind-set. There is therefore a reaction to help relieve the burden of negative attitudes towards mathematics in adults (Sun and Pyzdwoski, 2009). Whilst this is a positive reaction and beneficial to both the individual and to the UK as a whole, the same strategy should be applied to children and young people. Whilst there is an attempt to improve educational experiences by importing foreign curricula that appears successful, there is a greater need that is understanding of how children's attitudes to mathematics differ in younger ages. Attaining this understanding would allow researchers and practitioners alike to think about more effective strategies to build a numerically skilled nation by encouraging positive attitudes to numbers.

From Policy to Practice: The Importance of How We Learn

The way in which mathematics is taught can be regarded as a contributing factor to negative attitudes. As highlighted previously, less than five percent of primary school teachers in the UK have a mathematical background (Vorderman et al, 2011) and teach mathematics along with other subjects unlike highly numerate countries, such as China, where mathematics teachers are specialists with degrees in the subject and teach in teams (Tall, 2014). The Singapore curriculum, which has been identified as world-leading in mathematics education, has recently been introduced in some UK primary schools (Cartwright, 2017). Although evidence has been produced to suggest no significant impact as of yet, (Boylan, 2019), this style of teaching has opted to use different methods in the classroom that emphasises creative thinking as opposed to children accepting statements from teachers (Tall, 2014), which has been the common method within the UK (Jackson, 2005; Coltman and Whitebread, 2008). These methods, which require the pupil to be in a passive role (Sun and Pyzdrowski, 2009), are evidently a factor contributing to maths anxiety with anxious teachers passing on those messages of anxiety to their pupils (Beilock et al, 2010). Boylan (2019) suggests that rather than simply implementing new methods, focus should be applied to teachers having the same opportunities to learn how to best implement these methods like the teachers of the same methods in East Asia. Additional evidence emphasises the importance of teachers being confident in the methods they teach (Beilock et al, 2010) and receiving support to do so (ACME, 2016). This again highlights the need for policy to support practice.

How mathematics is taught is therefore a factor that contributes to negative experiences of and attitudes to mathematics. The evidence indicating this is a national problem (National Numeracy, 2016; Royal Society, 2019) also highlights how non-STEM identities can also be the result of teaching (Macdonald, 2014). This could be because of different areas associated with teaching such as the methods used to teach (Jackson, 2005), the anxiety of the teacher themselves (Beilock et al, 2010), or the relationship between the teacher and pupil (Willis, 1978; Birch and Ladd, 1997; Coe et al, 2014). Nevertheless, teaching methods are now driven by the desire to adopt the curricula of other countries where mathematics education appears to be significantly more successful (Tall, 2014). Furthermore, the attitudes of the teacher are argued to be the important factor to improving educational experiences rather than the methods (Boylan, 2019).

Where we are: Recognising the Need to Identify where Attitudes Develop

There is a growing awareness of the importance in providing young people with more support and understanding in their decisions with subject selection (Department for Education and Skills, 2005). However, attempting to make these efforts requires an understanding of young people's decision-making processes (Blenkinson et al, 2006) and more so what influences those decisions. Experiences and attitudes towards mathematics are evidently influencing these decisions (Scarpello, 2007; Archer et al, 2013; Marshall et al, 2016) with 85% of students post-16 not selecting maths (Hillman, 2014) and even fewer with mathematics backgrounds teaching maths at primary school (Vorderman, 2011; Tall, 2014). Research has identified that the variation in students' academic achievement in mathematics can be explained by maths anxiety and attitudes toward mathematics (Suinn & Edwards, 1982), providing reason to identify factors associated with negative attitudes as a means of trying to improve proficiency. Failure has been linked to mathematics anxiety (Mayes, Chase, & Walker, 2008). Therefore, a more positive and confident culture around mathematics and numeracy should expect a positive impact on skills and attainment (National Numeracy, 2016a).

An understanding of young children's attitudes to mathematics may therefore be more effective in meeting a long-term desire to maintain positive attitudes to STEM and have more pupils choose such subjects. By understanding how children's attitudes to mathematics may be affected, we can further consider how we change those attitudes and by changing attitudes, we can establish a more positive culture around mathematics (National Numeracy, 2016a; 2019b). However, in order to understand those attitudes, there must first be an identification of the factors that impact and relate to such attitudes. Identifying factors associated with attitudes to mathematics, at a certain point in the educational life course, provides the opportunity to develop an understanding of why particular factors are associated and then build a strategy towards establishing a positive mathematics culture. This doctoral research aims to provide that opportunity through the identification of factors associated with children's attitudes towards mathematics at the ages of eight and nine years old in Key Stage 2 (KS2), Year 4. Pupils at this stage of education have been found to establish attitudes (Bloom 2003) and appear to hold differences in those attitudes through to Key Stage 3 (KS3) (Syyeda, 2016). Therefore identifying what may influence attitudes at this stage of education can arguably help build an understanding of how attitudes can be changed.

What We Need: Overview of the Current Study

Whilst we can understand that we have negative attitudes, we do not always understand why. We may not understand what shapes our attitudes. More importantly, we may not understand how attitudes are shaped for us, not by us. This study identifies the external factors that shape year 4 pupils' attitudes to mathematics, by linking the relationship between a pupil's attitude and a school's average score in mathematics; and attempting to identify whether that link is mediated by the attitudes of teachers. This study uses an attitudinal questionnaire to measure 508 pupils' attitudes, along with the views of nineteen teachers, in ten different schools across Greater Manchester, Lancashire and Nottinghamshire. The aim of this approach was to measure pupils' attitudes to mathematics with a reliable questionnaire that engages respondents through the use of visible acts of meaning (Bavelis and Chovil, 2011), such as Emojis, and interactive methods such as ‘draw a person’ tasks.

By attempting to build a comparative sample that included a range of deprivation and ethnic diversity at the school level, and similar proportions of male and female pupils and teachers, this study aimed to measure pupils’ attitudes and identify whether a system of complex factors affected those attitudes. This system of factors consists of school, teacher and pupil characteristics. In order to address the possibility of multiple outcomes that can arise from the influence of a school, a particular teacher and how that affect can differ according to the characteristics of the pupil, the data was collected with the intention to analyse the influences of these multiple factors through a form of Multilevel Modelling. Using an observational approach, the purpose of this analysis was to meet the epistemological aim of reliably identifying whether this system of factors can produce different influences on pupils’ attitudes. This was in order to address the complexity of how pupil identities and attitudes can differ, resulting in multiple outcomes related to achievement in mathematics and crucial numeracy skills in adult life.

Justifying the Methodology

This study wished to answer a number of set research questions. Those research questions concerned assessing year 4 pupils’ attitudes to mathematics and identifying the associated factors. Given negative attitudes to mathematics are recognised as a national issue, it was important to consider how a sample could be established that was comparable to that of a national population of study. Furthermore, given the lack of research in this particular area, and concerning the need for reliability in measuring children’s attitudes, it was decided that survey research, followed by statistical analysis of the collected data, would be the strongest available method to reliably observe pupils’ attitudes in order to assess and identify the potential associated factors.

Concerning the practicality of working with such young participants in school conditions, were time constraints of teaching practitioners and learning needs of pupils need to be prioritised, a mixed method or qualitative approach seemed less justified.

Liaising with multiple practitioners of the primary schools who agreed to take part helped inform that schools would be less likely to dedicate a larger amount of time to their pupils and teachers to take part in more in depth interviews over a 10 minute self-completion questionnaire. Furthermore, interviews would have raised additional ethical concerns associated with the welfare of respondents and their vulnerability, as it was of utmost importance that all child respondents remained anonymous. In addition, interviews, if allowed, would have not been able to take place without a teacher or teaching member of staff present. Such guidelines, whilst undeniably are important, also compromise validity of the responses given the nature of the interview would concern their experiences of mathematics with that teacher.

It was therefore decided that a quantitative approach would be taken, measuring pupils' attitudes along with a series of influential factors that could be captured through the self-completion questionnaire or publicly available information, such as school characteristics. As these variables could be measured within the ethical parameters set, this became the focus of the study. This meant that other arguably important factors, such as dispositions and parental attitudes, could not be researched as they could not be measured. The discussion on dispositions recognises that such complex concepts cannot be measured within the required time frame of a self-completion questionnaire and reliably quantified. Additionally, parents were inaccessible due to the need to uphold anonymity of the pupils participating in the study. The research will therefore discuss these factors, whilst recognising the inability to assess them.

Chapter 1: Literature Review

Introduction to Chapter

This chapter will critically discuss theories concerning attitudes to mathematics and how they are measured; along with the factors that influence such attitudes. The aim of this chapter is to explore how different factors can influence attitudes depending on the identity of the pupil. This chapter will highlight a clear gap in the literature in relation to how pupils are subjected to a number of external factors simultaneously; most previous studies focus on one factor and do not utilise a complex analytical model. This study aims to fill this gap with a methodology that addresses how pupils' attitudes are influenced by multiple factors and that an identification must be made at an early stage of the educational life course, in order to build an understanding as to how certain pupils develop and are subjected to negative attitudes. This chapter will also introduce the methodological framework that would most accurately addresses how particular influential factors provide a 'clustering effect' to other factors. The chapter ends by introducing a conceptual framework, named the 'Attitudes 2 Mathematics' Model (A2M). This framework aims to expand on Tapia and Marsh's (2004) Attitudes Towards Mathematics Inventory, (ATMI) by adapting Hunt et al's (2011) UK Maths Anxiety Scale (UK-MAS) and applying a range of social factors that could influence how a balance of the four components of attitudes, enjoyment, confidence, value and motivation, can be attained.

This framework was established as a result of a literature review originally influenced by the issue of negative attitudes to mathematics in the UK. Much of the research conducted in the field has concerned concepts such as maths anxiety and adults. Whilst maths anxiety is a prominent issue amongst many individuals in the UK, a review or literature concerning younger individuals identified a gap in knowledge concerning maths anxiety and children. Furthermore, evidence suggests that maths anxiety is established through the formation of attitudes to mathematics (Chinn, 2012; Marshall et al, 2016), and the children in this study may not yet have established such definitive anxieties. Furthermore, the practical use of terminology such as anxiety, is not advised given the risk of children not understanding such terms at younger ages (Kellett, 2011). The literature review therefore recognises how maths anxiety is an issue related to attitudes to mathematics and is therefore discussable as an impact of poor attitudes. The focus of this research is children's attitudes to mathematics. Therefore, a literature review concerning both the psychological construction of attitudes, along with a review of the sociological and educational theory and evidence surrounding the influences of attitudes will take place in this chapter.

Attitudes to Mathematics

"Negative attitudes, rather than a lack of innate talent, are at the root of our numeracy crisis. In order for people individually – and the country as a whole – to improve and in turn benefit from raised levels of numeracy, our attitudes have to change." (National Numeracy, 2016a:1).

It is important to identify how attitudes to mathematics are shaped because of the long-standing impact that can result. Curtain-Phillips (2016) provides an example of the impact of poor attitudes to mathematics beyond education: individuals with low levels of numeracy tend to have higher levels of debt and low levels of financial literacy. Even for those who may have succeeded in attaining degrees, there is widespread acknowledgement that a great many undergraduates lack sufficient the numeracy skills required for their degrees (National Numeracy, 2019a). Therefore, to understand how experiences can improve to help challenge negative impacts, there has to be an understanding of the complex framework that contributes to negative attitudes.

Mathematical attitudes are developed through a tendency that is expressed by evaluating mathematics with some degree of favour or disfavour (Burnes, 2014). With disfavour, negative attitudes to mathematics often lead to mathematics anxiety, disengagement, and eventually, failure (Mayes, Chase and Walker, 2008). Terwilliger and Titus (1995) found that young children with positive attitudes towards mathematics were inversely associated with maths anxiety, as has been found in teenagers (Scarpello, 2007) and adults (Curtain-Phillips, 2016). The barriers to mathematics success from maths anxiety are due to the innate feelings of tension and uneasiness related to the perception of ability and affects millions on a daily basis (Burns, 1998).

Damon (2007) discusses dispositions, which are the beliefs and attitudes that direct the decisions a person makes, with mathematical dispositions being a specific type. Beyers (2008) further discusses how mathematical dispositions are a tendency to have or experience particular attitudes, beliefs, feelings, emotions or moods. Attitudes to mathematics can therefore be the result of the mathematical dispositions established through continuous experiences with mathematics. Those dispositions could also influence future experiences, which then recycle the same moods and feelings established. School children find generally that mathematics is the more difficult subject and often experience anxiety from poor marks or negative comparisons to peers or siblings (Carey et al, 2019). There are multiple arguments made as to the reason behind this, with some discussing the influences of parents (Eccles, 1993; Fan and Williams, 2010; National Numeracy, 2016b) as well as teachers (Jackson, 2005; Vorderman, 2011; Beilock et al, 2010). This highlights how we come to what National Numeracy (2016a) define as the 'Numeracy Crisis'. Attitudes to mathematics therefore requires further exploration through the application of work on Mathematical Dispositions.

Mathematical Dispositions

Dispositions are defined as distinctly different from attitudes, whilst heavily connected. The connection comes from how dispositions are best recognised as a power or tendency towards a particular outcome; and attitudes are argued to be the outcome (Webber, 2013:19). A disposition can be thought of as continuously active, and appears as the outcome when the countervailing pressure is weaker than the disposition itself (Mumford and Anjum, 2011). Dispositions are therefore visualised as the outcome or response to stimuli, and form attitudes as a result of their activity. Dispositions are beliefs, and attitudes direct the decisions people make, determining who they are and who they become (Damon 2007). There is therefore also an argument to be made that attitudes can influence dispositions: as dispositions, in their continuous activity (Mumford and Anjum, 2011) require a countervailing pressure that is ultimately influenced by a previous experience or association of mathematics (Scarpello, 2007). The connection between attitudes and dispositions is therefore also continuously active, providing a cyclical effect to how we act and react towards mathematical scenarios, with each experience contributing to a sense of ability and identity (Wenger, 1998; Macdonald, 2014).

Dispositions are particularly important in the context of learning, as they are the outcome of a particular learning encounter. Learning dispositions are defined as learning and coping strategies that become habits of the mind (Katz, 1993). Learning dispositions furthermore are formed by and form interactions that children have with people, places and things (Carr, 2002 in Duncan, Jones and Carr, 2008). Furthermore, by becoming habits of the mind (Katz, 1993), learning dispositions possess emotions and reactions to a particular encounter that we then associate with the concept. When children establish learning dispositions, they are forming attitudes about their own learning. Therefore, distinct learning dispositions can form distinct attitudes towards different aspects of learning. For example, continuous negative experiences with mathematics may go on to create negative mathematical dispositions, and those negative habits of the mind (Katz, 1993) lead to the outcome of negative attitudes. Attitudes have long been argued to be the distinct result of reinforced dispositions (Stokvis, 1953). Through these dispositions, we gain a sense of ability that becomes an aspect of our own identity (Wenger, 1998). This sense of ability can be recognised as confidence (Kalder and Lesik, 2011), which is recognised as a key component of our attitudes (Tapia and Marsh, 2004), which we must then exhibit in or to satisfy that sense of identity (Brewer, 1991; Smith and Hogg, 2008).

Considering dispositions as continuously active (Mumford and Anjum, 2011), can allow a system to be visualised that involves identities being continuously worked towards through the recurring development of attitudes. Experiences form dispositions, which then establish attitudes and attitudes are exhibited as a means of expressing identity (Smith and Hogg, 2008). This emphasises how mathematical dispositions can go to affect aspects of identity.

When establishing an identity, persuasive messages are more likely to change an attitude when shared with someone sharing the same identity or membership of identity than someone outside of that membership (Abrams et al., 1990; Wilder, 1990; McGarty et al, 1994). A classic example would be the negative identities females can experience in mathematics (Noyes, 2007), where they are found to adopt negative attitudes towards mathematics from female role models such as teachers (Beilock et al, 2010) and parents (Eccles, 1993). Therefore, attempting to change negative attitudes may become more difficult when persuasive messages, for example learning tasks, are set by a teacher who is perceived to share the same learner identity as pupils who share non-STEM identities (Macdonald, 2014). Recognising how dispositions are formed and in turn form attitudes is essential in understanding how attitudes to mathematics are established through mathematical dispositions.

Considering mathematical dispositions as a specific type of disposition, the National Research Council (2001, in Feldhaus, 2014) listed positive mathematical dispositions as a strand of mathematical proficiency and a negative mathematical disposition as equally damaging, particularly on mathematical achievement (Zaskis, 2011). It is also possible to have positive dispositions towards certain subjects, such as literacy, and poor dispositions towards other subjects (Feldhaus, 2014). The National Council of Teachers of Mathematics (NCTM 1989:233) discuss how mathematical dispositions are "not simply attitudes but a tendency to think and act in positive ways" and furthermore, considers positive dispositions as essential for successful mathematics education.

Mathematical Dispositions are therefore a crucial element of what establishes attitudes to mathematics. By attaining positive mathematical dispositions, mathematical proficiency (NRC, 2001 in Feldhaus 2014), and achievement (Zaskis, 2011), can be attained and positively impact further mathematical experiences (NCTM 1989; Damon, 2007; National Numeracy, 2016). A particular model by Tapia and Marsh (2004) focuses on how attitudes to mathematics have four particular components, which when all achieved, result in positive attitudes to mathematics. Unpacking these four components highlights how mathematical dispositions are the result of attaining, or not attaining, each component to establish an overall positive attitude to mathematics. Attitudes to mathematics and mathematical dispositions depend on one another. Attaining poor mathematical dispositions risks establishing a negative learning identity with mathematics (Macdonald, 2014), which can be shared with others and reinforced through the collective attitude amongst those sharing that identity (McGarty et al, 1994). Tapia and Marsh's (2004) four components break down how positive attitudes can be formed, through attaining positive dispositions in particular areas, to contribute towards building an overall positive attitude and positive mathematical learner identity.

Theoretical Framework:

The Four Components of Attitudes to Mathematics: Enjoyment, Confidence, Value and Motivation

Tapia and Marsh (2004) found from a Factor Analysis on their Attitudes Towards Mathematics Inventory (ATMI), four defined components: Enjoyment, Confidence, Value, and Motivation. This measure originally identified a reliable assessment of attitudes to mathematics in a sample of 545 high school students in the USA across all levels and has been found to consist of high psychometric properties (Chamberlin, 2010). The measure was further validated with 269 middle school students in the United Arab Emirates (Afari, 2013) and 699 students in South Australia in school years 7 and 8 (Majeed, Darmawan and Lynch, 2013). Whilst the original 40-item ATMI has been criticised for being too long (Yanez-Marquina and Villardon, 2016; Karjanto, 2017), the measure has also inspired a condensed version with a sample of over 1600 participants in Singapore (Lim and Chapman, 2013) that focused on enjoyment and motivation.

The original measure however, is regarded as one of the most extensively used instruments to measure attitudes towards mathematics (Palacios et al, 2014) for its recognition of the different factors of attitudes to mathematics. Furthermore, those factors are further effected through different experiences, which can range from both primary and secondary socialisation, and therefore establish a complex framework that shapes overall attitudes to mathematics. A discussion of each component is required to further understand how the four factors work collaboratively to shape an individual's attitudes to mathematics, which then establish mathematical dispositions, impacting educational experiences and outcomes.

Enjoyment

Kalder and Lesik (2011) discuss how enjoyment comes from a fondness for mathematical classes, problems, and tasks. Therefore, for enjoyment to occur, the teaching must provide fun, wonder and excitement, which can be attained through play (Coltman and Whitebread 2008). A wealth of research surrounding this has helped us come to understand that children best learn through both play and active learning (Vygotsky, 1978; Sinclair, 2004; Hirsh-Pasek et al, 2009; Lillard et al, 2013; Holmes et al, 2015; Whitebread et al, 2017; Zosh et al 2013), which require physical engagement with resources and people (Coltman and Whitebread, 2008). Play becomes less important in the curriculum as children grow older, which may highlight the possible reasoning behind the lack of engagement in mathematical learning at older ages in school based on teaching methods (Jackson, 2005), which then associates with negative experiences in adults (Scarpello, 2007; National Numeracy, 2016a)

UK Key Stage 1 (see footnote[1]) is an educational level where it is particularly important to learn through engagement with adults and play (Coltman and Whitebread 2008). There is a particular research focus on primary education that discusses the need for active engagement in learning. Classical theory, such as the work of Piaget, Vygotksy and Bruner, opposes the traditional 'behaviourist' approach that requires the pupil to learn in a passive position (Coltman and Whitebread 2008). Bruner for example, believed social interaction played a crucial part in children's mental development (Wood, 1998), finding experimental evidence in successfully teaching a classroom of 8 year olds quadratic equations, a concept often not taught in England and Wales until the age of 16. This study emphasised the role of the teacher and the importance of interactive engagement. Piaget (in Kaufman, 2017) additionally argued the importance of social interactions for intellectual development. This would help us to understand that children find tasks enjoyable when there is an active engagement that enforces elements of play.

The predominant emotions of play are interest and joy (Gray, 2013). Therefore, play is a crucial component of enjoyment. Optimal learning through play requires: the activity to be experienced as joyful, helps children find meaning in what they are learning, involves active engagement and interactive thinking, and involves social interaction (Hirsh-Pasek et al, 2015; Whitebread et al, 2017). Children best learn through actively playing a role in

[1] UK Key Stage 1 (KS1) refers to pupils between the ages of 5 and 7 years. This includes years: 1 and 2.

problem solving over being directly instructed (Zosh et al, 2013; Matte-Gagne et al, 2015) and active learning is dependent on the children being mentally engaged regardless of the activity of their bodies (Hirsh-Pasek et al, 2015). Play establishes that mind set and does not result in the downside to instruction-based pedagogy (Whitebread et al, 2017). There is therefore a need for pupils to attain a sense of enjoyment when carrying out the task put before them in order to develop a positive attitude and allowing learning through play, can aid that attainment.

Here the focus is on the teaching, which requires further discussion later. However, the important factor to consider is how the sense of enjoyment established through pedagogy can emit emotions of interest and joy (Gray, 2013) and eventually a fondness for those tasks (Kalder and Lesik, 2011). This raises a particular argument when reflecting on the context of Chinese education culture (lauded in the UK as a successful educational culture, especially in relation to mathematics) where the teachers are experts in their field (Tall, 2014). Chinese students possess the drive to attain high scores through academic beliefs inherited by parents and family members through the shared cultural belief of hard work; and success in government exams results in economic, social and political rewards for the student and the family (Ming Chiu, 2016). This sense of culture emphasises mastery, like the Singapore curriculum (Cartwright, 2017), and whilst this cultural belief does encourage pupils it also discourages them to take risks and attempt to solve problems outside of the routines with which they are familiar (Ming Chiu, 2016). Singapore's curriculum however, does encourage problem solving through interactive learning (Cartwright, 2017). This raises an interesting discussion again concerning the cultural beliefs of the pupils and how the curriculum must adhere to those beliefs in order to expect success. With enjoyment and play being a fundamental part of early years education (Coltman and Whitebread, 2008), an argument can be made that in order to maintain positive experiences, play should continue throughout the educational life course.

Confidence

Confidence in mathematics is regarded as the sense of ability to successfully deal with mathematical tasks and complete mathematical problems (Kalder and Lesik, 2011). Many adults in the UK lack confidence in their mathematical abilities (National Numeracy, 2016) often because of poor experiences of mathematics in school (Scarpello, 2007; Marshall et al, 2016). This highlights how attitudes are the outcome of dispositions. A lack of confidence can establish Maths Anxiety, which impacts students with succeeding in further studies (Onwuegbuzie & Wilson 2003), and even results in individuals avoiding situations where mathematics is involved (Chinn, 2012a), causing further impact beyond education (Curtain-Phillips, 2016; National Numeracy, 2016a). However, pupils' confidence in lower ages has received less attention (Attard, 2013). Research in Key Stage 3 (see footnote[2]) mathematics has shown that those who struggle to progress beyond this key stage have low self-concept as mathematics learners, with the possibility being that low self-concept is the result of low achievement whilst also resulting in low achievement (Nunes et al, 2009). This issue also applies in the context of higher education, with Social Science undergraduates facing problems related to the quantitative aspects of research methods (Williams et al, 2008). This cycle echoes the importance of confidence in mathematical ability to prevent consistent low achievement and negative attitudes (Kalder and Lesik, 2011; Chinn, 2012). Furthermore, confidence has been found to be effected itself through multiple factors such as teacher perception (Pretzlik et al, 2003) and gender (Fennema and Peterson, 1985; Beilock et al, 2010).

Students require a certain level of confidence to help maintain an essential positive mathematical disposition (NCTM; 1989). Research exploring confidence identifies a common theme, such as the phrase, "I can't do maths" said so often that it does not seem a strange thing to say (Kowsun 2008 in National Numeracy 2016a). A number of factors may contribute to a pupil's confidence. One being the experiences of numbers the student has already had and whether or not they were positive. Relatedly, Rogers and Kutnick (1990 in Coltman and Whitebread 2008) discuss an aspect that they believe associates with high self-esteem, which they refer to as the need for love and security. This argument refers to evidence that suggests that children who develop positive self-images, improving confidence and self-efficacy, are those surrounded in their earliest years by parents or carers who make them feel valued and so they come to value themselves (Coltman and Whitebread 2008). Coinciding with this is the evidence that suggests self-concept-enhancing interventions positively influences self-concept ability of mathematics (O'Mara et al, 2006; Pinxten et al, 2013), leading to positive self-efficacy (Bandura, 1977). Positive self-efficacy may provide a higher chance of a positive experience, such as possessing the belief to

[2] Key Stage 3 (KS3) refers to pupils between the ages of 11 to 14 years. This includes years: 7, 8 and 9.

complete a task and because of enjoyment, the student can attain confidence. Confidence is therefore, whilst a crucial aspect of positive mathematical dispositions, also a factor resulting from the influences of self-concept abilities (Pinxten et al, 2013) and feelings of security from parents (Coltman and Whitebread, 2008). This highlights the importance of parental support when it comes to developing positive self-efficacy (Fan and Williams, 2010).

Domains of learning, such as self-concept and attitudes, are crucial to all learning and therefore mathematics achievement (Hall, 2016). Noyes (2007) refers to a case study in which a pupil recognised as less able in mathematics, did not do well in their transition from primary to secondary school mathematics. However, her negative learner identity had already been established in primary school, which had detrimentally affected her confidence. An opposing case study was also used, where a male student was doing well in mathematics and was from a background where he discussed mathematics with his father and as a family. They understood the value and importance of mathematics and were therefore mathematically ambitious (Noyes 2007). Confidence can therefore be attained with the help of external factors, such as parents (Coltman and Whitebread, 2008) and provide pupils with higher chances of more positive mathematical experiences in the classroom as a result (Eccles, 1990; Noyes, 2007).

Value

Value perceptions are strong predictors of students' choices to participate or engage in a particular activity (Meece et al, 2006). Of all the school subjects, mathematics is most likely to determine progression towards further study or employment opportunities, and proof of proficiency in mathematics is often seen as the most crucial (Noyes 2007). However, this does not appear to mirror the value for mathematics, culturally amongst students (National Numeracy, 2016). Maths is seen as a remit of 'mad scientists', 'nerdy boys', and the socially inept (Epstein et al 2010 in National Numeracy 2016a). This perception has existed in the UK for a long time and has helped to reinforce the idea that maths is exclusive to certain types of people who are innately 'good at maths' (Whelan, 2009). Bilton (2017) discusses the typicality of an engineer or computer scientist consistently being imagined as a middle class, white man and schools fail to tell otherwise. The wider impact is shown after education where female, BME and disadvantaged young people are under-represented in STEM fields (Macdonald, 2014).

Another important factor to note is the supportive background, and how parents can ultimately influence choices, which depends on their own perceptions (Eccles 1993; Bilton 2017). Fredricks and Eccles (2005) found positive relationships between parental value and child perception of tasks, whilst Parsons et al (1982; 1984) discuss how female children adopt their parents' beliefs about their abilities in mathematics. Children's beliefs about their abilities affect their motivation, interest and achievement levels (Partridge et al, 2008). Eccles's expectancy value theory (1993) discusses how the child can establish a sense of identity through the reactions and interactions of their parents. Therefore, if their parent does not expect them to succeed in a particular subject, then the child would not value that particular subject as highly as one in which a parent would expect success. A common example in the UK is the gender ability beliefs concerning males to be higher skilled in mathematics (Boaler, 2004; Mendick 2005; Department for Education and Skills, 2007) as opposed to looking at mathematics as an obtainable skill for all (National Numeracy, 2016a). This common example, which promotes and normalises the underachievement of girls in mathematics (Hargreaves et al, 2008) and is reinforced through parental beliefs (Eccles, 1993), results in the said underachievement (Hall and Hoff, 1988; Beilock et al, 2010). Individuals work towards the satisfaction of their own identity (Brewer 1991) and when in the context of achievement, learner identities are established (Macdonald, 2014), which affects achievement (Gray, 2014).

Evidence of females having advantages in reading from the early years of education onwards (Breda and Napp, 2019) additionally provides reinforcement to pupils and parents alike that girls are better at English than mathematics. This early advantage in English may provide a sense of identity for girls, which as highlighted in Snow's (1959) "The Two Cultures", may promote a sense of identity that associates with the exclusion of certain abilities, such as scientific thought. Based on the theory discussed however, it must also be acknowledged that the so-called advantages identified in young females may already be the result of parental expectations (Eccles, 1993) along with expectations set by practitioners based on experiences with females of that age (Becker, 1963). Therefore, the establishment of learner identities (Wenger, 1998) may already be occurring in earlier years and therefore providing certain advantages that Breda and Napp (2019) identified, along with disadvantages as a result of associated non-STEM identities (Macdonald, 2014).

The UK's value of maths is not regarded as positive. Negative attitudes are highly common amongst adults (National Numeracy, 2016a; Royal Society 2019), which effects children in their learning and may result in low achievement (Mayes, Chase, & Walker, 2008; Zaskis, 2011; Feldhaus, 2014), along with avoiding the subject after 16 (Scarpello, 2007; Pampaka et al, 2012; Hillman, 2014; Marshall, et al, 2016). Given that mathematics is a core subject of the National Curriculum and globally regarded as one of the most important subjects to equip students with an education, a change may be needed if we are to try to improve how young people value mathematics. . Research has shown that the subject choices young people want to make are often decided at an early age (Archer et al, 2013), highlighting the importance of valuing mathematics in young children. Numerical ability is as important as literacy, as it is the using of mathematical skills in real life (National Numeracy, 2019b). However, individuals who do not value numeracy, and therefore do not value mathematics, do not feel that importance and their overall attitudes towards mathematics is impacted. Value is an important factor of establishing positive mathematical dispositions, because it can be the result of enjoyment and confidence, and the determining factor to the final component of attitudes to mathematics, motivation (Tapia and Marsh, 2004).

Motivation

Psychologists have defined motivation as an internal state that arouses, directs and maintains behaviour, through biological, social and psychological factors that move us to action, be it eagerly or reluctantly (Woolfol et al, 2008; Miller, 1962 in Gallard & Cartmell, 2014). Autonomously motivated children in school contexts are more likely to pay attention, invest their efforts in class and therefore demonstrate more positive outcomes, such as high overall grades (Hagger et al, 2015). The opposite, amotivation, is where the individual does not feel competent to complete the task, expects no desirable outcome from the task, or feels the task possesses no value (Ryan and Decci, 2000). There is also extrinsic motivation, which may well link to extrinsic factors, where a pupil has the desire to complete given tasks but for an unrelated outcome (Spaulding, 1992). Identifying factors associated with motivation can therefore help begin to understand the difference in pupil attitudes.

Autonomous motivation can be established through various techniques of teaching, including providing choice, avoiding controlling directives and commands, and acknowledging the student's perspective (Reeve & Jang 2006; McLachlan & Hagger 2005, in Hagger et al, 2015). Bandura (1976 in Skaalvik et al 2015) discusses how motivation can be affected by self-efficacy, where the student also requires the belief that they can complete the task put in front of them, the opposite to amotivation (Ryan and Decci, 2000). It is argued that the teaching of mathematics is confined to being taught in a particular set of ways that requires the pupil to be in a typically passive role (Sun and Pyzdrowski, 2009), which can therefore affect how students perceive the task (Jackson, 2005), and determine their level of motivation to complete the task. If there is a lack of motivation, then there is a risk of negative mathematical dispositions and a resulting risk of negative attitudes towards mathematics.

Motivation concerns energy, direction, persistence and equifinality – all aspects of activation and intention (Ryan and Decci, 2000: 69). Motivation in mathematics is important in young pupils if positive attitudes are to be developed. However, motivation in adults is a clear issue and has been linked to expectancy value (Feather, 1988; Butler, 2016), where the value of parents drives the value of children (Eccles, 1993) who then continuously work towards their learner identity (Smith and Hogg, 2008; Mumford and Anjum, 2011) and continue that sense of identity in adult life (Chinn, 2012a; 2012b). Motivation therefore needs to be supported by external influences, and those with self-endorsed motivation have more confidence and therefore enhanced performance (Decci and Ryan, 1991; Sheldon et al, 1997; Kalder and Lesik, 2011; Chinn, 2012b). Extrinsic motivation can be recognised in pupils for example those who complete homework because they personally value how it enables working towards a chosen career (Ryan and Decci, 2000). Such an example can be linked to the previously discussed cultural value of mathematics within Chinese education, in both education and home life, where there is a belief towards success in mathematics providing rewards associated with economic, social and political value for those who succeed and their family (Ming Chiu, 2016). Whilst this highlights the importance of both school culture and home culture in reflecting the same value in order to achieve motivation, it also highlights the dependency motivation has on value and those two factors would be more likely to attain enjoyment in engaging in the task and therefore succeeding would implement confidence. Motivation is therefore an important aspect of attitudes to mathematics, given its dependency on other aspects whilst also being a required component in establishing a positive attitude to mathematics that can enforce positive mathematical dispositions.

The impact of failing to attain all four components

Negative Attitudes and Maths Anxiety

Some evidence indicates that enjoyment and achievement are not linked in school education and high performing countries can still have low levels of enjoyment in mathematics (Askew et al, 2010). However, failing to attain aspects such as confidence and enjoyment has been identified as contributing to negative attitudes. Negative attitudes to numbers are found to be related to higher levels of maths anxiety (Terwilliger and Titus 1995; Beasley et al 2001; Onwuegbuzie & Wilson 2003). Maths anxiety has been linked to low levels of achievement and failure (Beasley et al, 2001; Beilock et al, 2010; Marshall et al, 2016; Mayes, Chase and Walker, 2008) along further negative impacts in later life (Chinn, 2012a; Curtain-Phillips, 2016). Maths Anxiety is defined as a debilitating emotional reaction to mathematics that is increasingly recognised in psychology and education (Nuffield Foundation 2016).

Maths Anxiety is not a new discovery. Richardson and Suinn (1972), who created the first measure for maths anxiety, describe it as feelings of tension and anxiety that interfere with the manipulation of numbers. Meece, Wigfield and Eccles (1990) discuss the feeling of tension and uneasiness that is related to an individual's perception of their own mathematics ability along with how they expect to perform. Therefore, once somebody experiences maths anxiety, it can be argued that such an experience will affect future encounters with numbers. This argument can be validated when considering mathematical dispositions and their effect on establishing learner identities (Wenger, 1998), and attitudes (Stovkis, 1953), which are formed to work towards those identities (Abrams et al., 1990; McGarty, Haslam, Hutchison, & Turner, 1994; Wilder, 1990). Macdonald's (2014) notion of non-STEM identity echoes the characteristics of those with maths anxiety, providing an argument that maths anxiety is an aspect of identity. Identities are fulfilled through the sharing of attitudes associated with the membership of that identity (Wenger, 1998; Smith and Hogg, 2008). Understanding maths anxiety is therefore essential to understanding how attitudes to mathematics are established.

There are two main factors, said to be causing mathematics anxiety. Intrinsic factors, which refers to failures of cognition, and extrinsic factors, referring to negative emotions transferred from other people, such as parents and/or teachers (Sun and Pyzdrowski 2009; Beilock et al, 2010). Took and Leanord (1998) and Dodd (1992 in Sun and Pyzdrowski 2009) discuss how intrinsic factors are effected through poor instruction, such as traditional teaching methods focused on lecturing and the remembering of algorithms. Extrinsic factors, such as parental attitudes (Eccles, 1993; Scarpello, 2007; Tomasetto, Alparone and Cadinu, 2011) and teachers emotions in mathematics classrooms (Beilock et al, 2010), can effect a student's maths anxiety through transferring emotions or attitudes that influence the student's beliefs and ultimately generate maths anxiety. Whilst intrinsic factors are equally important, a focused discussion on the extrinsic factors can help build an understanding of how such factors contribute to establishing attitudes to mathematics and dispositions.

How Maths Anxiety causes Impact beyond Education

Whether we like it or not, numbers surround us in many aspects of our lives, and we require numeracy in order to solve problems that require mathematic skills in everyday life (National Numeracy, 2019b), yet many factors influence how we feel about the subject (Cockburn & Littler 2008). Research has demonstrated that those with poor experiences of maths go on to further study by purposefully avoiding maths related subjects (Marshall et al 2016) and maths related issues in real life (Chinn, 2012). This provides a significant impact on the number of choices that can be made, and may restrict career options (Noyes, 2007; Scarpello 2007).

Another example of an impact beyond education is working with numbers either in the workplace or in an individual's personal life. Debt and unbalanced chequebooks are examples of negativity associated with numbers beyond education (Curtain-Phillips 2016). Such examples reveal the importance of establishing positive mathematical dispositions and attitudes (Tapia and Marsh, 2004) for students that will reduce students experiencing maths anxiety and further challenges associated with numeracy. Other arguments that would help support this are the findings of health research that discusses the significant associations between health and debt. Cain et al (2015) found clients seeking advice regarding debt or financial issues had all experienced effects on their physical health, mental health, or sense of wellbeing, with examples such as chest pains, depression, anxiety and insomnia.

Therefore, those who become mathematically anxious are at more risk of facing financial issues that induce stress. The impact of maths anxiety can therefore affect much more than how a student feels in a classroom. If a student fails to overcome maths anxiety in school, that anxiety is carried forward along with career choices (Vorderman, 2011; Hillman, 2014; UK Commission for Employment and Skills, 2013; 2015, Marshall et al, 2016), opportunities (Noyes, 2007; National Numeracy, 2016; 2019), and in trying to use necessary skills in everyday life to maintain financial wellbeing (Chinn, 2012b; Curtain-Phillips, 2016).

Extrinsic Factors of Maths Anxiety: From Home Culture to School Culture

There are arguably different ways in which a student can be regarded as mathematically anxious. Considering how attitudes to mathematics can be externally influenced requires a discussion on the many different extrinsic factors. These factors concern not the cognition of the pupil, but the social surroundings and influences that may support or not support their engagement with mathematics, ultimately leading to particular experiences that may or may not lead to maths anxiety. With discussion on extrinsic motivation (Spaulding, 1992) along with the other components required to attain positive attitudes to mathematics, research is required on how failing to meet those components can lead to maths anxiety. Pupils can be extrinsically influenced through their teacher and his/her teaching methods; (Jackson, 2005; Sun and Pyzdrowski 2009; Beilock et al, 2010) and the value and support provided by parents (Eccles, 1990; Scarpello, 2007). There is therefore a requirement for further identification of how both parents and teachers play a vital part in establishing a child's attitudes to mathematics.

Home Culture

Parental attitudes are said to be the main social influence that children's experience during their early years, forming their beliefs, attitudes and behaviours(Zunich, 1966). Parents and families are recognised as primary educators of children, instilling both a social and intellectual foundation for learning (West et al 1998). This view has continued to be the case through research that has provided clear evidence on the benefits that parental support provides to children's learning, (Cairney, 2000; Fan and Williams, 2010; National Numeracy, 2016; Jay et al, 2018). There is untapped potential in the family as an important encourager or influencer for young people (Macdonald, 2014:6). Parental aspiration has been found to be one of the key determining factors in their children's academic and social development (Mahamood et al, 2012). The adverse attitudes disadvantaged mothers have toward education is said to be an important factor associated with low attainment by the age of eleven (Gorard, See and Davies, 2012). Parental involvement has been found to relate to an improvement in self-efficacy (Fan and Williams, 2010), which has been found to affect motivation (Skaalvik, 2015), a required component of attitudes to mathematics (Tapia and Marsh, 2004). Parental support also provides a sense of confidence to children through feelings of love and support (Coltman and Whitebread, 2008). Confidence, being considered another aspect of attitudes to mathematics is essentially a component that if not achieved through the support of extrinsic factors can lead to maths anxiety (Mayes, Chase and Walker, 2008).

There must also be recognition on how parental involvement becomes more complex when children start school (Jay et al, 2018). This has been echoed through the clear evidence that parental involvement enhances children's learning (Desforges and Abouchaar, 2003; Fan and Williams, 2010). However, attempts to improve pupils' attainment through improving parental involvement appears to be rarely successful (Patall et al, 2008; Gorard and Huat See, 2013) due to the differences in parents' attitudes and abilities (Menheere and Hooge, 2010). More specifically, improving parental support for pupils in mathematics has been found to be more difficult than with other subjects because of the parents' own attitudes towards, achievement in and experiences of mathematics (Peters et al, 2008). However, 79% of teachers reported significant increases in their pupils' concentration during maths as a result of increased parental engagement, with 88% of pupils believing they had improved in their maths (National Numeracy, 2016b). This highlights the importance of programmes, such as 'Family Maths Scrapbooks' accompanied by weekly activities to encourage maths conversations and activities between children and parents/carers, for school years 1 to 4; and free access to the 'National Numeracy Family Maths Toolkit' website (National Numeracy, 2016b:2). Other research has identified consistencies where parental support is positively related to student achievement ("Assessment Matters!" 2013; OECD, 2013).

Whilst family background affects the chances of attaining strong GCSEs, there is further impact on post-16 choices (Payne, 2003). Maltimore (1991) has gone as far as to say that, at times, family background can exert such a powerful influence that is above the influence of the school attended. Furthermore, the importance of feeling secure in the early years of the family home was found to be associated with attaining the confidence needed for the positive self-image (Coltman and Whitebread, 2008) that helps learning. This again highlights the importance of parental influence with children's attitudes to mathematics and maths anxiety, and perhaps shows how a child's attitudes are almost dependent on their parents until a certain age. It is therefore important to explore the effects that parents attitudes to mathematics may have on their children. The shaping of children's attitudes to mathematics is strongly influenced by those at home; ultimately impacting on children's perceptions of subjects, success at school, further education and career choices.

The complexity arises however, when a child enters school (Jay et al, 2018). At this stage, there must also be recognition of the influence of another powerful figure to children, their teacher (Beasley et al, 2001; Beilock et al, 2010). This also shows a need to have a more solid stream of communication between teachers/schools and parents.

School Culture

Teachers exert a powerful influence on students as students' understanding of mathematics is shaped by the pedagogical practices they encounter in school (NCTM, 1989; Kena et al, 2014). It can be argued that experiences of mathematics in the classroom or school environment, what Sun and Pyzdwoski (2009) refer to as the extrinsic factor, are therefore a significant contributor to pupils' attitudes to mathematics. Beasley et al (2001) found from their study that students with high levels of maths anxiety go on to have low grades in their maths tests. In terms of trying to apply such impacts to classroom experience, Beilock et al (2010) focused on the impact in early years schools (ages 5 to 7 years old) when comparing males to females. They found female students were negatively affected by maths anxious, female teachers significantly more than males as children were found to be more likely to emulate the behaviour and attitudes of same-gender adults (Perry and Bussey, 1979; Bussey and Bandura, 1984). This echoes Smith and Hogg's (2008) argument concerning how persuasive messages are more powerful between those sharing a membership within their identity, and may therefore explain why male pupils are not as maths anxious as females as a result of their anxious female teachers. Teachers in STEM who have lower, more stereotypical, expectations of under-represented groups are reinforcing those pupils' non-STEM identities, which pupils are shown to identify with from as early as ten years old (Macdonald, 2014).

The National Council of Teachers of Mathematics asserts that student understanding of mathematics and beliefs about mathematics are shaped by the teaching encountered in school and argues that teachers "exert a powerful influence on students'… and on their ultimate mathematical disposition" (NCTM, 1989, p. 233). Teachers are significant adults in children's lives, and therefore play a critical role in developing children's emotional and educational development (Smith, 2006). The ability of teachers to emotionally connect with their pupils may have an impact on the learning that occurs in the classroom. Positive associations have been identified between teacher and student relationship, engagement (Attard, 2013) and academic achievement (Birch and Ladd, 1997).

Teacher-centred classrooms, where the teacher is the sole leader and implements discipline, rules rewards and consequences (Garrett, 2008), are said to negatively impact student beliefs (Muis 2004) as the mathematical concepts are taught as isolated concepts rather than procedures and processes that are in fact in interconnected (Muis 2004; Salk & Glaessner 1993 in Szydlik 2003). This reduces the responsibility of students (Garrett, 2008) and is particularly problematic when considering the attitudes of teachers and how their anxiety can be transmitted to students (Beilock et al, 2010). Teaching methods are also said to be an impacting factor in contributing to maths anxiety being the consequence of the teaching approach, such as poor instructions (Smith, 2004; Took & Leanord, 1998 and Dodd 1992 in Sun and Pyzdrowski 2009) and negative emotions transferred from teachers (Smith, 2004; Sun and Pyzdrowski 2009; Beilock et al, 2010). There is a common belief that rules must be applied in a specific way and must be remembered in order to teach mathematics (Cornell, 1999 in Jackson, 2005) which lacks creativity (Austin and Wadlington, 1992 in Jackson, 2005). Teachers' methods have been found to work more towards the goal of helping their pupils achieve high grades, which can prevent understanding (Oxford and Anderson, 1995 in Jackson, 2005; Pampaka and Williams, 2016). Additionally, pupils see mathematics as rule-oriented, preventing them from experiencing any richness and the other approaches that can help develop their understanding of the subject (Mensah, Okyere, and Kuranchie, 2013). Whilst this has been argued, there has additionally been recognition of the need for creativity within teaching methods (Worthington, 2006).

Teaching methods can therefore be recognised as an extrinsic factor to a child's attitude to mathematics through the consequences of how they experience mathematics being taught to them. This experience of mathematics can then influence their attitudes to mathematics and shape the establishment of their mathematical dispositions. This is particularly problematic in the context of UK primary schools where less than five percent of primary school teachers in the UK have a mathematical background (Vorderman et al, 2011). There is also the influence of the National Curriculum to consider; where the programmes for KS2 (see footnote[3]) are already set, as are expectations, such as, "By the end of year 4, pupils should have memorised their multiplication tables up to and including the 12 multiplication table and show precision and fluency in their work" (Department for Education, 2013:17). These expectations reflect the teaching methods commonly used, relying on the pupil to retain information through teacher centred approaches, (Jackson, 2005; Sun and Pyzdrowski 2009; Coltman and Whitebread, 2008) where the pupils engage in a passive position by accepting statements from teachers (Tall, 2014),

Teacher behaviour is also an important factor in how pupils relate to them (Brown et al, 2001 in Coe et al, 2014). More specifically, Beilock et al (2010) discuss how pupils can imitate behaviours of their teachers when sharing the same gender and over 90% of female teachers were found to have high levels of maths anxiety. Therefore, teacher influence must be recognised as a factor that could in fact shape attitudes towards mathematics. This example provides an indication that maths anxiety can essentially be passed through teaching. However, this may not be specifically through the teaching of maths, but through the many experiences students can have, that determine how they perceive, when being taught maths. That being said, Beilock et al (2010) importantly acknowledge the many factors that are also likely to affect mathematical achievement and gender ability beliefs, such as parents, peers and siblings. A case study that can apply, is the previously mentioned female pupil in Noyes (2007) possessing a negative learner identity that had been established in primary school, and continuing to receive negative results in secondary school.

[3] UK Key Stage 2 (KS2) refers to pupils between the ages of 7 and 11 years. This includes years: 3, 4, 5 and 6.

Whilst there is a need to discuss teaching methods, teaching would arguably be more successful in more confident teachers. This reflects the success of maths education in countries such as Singapore and China where maths teachers are regarded as specialists (Tall, 2014). Therefore whilst the methods are important, there is also the need for the teacher to be confident in the method they use (Boylan, 2019) highlighting the need to foucs on teacher attitudes. By understanding teachers' attitudes towards mathematics, a link towards their pupils attitudes to mathematics can be established in order to help identify contributing factors. There is said to be little communication between mathematics test developers and the teaching community, causing an impact on teachers' ability to meet the aims of the National Curriculum (ACME, 2016). Teachers can therefore be teaching in the classroom with high levels of maths anxiety, preparing students to take tests to which they have little preparation themselves. This can arguably prove to be a problematic model, and it has already been found in previous research that high levels of teachers' maths anxiety is associated with high levels of students' maths anxiety and low levels of mathematical performance (Beasley et al 2001). A particular danger found by Beilock et al (2010) was that female students were in fact more likely to suffer from maths anxiety by the end of the school year, than their male counterparts, when being taught by teachers with higher levels of maths anxiety.

Another aspect of teacher influence is how pupils feel teachers behaviour towards them may influence them to think there are certain individual expectations to which they must adhere. Rosenthal and Jacobson (1968) discussed the 'Pygmalion Effect', where children's behaviour occurs as a response to the expectations set of them and concluded that a child tends to be more likely to succeed when that is expected of them. Chang (2011) highlights how the 'Pygmalion effect' is also known as the 'Rosenthal effect', due to the study by Rosenthal and Jacobson (1968), which deceived teachers into believing that certain students had been confirmed as high achievers or "bloomers" who were found to achieve more than pupils who were not given such labels. This led to an outcome of 'self-fulfilling prophecy' because of teachers' expectations (Chang, 2011). This links to Labelling theory (Becker, 1963), which has been commonly applied to education; children are labelled (positively and negatively) by teachers based on their stereotyping of pupils' behaviour and the label proves hard to shift. Children can live up to and reinforce their labels or can resist and challenge their labels.

The discussion on home and school culture reflects the importance of parents and teachers; and their role in establishing a child's interpretations of their early experiences of mathematics. This highlights the need for a consistency in how parents and teachers communicate the worth of mathematics to pupils in order to help pupils avoid experiencing maths anxiety. The need to understand how different pupils can be affected by parents and teachers, based on expectancy value and teachers perceptions, is crucial. The complexity is how pupils' attitudes to mathematics is already evident in the extrinsic factors of mathematics anxiety. Relatedly we must consider how such factors may provide different influences to pupils' attitudes depending on the identity of the pupil themselves. In addition, we must also consider how the relationship between a pupils' attitude and the influences of both parents and teachers could also further depend on the school where the educational experiences take place.

The Impact of the School attended

Student understanding of mathematics and confidence in doing mathematics is shaped by the pedagogical practices students encounter in school (Bogdan and Biklen, 2007; Kena et al, 2014). Whilst the National Curriculum requires the set programmes of KS1, 2 and 3 mathematics to be completed by the end of the key stage, there is flexibility for schools to introduce content at times they see appropriate (DfE, 2013). Schools may therefore experience different attitudes in their pupils ,give there are different experiences. OFSTED (2018) argues that pupils prefer 'traditional algorithms' in their learning over other learning methods. This would be strongly countered from education theorists such as Took and Leanord (1998 in Sun and Pyzdrowski 2009) and classical psychologists such as Bruner (Wood, 1998) who argue traditional learning methods limit cognition in pupils as a result of relying on themselves to remember instructions rather than develop an understanding. OFSTED (2018) do however, go on to say that problem solving skills are often more favoured and further add that the National Curriculum does not dictate when schools should teach algorithms, but most schools prefer to teach methods such as column addition and subtraction in year 4 (OFSTED, 2018). An argument can therefore be made that from as early as year 4, pupils learning can be affected by their experiences of being taught.

Furthermore, when considering the application of the role of the teacher and pupils' development, this impacts and differentiates pupils' attitudes towards mathematics which highlights a need for research.

The school a child goes to is often decided by the parent, and some schools tend to be in higher demand than others, typically because of OFSTED inspections over other school performance measures (Hussain, 2016). Furthermore, progression scores found on government sources also indicate that certain schools perform higher in mathematics than others. *The Education (Schools) Act* (1992) created the Office of Her Majesty's Chief Inspector in order to with manage and regulate a national school inspection system (Matthews, 1995). Additionally, OFSTED (Office for Standards in Education) inspect and report the quality of education provided by schools to Secretary of State (Matthews, 1995). *The Education Act* (1993) also provided procedures to improve educational standards for schools identified as 'failing' or 'likely to fail' as a result of the inspection (Matthews, 1995). The intense debate concerning the impact of OFSTED is not new, nor is the considerable media attention (Scanlon, 1999). A particular impact on schools is the value assigned to schools by OFSTED inspections.

Homeowners are believed to receive immediate boosts to the value of their property when a local primary school is awarded a higher rating by OFSTED (Hussain, 2016) as parents are said to use OFSTED ratings as a time saving way of accessing school performance (Pickford, 2016). This is believed to be a more popular method for parents to use rather than the performance measures of exam results (Hussain, 2016). An additional factor Hussain (2016) discusses is the positive effect for properties located near schools serving lower proportions of free school meals, with an approximate increase in value of 1.5% for each unit change in the rating of the school, whilst the effect is close to zero for properties near schools serving higher proportions of free school meals. This finding implies that less advantaged families are either: insensitive to marginal changes in school quality or they are unaware of the ratings (Hussain, 2016). Either way, there is a need to understand the relationship between the percentage of free school meals and attitudes to mathematics (shaped by the school attended).

Variations in student achievement can be explained by the advantages often available from the capital associated with socio-economic background, such as economic capital (Tan, 2015). Associations between improved mathematical ability and provision of resources such as books and discussion of everyday facts have been identified in previous research (Chie and Xishua, 2008). A modern and more macro example of a specific economic capital is given by Hussain (2016), who identified a significant relationship between house prices and OFSTED inspection rating, when controlling house type, where an increase in one unit of the rating given was associated with an estimate of 0.5% increase in house price. There is therefore an expectation that schools with higher OFSTED ratings would have pupils from families with more economic capital. This not only provides an example of socio-economic background providing an advantage (Tan, 2015), but also provides an indication that attitudes to mathematics could also differ. If attitudes are influenced through experiences within schools, then there could be a difference in attitudes based on the school attended through the differences in schools' pupil socio-economic background and the associated identities, including ethnicity (Payne, 2003) and gender (Mutodi and Ngirande, 2014), which could be further affected by parental expectations (Eccles, 1993).

Another important factor regarding the effects of OFSTED and school league tables is the influence on school agendas. Schools lower in the League Tables, and often consisting of more working class children, are under more pressure to increase their league table position and focusing rigorously on reading, writing and arithmetic (Reay, 2017). The increasing pressure on schools to perform well, can only accompany a pressure to teach content and more so in a certain way, reducing creativity (Jackson, 2005). Reay (2017) also makes the case that the competitive culture of the English schooling system, operates whilst denying the international evidence that collective and collaborative systems and pedagogies are more effective in improving educational outcomes and experiences for all (Jones, 2019). This added pressure also contributes to anxiety and with subjects like mathematics, is arguably a reason for maths anxiety in teachers, which is already evident to be higher in female teachers (Beilock et al, 2010). Greater transparency and communication between test developers and the mathematics teaching community could become a positive influence on achieving the National Curriculum's aims (ACME 2016). The aims of the national curriculum are: "to become fluent in the fundamentals of mathematics", "reason mathematically by following a line of enquiry" and to "solve problems by applying mathematics to a variety of routine and non-routine problems with increasing sophistication" (Department for Education, 2014:online).

Maths and Identity

Linking Extrinsic Factors to Intrinsic Factors

Whilst discussing Maths Anxiety as an impact of poor mathematical experiences within education and the home, there is also a need to discuss poor mathematical experiences that can be linked to the individual. Eccles' (1993) expectancy value theory focuses on how the identity of an individual can associate with not just the teacher, but also the teacher's and parent's perception of a child's ability. An example of stereotypes can be the perception of boys being expected to succeed more in mathematics whilst girls are expected to do better in English (Beilock et al, 2010). This is not an uncommon stereotype in the UK (Department for Education and Skills, 2007). This can affect a child's first few experiences of mathematics by how the outcome of their participation in mathematics is both rewarded, reacted to, and ultimately, valued. Both teachers and parents also share this common cultural perception (Hyde et al 1990; Boaler, 2004; Mendick 2005), which is why Eccles (1993) argues that this can influence the child's perceived ability and how they approach and value the subject, affecting the outcome of their participation. This common example promotes the view that girls are not expected to do as well boys in mathematics (Hargreaves et al, 2008) and can result in girls not doing as well as they may be able to: a self-fulfilling prophecy (Hall and Hoff, 1988; Beilock et al, 2010).

Optimal Distinctiveness Theory (Brewer 1991; Leonardelli, Pickett & Brewer 2010 in Gray 2014) discusses how individuals work towards the satisfaction of their own social identity by either differentiation or assimilation. Moreover, these needs serve as driving forces behind the attitudes people adopt and enact, and are therefore likely to also be present in achievement contexts (Gray 2014). The significance of needing to stand out and/or fit in motivates students in the classroom. Gray (2014) found from researching STEM-focused student attitudes, that motivation for tasks was associated with tasks differentiation where they stand out (positively) and tasks assimilation where they 'fit in' with their classmates.

These two theories provide grounds to argue that people associate mathematical abilities with a sense of identity. Therefore those who are not traditionally expected to succeed in mathematics may also develop a sense of self that does not value success in mathematics because it is simply not who they are. In other words, they share what is known as a non-STEM identity (Macdonald, 2014). Attitudes are grounded in social consensus defined by group membership (Smith and Hogg, 2008). Identity can therefore be reinforced through the behaviour of others (Eccles, 1990; Brewer, 1991; Gray, 2014) and the notion of a non-STEM identity can be reinforced and shared with others associating with the same identity. Williams et al (2008) found in their study of social science undergraduates that the majority had attitudes categorising the quantitative aspect of research methods to be more 'difficult', and in addition, those who regarded quantitative methods more 'difficult' were three times more likely to fail in research methods modules. These findings are not new and have been identified in previous research (Rice et al., 2001; Townsend and Wilton, 2003), with a key finding being that students were uninterested in quantitative methodology because they saw themselves as 'non-mathematical persons' (Williams et al, 2008: 1007). This further reflects the notion of polarised learning cultures between 'scientific and intellectual' learners (Snow, 1959). Our learner identity is established by our dispositions (Wenger, 1998) and attitudes are the result of us working towards our identity (Smith and Hogg, 2008). By succeeding, or not succeeding, in the subjects they are expected to, students actively build their identity through the succeeding in tasks that they do value, and more so to work toward their identity for the purpose of differentiation or assimilation. If mathematics is therefore effective in building learner identity, the theories that discuss how this happens must be acknowledged when attempting to understand how these effects can be changed or developed for students to progress, rather than regress.

Gender

Mutodi and Ngirande (2014) discuss the mixture of results in recent research where some have found a relationship between gender and Maths Anxiety (Bidin et al 2003; Woodard 2004; Sahin 2008 in Karimi and Venkatesan, 2009) and others have found no relationship (Marsh 2004; Stevens 2013 in Mutodi and Ngirande, 2014). Of those that have found a relationship, Beilock et al (2010) and Mutodi and Ngirande (2014) highlight the consistency in their research, which found females experience Maths Anxiety more than males. The significance of this is highlighted in the under-representation of females in STEM related careers (Macdonald, 2014; Mcmaster, 2017) accounting for approximately 5.7% of the population of engineering professionals and declining by 10% since 2012 in engineering technicians (WISE, 2015). Dowker, Bennet and Smith (2012) also found that females' confidence in self-rating their mathematical abilities also decreases as they progress from years 3 to 5, whilst there was no significant change in the boys' self-rating. Furthermore, whilst the females' self-rating decreased, their actual basic number skills test scores increased. This provides an interesting finding that reveals females' levels of confidence does not necessarily increase along with their ability. There is also concern regarding the difference in the value of mathematics in relation to gender, with a wealth of evidence suggesting differences in value (Eccles 1994; Eccles et al, 1983; Parsons et al 1984; Wigfield and Eccles, 1992; Beilock et al 2010), which go on to impact choice, engagement and performance (Meece et al, 2006). Macdonald (2014) and McMaster (2017) highlight how the under-representation of women in STEM may be related to females not associating their identity as 'STEM', similarly to how Williams et al (2008) discusses the notion that people can see themselves as 'non-mathematical'.

The difference in findings between those who have or have not identified a relationship between gender and attitudes to mathematics highlight that there may not necessarily be an obvious gender difference in mathematical abilities. There is an emerging view that social aspects provide better explanations to performance differences (Hargreaves et al, 2008). Whilst researchers have recognised that focusing on gender as a single analytical category leads to methodological limitations, there has still been a lack of recognition in the intersectionality of factors associated with identity that includes gender (McCall, 2005). Research with early years practitioners has identified, that gender was not an issue in their setting and they tended to focus on pupils as individuals (Chapman, 2016) and that children still develop gender identities with or without the interventions of their educators (MacNaughton, 1998 in Chapman, 2016). Gender however may be an issue with some practitioners and not with others, as evidence has identified gender expectations from the view of practitioners (McCall, 2005). Parental value additionally contributes to the formation of gendered learning identities (Eccles, 1993), and this again does not exclusively concern gender but also issues of class (Becker, 1963; Willis, 1978) and ethnicity (Payne, 2003). This poses the methodological challenges of capturing the complex nature of identities and their social influences (McCall, 2005). The same challenge is presented in this study, where gender, ethnicity and social class would be expected to overlap with one another in order to develop different aspects of learner identity, some of which will consist of poor attitudes to mathematics. This study will therefore aim to consider how gender affects attitudes whilst acknowledging that any relationships as such would differ when considering other aspects of identity.

In terms of the difference in attainment between males and females, the Department for Education (2016a) published SATs scores, which are the first for the new curriculum which was introduced in 2014, showing that girls outperform boys in every subject except mathematics.

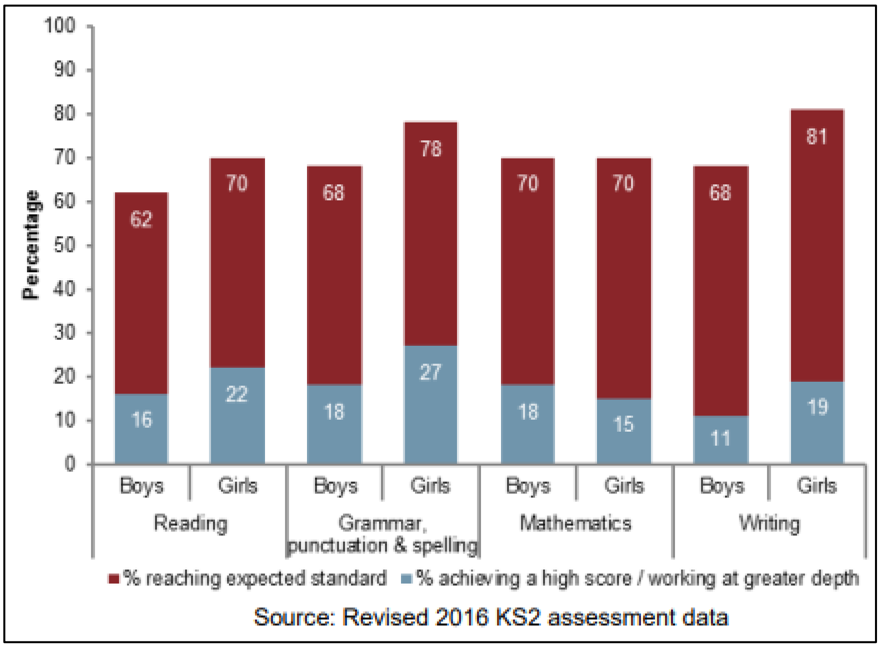


Figure 1: Attainment by Subject and Gender from Department for Education (2016a:16)

It was found that exactly 70% of both genders performed to the expected standard. This was the highest percentage for boys whilst being the joint lowest for girls (Department for Education 2016a). For the other three subjects, Reading, Writing, and Grammar, punctuation and spelling, a higher percentage of girls were reaching the expected standard of ability than boys. Therefore, the only subject females were not exceeding males in was mathematics. Breda and Napp (2019) identified a potential reason being that females of this age have natural advantages in reading than their male counterparts. This, coinciding with the consistently in research finding females with higher levels of maths anxiety, displays a need to understand why there is a difference in attitudes towards mathematics between males and females already at 9 or 10 years old.

The idea of a natural advantage in reading and writing that Breda and Napp (2019) suggest however, poses problems. This is because of the wealth of evidence that discusses the social construction of gender at an early age, including the influence of parents (Eccles, 1993; 1994). Play, for example, has been regarded an important aspect of children's social development (Mahamood et al, 2012) and play can be gendered from as young as two years old (Our Watch, 2018; Rafferty, 2018). Therefore, before the educational experiences begin, children may already be subjected to gender stereotypical forms of play, and females have been found between the ages of two and three to show a desire for toys that are socially associated with their gender (Our Watch, 2018). An example would be the common acceptance for female children to be rather intellectually challenged than physically, with the opposite being said for their male counterparts, with the expectation that young boys are expected to rely on space-using games, such as football. (Chapman, 2016). This natural advantage in reading is therefore arguably the cause of gendered learning before school contexts, which can only develop more through the expectations and influence of early years practitioners (Wingrave, 2016). This nevertheless provides an opportunity to investigate the relationship between gender and attitudes to mathematics, based on the theory that gender stereotypes within the realms of academic success stem from earlier years (McCall, 2005; Rafferty, 2018) and often associates success in mathematics with males (Noyes, 2007; Beilock, 2010; Macdonald, 2014).

Ethnicity

The Department for Education (DfE 2003) produced a report which aimed to address the underperformance of ethnic minority pupils in UK schools, whilst further acknowledging that Indian and Chinese students achieve better than average in exams unlike Pakistani and Black (British, African and Caribbean) pupils who do worse. The DfE (2006) expresses the importance in the curriculum of options that reflect the experiences of pupils and their identity and culture in order to be inclusive. In order to engage students from ethnic minorities in any subject, there must be options that reflect their culture.

A possible explanation behind why certain ethnic minorities perform less well than the average could be that they are more likely to live in disadvantaged areas. If this is indeed the case then whilst there may be an issue of culture, there may also be an issue of class. However, previous research (Mirza 1992; Basit 1997; Leslie and Drinkwater 1999 in Payne 2003) indicates that ethnic minorities are more likely to have positive attitudes to education for reasons related to social mobility and the concern for higher chances of unemployment.

Cline et al (2002) highlight the increasing gap that was found between black and white pupils that increases from KS2 to KS3; and further through to GCSE. Black pupils were found to underperform throughout the curriculum. However, more recent statistics show that since 2010, black pupils have improved in both primary school tests and GCSEs, more than any other ethnic group. The DfE (2014) suggest the reasons being the acceleration of academies running schools in more disadvantaged areas, the introduction of the English Baccalaureate that has encouraged schools to enter thousands of pupils into key academic subjects, and the Pupil Premium, which provides schools with extra money to improve the performance of the poorest pupils. Another explanation in a report published by the DfE (2015) explains the importance of parental, student and school factors in explaining why ethnic minority pupils from disadvantaged backgrounds have shown higher levels of educational attainment than their white counterparts. A related factor in the same report, points out another factor, which is students' own aspirations, that encourage students to engage with schooling which can be reflected by behaviours such as completing homework when asked. If parental factors provide an advantage to ethnic minority children in less privileged areas, then the notion of culture or primary socialisation may be a factor in affecting attitudes to education, and possibly attitudes to mathematics.

Cline et al (2002) found the difficulty in assessing the differences in educational attainment between different ethnicities was due to the complications in measuring ethnic background. It was found that when researching mainly white schools, which are defined through having only 4-6% of pupils who are ethnic minorities, there was a further challenge of researching the particular field with such small numbers of participants. Furthermore, when trying to use data from either schools or LEAs, there was said to be uncertainty in how ethnic background was recorded (Cline et al 2002). In order to assess the differences, a reliable measurement and sample is needed to infer any conclusion.

What Cline et al (2002) did find with reliable evidence, was that white children in white schools over performed their counterparts in more diverse schools at the end of KS2 in their SATs. They found from interviewing a mixture of pupils, that ethnicity was a core part of students' 'self-identification' in school, with a mixture of desire to express that identification with others.

The DfE (2015) concluded that whilst there was limited evidence of effective practice, factors such as parents, students and schools all contribute to raising attainment, more initiatives should be available to address these factors.

When focusing particularly on mathematics, research suggests BME students are more likely to have positive attitudes towards mathematics than White pupils (NAO, 2018). The reasons behind this are found to relate to parental background and culture rather than specifically ethnicity (Maltimore, 1991; Strand, 2011). For example, BME pupils have also been found to be more likely to choose STEM subjects with parental attitudes tending to be more favourable in these groups with more focus on the outcomes of studying STEM, such as social mobility (Strand, 2011; Mcmaster, 2017). However, such arguments were made with a sample of year 7 and 8 as opposed to primary schools. However, another interesting factor from the same study was that year 8 pupils were much more likely to find maths difficult and less likely to find it enjoyable than year 7 pupils within the same sample. Such evidence indicates a steep change in the mathematics curriculum, be it content, teaching and/or assessment. Whilst ethnicity is an important factor to consider in how attitudes may differ, and is a factor we know is measurable (Rees et al, 2008); family background and culture is arguably the driving factor and should be recognised where possible. Therefore, further study into the early years is of utmost importance, to identify if there is another point where such a steep change could be identified.

Socio-Economic Status

When discussing the socio-cultural factors that may in fact be associated with attitudes to mathematics, an important factor that may in fact explain the relationship between other factors is socio-economic status (SES). Previous studies have found little difference when measuring factors such as ethnicity, with the difference being explained by SES (Signer et al, 1995).

SES can have a particular impact on a child as it can strongly determine the type of school they attend. The DfE's (2017) study on the link between house prices and quality of schools found that there was a clear link between the price paid for a home and access to 'good schools', with an estimate of £18600 more than the average house price for a house in a catchment area near the best performing primary schools. A strong determining factor of socio-economic status is parental income. Those with higher incomes are more likely to be able to access housing in areas of higher demand and a determining factor for that demand is schools. Furthermore, higher levels of attainment in schools within areas of higher house prices were found to be associated with the high achieving pupils attending coming from higher income families (DfE, 2017), who are therefore more likely to succeed than children from poorer families.

Socio Economic Status can also affect attitudes due to the influence of parents and families, with lower income families being less aware of the career choices available with STEM skills, and more inclined to non-STEM identities due to their own experiences and perceptions (Macdonald, 2014). Goodman and Gregg's review (2010) found an increase in mothers hoping their child will got to university as their socio-economic position increased.

Students with parents in working class occupations are less likely to choose to study STEM subjects further, which has also been explained by parents' prior attainment (Mcmaster, 2017). This concerns both the parents' own mathematical experiences and successes, which then may influence their expectations of their child (Eccles, 1993). This further affects the child's concentration in mathematics (National, Numeracy, 2016) and further reinforces their non-STEM identity (Macdonald, 2014). Lacking that mathematics identity would then therefore affect the likelihood of attaining enjoyment, confidence value and motivation, which Tapia and Marsh (2004) argue are required to attain positive attitudes to mathematics. This then goes on to impact on subject and career choices (Archer et al, 2013; Marshall et al, 2016) and contributes to the shortage in STEM graduates (Wilson, 2009; UK Commission for Employment and Skills, 2013; 2015).

External Influences of Attitudes to Mathematics: Identifying the Variables for the Research Methodology

The Cumulative Role of Parents, Teachers and Schools

More positive experiences of mathematics could lead to more positive mathematical dispositions and improve attitudes to mathematics (Damon, 2007; National Numeracy, 2016). The discussion on extrinsic factors highlights the complexity in how children's attitudes to mathematics are established. There is, however, a further need to recognise how the extrinsic factors can collaboratively establish attitudes and how certain extrinsic factors can support other intrinsic factors. The primary socialisation of the pupil and parental influence is found to be a strong influence (Eccles, 1993; Desforges and Abouchaar, 2003; Fan and Williams, 2010) and each pupil has their own parental influence (Patall et al, 2008; Gorard and Huat See, 2013). Furthermore, this becomes more complex when entering school due to the differences in parents' attitudes and abilities (Menheere and Hooge, 2010; Jay et al, 2018) whilst sharing the same teacher influence (Beasley et al, 2001; Jackson, 2005; Sun and Pyzdrowski, 2009; Beilock et al, 2010).

Gender, Ethnicity, Culture, and even Class, can be factors that all collaboratively contribute to how both parents and teachers expect pupils to perform in particular subjects. Therefore the child themselves may feel a sense of identity when it comes to their learning, which would then affect how they value certain subjects, and ultimately how they perform in those subjects.

Whilst this research did not capture the views of parents, due to issues with accessibility, it did capture how pupils perceived the support they received from parents with mathematics homework, as evidence highlights the positive impact that parental support provides to children's learning, (Cairney, 2000; Fan and Williams, 2010; National Numeracy, 2016; Jay et al, 2018). Parental attitudes must therefore be considered factors that can externally influence pupils' attitudes, whilst still being recognised as influences to individual pupils rather than a group of pupils, unlike teachers.

The influence of teachers is an important factor to consider in the development of attitudes to mathematics. Theories such as the 'Pygmalion effect' (Rosenthal and Jacobson, 1968) and labelling theory (Becker, 1963) can be applied and studies such as Beilock et al (2010) mirror the arguments made from those theories with evidence suggesting female teachers with high levels of maths anxiety are associated with high levels of maths anxiety in female pupils.

The confidence of a teacher has been argued to be a stronger factor than the teaching method (Boylan, 2019) and the importance of student-teacher interaction has already been evidenced (Willis, 1978; Birch and Ladd, 1997; Coe et al, 2014). Furthermore, the need for more creativity within teaching methods has been previously highlighted (Worthington, 2006). However, this need for creativity has been overshadowed by the emphasis on outcomes and grades. For example, there is a known commitment to improve grades because of the national drive to improve the standards of STEM education, which primarily concerns helping pupils score high grades rather than considering classroom reform (Pampaka et al, 2012). These pressures are additionally reinforced through measures such as school league tables (Siraj and Taggart, 2014). Such pressures would therefore be expected to differ amongst schools under different pressure depending on their average grades. This complex framework therefore needs unpacking and there must be a discussion on how pupils share very different influences from different extrinsic factors that cluster pupils in very different ways.

Schools are additionally a factor that must be considered influential variables of pupils' attitudes to mathematics. The school a child attends could influence their grades, and attitudes to mathematics have previously been linked to academic success (Beasley et al, 2001; Beilock et al, 2010; Marshall et al, 2016; Mayes, Chase and Walker, 2008). There must therefore be an identification as to whether the school a pupil attends affects their attitudes to mathematics.

Putting it all together: Introducing the Conceptual Framework, A2M

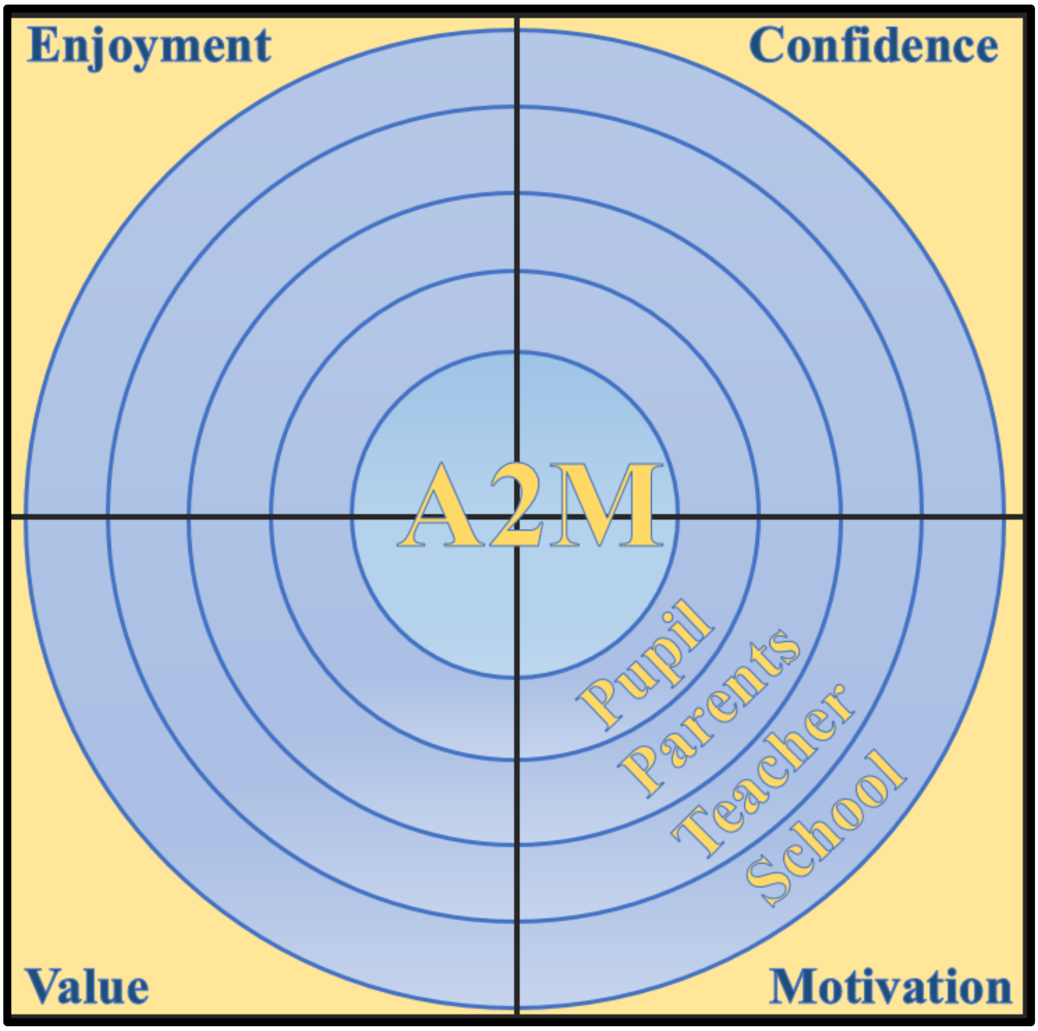


Figure 2: Pupils' Attitudes to Mathematics (A2M) Model

Figure 2 aims to provide a visual aid for the discussion of the various influences on attitudes to mathematics. This captures how attitudes to mathematics are influenced through various factors that fall within a system of hierarchal clustering and impact the balance of Tapia and Marsh's (2004) four components: Enjoyment, Confidence, Value and Motivation.

This framework, whilst focusing on the four components of attitudes, recognises that attitudes are distinct outcomes of dispositions, whilst identity is the outcome of attitudes. Furthermore, some of the components are more related to the outcome of a disposition whilst others are more likely to influence identity. For example, negative mathematical dispositions, formed by negative experiences, may go on to affect aspects such as confidence and motivation, whilst enjoyment and value may be elicited as a result of affirming a sense of identity. This research therefore recognises that whilst there are four components to an attitude to mathematics, there are other key concepts that must still be considered. This theoretical framework aims to focus on the components of attitudes that can be measured. Therefore, whilst dispositions and identity have influenced the decision to use this theoretical framework, they are not included due to the issue of measurement, which will be discuss in further detail in the methodology section.

The surrounding circles are developed through the literature review's discussion of the extrinsic factors that influences attitudes to mathematics. This concerns the perception of parental help from the pupil and whether they believe they do mathematics at home; the teachers' perceptions; and school characteristics. The overall model was influenced by theories such as Brewer's Optimal Distinctiveness theory (in Gray, 2014), which concerns factors resembling the individuals' identity and how they work towards that identity. An example would be someone who believes they are good at maths and therefore is more confident, which we would to have a more positive attitude to mathematics than someone who is not confident. The confidence would therefore act as a variable that influences attitudes to mathematics, and shows how our learner identities establish our attitudes (Macdonald, 2014).

There is additionally Eccles' Expectancy Value Theory (1993), which concerns the parental influence and is dependent on the parents' identity and the resulting identity of their child. A common example would be gender and how females may work towards a non-STEM identity (Macdonald, 2014) based on the perception that they may not be expected to succeed in mathematics as much as males and therefore do not have as positive attitudes as males (Perry and Bussey, 1979; Bussey and Bandura, 1984; Beilock et al, 2010; Mutodi and Ngirande, 2014). Ethnicity, a strong aspect in constructing a pupil's identity (Regmi, 2003; DfE, 2006), could be an additional factor that may influence attitudes to mathematics whilst also influencing how gender affects attitudes to mathematics (Mirza 1992; Basit 1997; Leslie and Drinkwater 1999 in Payne 2003). Interactions such as this have been identified in previous research (Lockheed et al, 1985) and are argued to an more important factor in attitudes to maths(Nunes et al, 2009).

The first surrounding circle resembles the factors associated with the pupil’s identity (Brewer 1991 in Gray, 2014), such as gender and ethnicity that ultimately contributes to dispositions through the recognition of how their experiences of mathematics are impacted by their perception of and their working towards their identity.

The second surrounding circle resembles the primary socialisation support system to the individual that impacts their identity. This concerns parental attitudes (Eccles, 1993), which are ultimately dependent on their own mathematical dispositions that are determined by the same factors. This support structure is important when considering how they relate and influence the effects of the pupil’s identity and differ through factors such as socio-economic status (Goodman and Gregg, 2010).

The third surrounding circle, highlights the support available to parents, and pupils respectively, through recognition of clustering. Children are clustered according to their parents, which are then clustered further according to the teacher. The teacher can therefore affect how the primary socialisation can support the factors associating with attitudes to mathematics through teacher-parent communication.

The fourth surrounding circle highlights the clustering nature of schools. Therefore pupils and their parents are clustered by teachers, who are further clustered by schools. Schools therefore hold an influence on pupils’ attitudes to mathematics, based on how they expect teachers to teach the mathematics set in the curriculum with the flexibility allowed, which may also differ based on resources available to the school along with the characteristics of the school based on the area situated and therefore the pupils attended.

The complexity in the system of factors that influence pupils’ attitudes is highlighted in how certain factors are subject to clustering by other factors. For example, a range of pupils are subjected to the particular effect of a factor when sharing the same teacher (Steele, 2008). The same issue can be applied with teachers as they are clustered according to the school they are teaching in. Therefore, the influences pupils can be subjected to can differ in a number of ways. For example, pupils may be influenced differently when taught by a confident teacher in a lower than average performing school, in comparison to a teacher who lacks confidence in a lower than average performing school or higher performing school. There are number of different influences that can occur, which further highlights the complexity of this issue. Whilst previous research has identified issues such as identity (Beasley et al, 2001), parental support (Fan and Williams, 2010), teacher perceptions

(Beilock et al, 2010) and the impact of the school (Kena et al, 2014) there is a need for a study that looks at all influential factors holistically. Previous studies have also identified the need to use data analysis models that address what would be known as hierarchal clustering. Failing to recognise the hierarchal structure of these factors would lead to significantly underestimating the standard errors of predictions (De Leeuw and Meijer, 2008) and providing inaccurate predictions of how influential clustering factors are. It is therefore of high importance not to ignore hierarchal clustering within data, and studies on educational data with hierarchal clustering have provided evidence that Multilevel Modelling can be used to provide more robust predictions of particular influences (Ruiz, 2015). Based on the theory discussed, this study will apply a Multilevel Model to accurately assess the influence factors such as teacher views and school characteristics, whilst additionally considering the influence of variables associated with pupils, in order to provide a reliable contribution to the identification of influences to pupils' attitudes to mathematics amongst children as young as eight years old.

Conclusion: The Need for Identifying a System of Factors Associated with Attitudes to Mathematics

Being numerate has long been recognised as an important part in being a productive and participative citizen in a mature democracy (Miller, 2012) and those who are healthy and able, are equally capable of becoming numerate (NCTM, 2000). The need for the UK to improve its numeracy skills is higher than ever in the current economic climate (National Numeracy, 2019c). The discussion of maths anxiety and mathematical dispositions highlights the negative impact of failing to attain positive attitudes to mathematics. Expectancy value theory (Eccles, 1993) however, highlights how experiences of mathematics are predetermined by the pupils' experiences of both mathematical tasks and the reactions of parents and teachers. These factors also resemble how a pupils' identity establishes their attitudes (Smith and Hogg, 2008), meaning a pupils' learner identity does not just rely on their gender and ethnicity, but also experiences with parents and teachers, which are further dependent on the attitudes and experiences of those parents and teachers, which establish their own attitudes (Eccles, 1993). There must also be consideration of how the school a child attends and a teacher teaches. There are multiple external factors beyond a pupil's control that can affect how a pupil's attitudes to mathematics, or any subject. There is therefore a need to identify these multiple factors simultaneously to capture the complexity of how attitudes to mathematics are established, which could additionally reflect how they have been continuously established for a significant length of time (Whelan, 2009).

The school a child attends, can affect the pupil through the pressures set externally by governing bodies such as OSFTED (Jackson, 2005; Reay, 2017) and there is already evidence to suggest that schools in wealthier areas produce have higher OFSTED inspection ratings, which suggests they are more successful in teaching (Hussain, 2016). The teacher a pupil is taught by can affect the pupil through their own attitudes to mathematics(Smith, 2006; Beilock et al, 2010; Coe et al, 2014; Jones, 2019), which could be further affected by the school where they teach (Bogdan & Biklen, 2007; Kena et al, 2014). The parent of the pupil, can affect the pupil through their own attitudes and experiences of maths along with their own expectations of how well their child succeed in maths Scarpello, 2007; Tomasetto, Alparone and Cadinu, 2011; Gorard, See and Davies, 2012), which could also be further predetermined by their experiences that have shaped their beliefs and attitudes (Eccles, 1990). The identity and perceptions of the pupil can affect the pupil through their own beliefs, which may be the result of previous mathematical experiences and their own expectations, which are influenced externally from others (Chang, 2011; Rosenthal and Jackobson, 1968).

Attitudes to mathematics need to change (National Numeracy, 2016a). However, the complexity in how a pupil's attitude to mathematics can be influenced highlights the need for a lengthier process in trying to understand how attitudes can be changed. Furthermore, the nature in how mathematical dispositions are established reflects a cyclical process that reaffirms the attitudes established (Carey et al, 2019). A particular concept that captures these negative attitudes is the sense of a non-STEM identity (Macdonald, 2014). This identity has arguably been a shared identity amongst many UK pupils and students who actively avoid maths related subjects post-16 (Hillman, 2014; Marshall et al, 2016). Poor experiences of mathematics lead to poor mathematical positions and poor attitudes to mathematics, which have further negative impacts in later life. In order to change this cycle, recognition of where in the educational journey the cycle begins is needed in order to move forward in answering the question that concerns how and where attitudes to mathematics are influenced and more importantly, where those influences are negative. Evidence shows attitudes can differ from as young as ten years old (Macdonald, 2014). However, influences from teachers are evidenced to occur with pupils from at least five years old (Beilock et al, 2010). Based on the theory discussed, attitudes to mathematics may differ amongst pupils as young as 8 years old (year 4) where they already have a range of experiences with mathematics and other subjects that are arguably enough to establish their ability and recognise the identity associated with that ability. This may be enough to establish how they feel towards mathematics, and therefore be enough to identify the differences in attitudes amongst those feelings.

In order to build an understanding, an identification of associated factors must be found in order to explain what may or may not affect certain mathematical attitudes. That identification then provides an opportunity to further understand why such attitudes are associated. By attaining that understanding, can reasonable propositions be made to change the negative attitudes. By making those changes, we can reasonably expect a change in choosing mathematical subjects as attitudes to maths improve (National Numeracy, 2016a; Marshall et al, 2016). If attitudes to maths improve and result in more students selecting maths related subjects after the age of 16, the chances of producing STEM graduates can also increase. However, this cannot be expected to occur without recognising where negative attitudes are being established and understanding how those changes can be made.

Identification of negative attitudes to mathematics have been recognised through the division of literary and scientific intellectuals (Snow, 1959) which has occurred long history and is still present (Whelan, 2009). Furthermore, the recognition of non-STEM identities (Macdonald, 2014) highlights the complexity in individuals who regard mathematics as something that can or cannot be done rather than a skill that can be developed (National Numeracy, 2016a). Innumeracy is something that has become culturally acceptable (Kowsun, 2008, in National Numeracy, 2016a), Epstein et al, 2010; Royal Society, 2019) or even something of which to be proud (Sharp, 2017). Evidence has identified that attitudes can be established in children from as young as nine years old (Bloom, 2008). Furthermore, aspects of traditional learning have been favoured in KS2 (OFSTED, 2018), where pupils are eight or nine years old. Attitudes have been found to differ from as young as ten years old (Macdonald, 2014), meaning an identification of factors that influence attitudes is needed in Key Stage 2 year 4 in order to discover if attitudes can differ from even younger ages, when they are evidentially established.

The UK is a nation that has a strong non-STEM identity given its national bias towards literacy (Nuffield Foundation, 2010). This is why there is a shortage of STEM related skills (Wilson, 2009; UK Commission for Employment and Skills, 2013; 2015) potentially affecting graduates' prospects for future employment (Noyes, 2007) and risking the UK's future economic growth (Macdonald, 2014; National Audit Office, 2018).

Whilst the issues caused by negative attitudes to mathematics are well known and there is a demand for attitudes to change, there is a lack of identification of how attitudes to mathematics can be established and at what point in the education life cycle this causes negative impact. This literature review aimed to capture how attitudes to mathematics are established and provide justification for the need to identify the external factors that contribute to the establishment of young pupils' attitudes. This research aims to make the first step towards understanding how attitudes to mathematics are established by concerning the many external influences beyond the pupil's control, as opposed to the style of teaching, or psychological factors associated with the pupil. Whilst this literature review has discussed evidence concerning establishing and exhibiting attitudes, along with what is needed for positive attitudes to mathematics, it also focused on the more social factors that are equally important when discussing how our attitudes can be influenced and established and contribute to our learner identity. The need for this understanding is evident in the need for attitudes to be changed. However, an understanding begins with an identification. This research aims to make that identification.

Chapter 2: Research Questions

Pupils' Attitudes

Research Question 1: *Can we use questionnaires to reliably measure pupils' Attitudes to Mathematics?*

Null Hypothesis 1a: The 17-item scale measuring "Behavioural Attitudes to Mathematics" is not a reliable measure of pupils' attitudes to mathematics.

Aim: To produce a reliable measure of attitudes to mathematics that focuses on behavioural aspects.

Objective: Using a Cronbach's Alpha test meeting the aim through analysing the internal consistency of the measure with the research sample.

Null Hypothesis 1b: The 6-item scale measuring "Emotional Attitudes to Mathematics" is not a reliable measure of pupils' attitudes to mathematics.

Aim: To produce a reliable measure of attitudes to mathematics that focuses on emotional aspects.

Objective: Using a Cronbach's Alpha test meeting the aim through analysing the internal consistency of the measure with the research sample.

Pupil Characteristics

Research Question 2: *Do pupil Characteristics influence pupils' Attitudes to Mathematics?*

Null Hypothesis 2a: There is no significant difference in attitudes to mathematics between male and female pupils' attitudes to mathematics.

Aim: To produce evidence that suggests pupils' attitudes to mathematics differs based on their gender.

Objective: Using bivariate analysis (*t*-Test) to test for difference in the average "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores between male and female pupils.

Null Hypothesis 2b: There is no significant difference in attitudes to mathematics between white and BME pupils' attitudes to mathematics.

Aim: To produce evidence that rejects the null hypothesis and contributes to the ongoing discussion concerning the difference in abilities in maths when concerning Ethnicity.

Objective: Using bivariate analysis (*t*-Test) to test for difference in the average "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores between white and BME pupils.

Null Hypothesis 2c: There is no significant difference in attitudes to mathematics between pupils who elicit confidence in mathematics and pupils who do not.

Aim: To identify and produce evidence that suggests those who agree they are good at maths have more positive attitudes to mathematics than those who do not agree.

Objective: Using bivariate analysis (*t*-Test) to test for difference in average "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores between those who indicate they are good at maths and those who do not.

Null Hypothesis 2d: There is no significant difference in attitudes to mathematics between pupils who value mathematics as their favourite subject and pupils who do not.

Aim: To identify and produce evidence to suggest that those who indicate to ben mathematic as their favourite subject will have more positive attitudes to mathematics than those who do not.

Objective: Using Bivariate analysis (*t*-Test for BAM; Mann-Whitney for EAM) to identify whether the average attitudinal score differed between pupils who indicated and did not indicate mathematics to be their favourite subject.

Null Hypothesis 2e: There is no significant difference in attitudes to mathematics between those who elicit motivation (agree to do maths at home) and those who do not.

Aim: To identify and provide evidence to suggest that those who agree to doing maths at home will have significantly more positive attitudes than those who disagree.

Objective: Using Bivariate Analysis (*t*-Test for BAM; Mann-Whitney for EAM) to identify if the average attitudinal score differs between those who agree and disagree that they do maths at home.

Null Hypothesis 2f: There is no significant difference in attitudes to mathematics between pupils who indicate they receive parental support and pupils who do not.

Aim: To identify and produce evidence to suggest that pupils who believe they receive help from parents with mathematics homework will have more positive attitudes than those who do not.

Objective: Using Bivariate analysis (*t*-Test) to identify if those who agree that their parents help with mathematics homework have significantly more positive attitudinal scores than those who disagree.

Null Hypothesis 2g: Gender Ability Beliefs will not influence pupils' attitudes to mathematics.

Aim: To identify and produce evidence that suggests those with more stereotypical gender ability beliefs (male good at maths, females good at reading) have more positive attitudes towards mathematics.

Objective: Using bivariate analysis (ANOVA) to test for difference in average "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores between three different types of gender ability beliefs.

Teacher Characteristics

Research Question 3: *Do Teacher Characteristics influence pupils' Attitudes to Mathematics?*

Null Hypothesis 3a: There is no relationship between Teachers' Maths Anxiety score and pupils' attitudes to mathematics scores.

Aim: To identify and produce evidence that contributes to the discussion concerning teachers' maths anxiety and its effect on pupils' attitudes.

Objective: Using a Spearman's Rho correlation to test for a relationship between Teachers' Maths Anxiety scores and pupils' attitudes to mathematics.

Null Hypothesis 3b: There is no relationship between Teachers' Emotional Attitudes to Mathematics and pupils' attitudes to mathematics.

Aim: To identify and produce evidence to suggest that teachers' attitudes to mathematics influence pupils' attitudes to mathematics..

Objective: Using a Spearman's Rho correlation to test for relationship between Teachers' Emotional Attitudes and Pupil Attitudes.

Null Hypothesis 3c: There is no significant between pupils' attitudes to mathematics based on the confidence and motivation of their teacher.

Aim: To identify and produce evidence to suggest that techers' self-confidence, confidence in teaching, and motivation influence pupils' attitudes to mathematics.

Objective: Using a series of bivariate analysis to test for difference in pupils' attitudes according to their teachers responses to statements regarding confidence and motivation.

School Characteristics

Research Question 4: *Does the school attended influence pupils' Attitudes to Mathematics?*

Null Hypothesis 4a: The variation in pupils' attitudes to mathematics will not be explained by the school attended.

Aim: To identify and produce evidence that suggests pupils' attitudes to mathematics differs according to the school they attend.

Objective: Using an unconditional Multilevel linear model to identify if the variance in pupils' Pupils' "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores is explained by the school attended.

Null Hypothesis 4b: There will not be a significant difference in pupils' attitudes to mathematics based on their schools' percentage of pupils eligible for free school meals.

Aim: To identify and produce evidence that suggests pupils' attitudes to mathematics differs according to the level of index of multiple deprivation where the schools attended situates.

Objective: Using a test for difference (ANOVA) to assess whether there is a difference in average Pupils' "Behavioural Attitudes to Mathematics" and "Emotional Attitudes to Mathematics" scores based schools' percentage of pupils eligible for free school meals.

Null Hypothesis 4c: There will not be a significant difference in pupils' attitudes to mathematics based on their Schools' Index of Multiple Deprivation

Aim: To produce evidence that suggests whether pupils' attitudes do or do not differ according to the schools' index of multiple deprivation.

Objective: Using a test for difference to assess whether there is a significance difference amongst schools' attitudes to mathematics based on their index of multiple deprivation.

Null Hypothesis 4d: There will not be a significant difference in pupils' attitudes to mathematics based on their schools' average score in mathematics.

Aim: To identify and produce evidence that suggests whether pupils' attitudes do or do not differ according to the average score in mathematics their school receives.

Objective: Using a test for difference to assess whether there is a significant difference amongst schools' attitudes to mathematics based on their average score in mathematics.

Null Hypothesis 4e: There will not be a significant difference in pupils' attitudes to mathematics based on their schools' maths progression score.

Aim: To identify and produce evidence to suggest whether the attitudes of pupils differ based on their schools' maths progression score.

Objective: Using a test for difference to assess whether there is a significant difference amongst schools' pupils' attitudes to mathematics according to the maths progression score of the school.

Multivariate Analysis

Research Question 5: *Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes to Mathematics?*

Null Hypothesis 5a: The model containing demographic factors, gender ability beliefs and pupil confidence will not be significantly different (better) than the one without, when predicting the influences of pupils' behavioural attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics.

Objective: Using a multiple linear regression to estimate the effects of the independent variables collaboratively on pupils' Pupils' "Behavioural Attitudes to Mathematics" scores.

Null Hypothesis 5b: The model containing demographic factors, gender ability beliefs and pupil confidence will not be significantly different (better) than the one without, when predicting the influences of pupils' emotional attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics.

Objective: Using a multiple linear regression to estimate the effects of the independent variables collaboratively on pupils' Pupils' "Emotional Attitudes to Mathematics" scores.

Research Question 6: *Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics?*

Null hypothesis 6a: The unconditional model containing demographic factors, gender ability beliefs, pupil confidence and teachers' attitudes will not be significantly different (better) than the one without, when predicting the influences of pupils' behavioural attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics when considering the influence of teachers' attitudes to mathematics.

Objective: Using a Multilevel Model to estimate the effects of the independent variables along with teacher attitudes variables collaboratively on pupils' "Behavioural Attitudes to Mathematics" scores.

Null hypothesis 6b: The unconditional model containing demographic factors, gender ability beliefs, pupil confidence and teachers' attitudes will not be significantly different (better) than the one without, when predicting the influences of pupils' attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics when considering the influence of teachers' attitudes to mathematics.

Objective: Using a Multilevel Model to estimate the effects of the independent variables along with teacher attitudes variables collaboratively on pupils' "Emotional Attitudes to Mathematics" scores.

Research Question 7: *Do demographic factors, confidence, value and motivation and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics and factors associated with the school studied?*

Null hypothesis 7a: The model containing demographic factors, gender ability beliefs, pupil confidence, teachers' attitudes and school factors will not be significantly different (better) than the one without, when predicting the influences of pupils' behavioural attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics when considering the influence of teachers' attitudes to mathematics and factors associated with the school.

Objective: Using a Multilevel Model to estimate the effects of the independent variables along with teacher attitudes and school factor variables collaboratively on pupils' Pupils' "Behavioural Attitudes to Mathematics" scores.

Null hypothesis 7b: The model containing demographic factors, gender ability beliefs, pupil confidence, teachers' attitudes and school factors will not be significantly different (better) than the one without, when predicting the influences of pupils' emotional attitudes to mathematics.

Aim: To identify whether demographic factors of pupils, their self-confidence and gender ability beliefs collaboratively affect their attitudes to mathematics when considering the influence of teachers' attitudes to mathematics and factors associated with the school.

Objective: Using a Multilevel Model to estimate the effects of the independent variables along with teacher attitudes and school factor variables collaboratively on pupils' Pupils' "Emotional Attitudes to Mathematics" scores.

Chapter 3: Methodology

Introduction to the Chapter

This chapter introduces the epistemological underpinnings of the study, and why a quantitative stance was used to provide a deductive approach to the children's attitudes to mathematics. This chapter provides a discussion on the use of an observational method of self-completion questionnaires, and more specifically questionnaires with children. The methodology used previously validated methods to measure attitudes, such as Likert scales and 'draw a person' tasks. Rather than using words, in areas of the self-completion questionnaire, respondents had to circle Emojis to elicit their responses that were also presented in the form of Likert scales. The internal consistency of the measure was found to be highly reliable. With evidence of reliability, this methodology argues that the techniques employed to elicit responses provide high reliability in young respondents such as the sample that were aged 8-9 years old. A discussion of the sample and sampling strategy will also take place in order to highlight the strengths and limitations of using cluster sampling via schools in order to gather observational data.

This methodology concludes that in order to identify factors associated with attitudes to mathematics, an observational approach provides benefits associated with access, abiding by ethical frameworks, collecting large volumes of data efficiently and reliably, whilst also allowing factors associated with teacher and school characteristics to be in the same analytical model as pupils' attitudes.

Choosing a Methodological Approach:

Educational research has a history of using both quantitative and qualitative methods. These methods have all recognised the difficulties that come with researching children, such as reliability in responses (Kellett, 2011; Mabelis, 2019), and ethical concerns such as consent (Wendler and Wertheimer, 2017) and whether they understand the nature of what is being researched (McLeod, 2009). This study therefore acknowledges those issues, the vulnerability that comes with child participants, and the extra steps that should be taken when researching in schools settings (Felzmann, 2009). Whilst acknowledging these issues, the study also had to consider its methodological aims. A decision was made to adopt a deductive approach that used quantitative methods to observe children's attitudes to mathematics and their external factors. This was through an epistemology that relied on the development and testing of hypotheses to explain social issues through logical analysis (Kaboub, 2008).

This research also recognised such importance, whilst acknowledging that the interpretation of findings from the researcher are still subjective. This was attempted through reliable methods that can be repeated again in other studies. The current study therefore demands the role of the researcher to be an observer and rely on the methods to examine data (Cohen, 2007). However, there must also be a link between the methodology and the narrative characteristics of the data collected (Elliott, 2005). Ultimately, the goal of this methodology was to provide an impartial, ethical, and therefore repeatable methodology. This was upheld somewhat through the use of reliable measures and ensuring participants' fully informed consent with parents having the additional opportunity to withdraw their child (Felzmann, 2009). However, the objectivity of this research is still questionable for various reasons related to the narrative characteristics of the research, (Elliott, 2005), the time the research was taken, and the fact that the data still requires subjective interpretation form the researcher (Wlliams, 2009).

The analysis of this research identified external factors associated with pupils' attitudes to mathematics using self-completion questionnaires by pupils and teachers, whilst measuring school characteristics from publicly accessible sources. More specifically, the research placed emphasis on statistical techniques to identify findings, such as multiple regression techniques to assess the influence of multiple independent variables on the outcome of a particular dependent variable (Elliott, 2005). Social scientists, however, whilst able to manipulate their data as if it had an objective existence, can still have their findings and the raw data itself contested by other social scientists as the data is observational and thus reliant to an extent on the subjectivities of research participants (Williams, 2009). Since human beings are both the subject and object of the study, interpretive assumptions are a consequence of social science (Cohen, 2007). This study therefore analyses data through scientific method and will relate those findings to the wider of population of study through a sociological perspective informed by the literature review.

Interpreting Quantitative Data

As stated previously, this quantitative approach recognises that the data collected and analysed through scientific method (Riley, 2007) still requires subjective interpretation from the human researcher. Elliott's (2005) emphasis on the need for narrative in social research highlights the limitations of quantitative methods, where narrative is not as clearly available in cross-sectional studies in comparison to longitudinal studies. The need for narrative further highlights the need for subjective interpretation from the researcher. Therefore, interpreting quantitative data poses additional concerns as does collecting quantitative data. Assumptions that impartiality and objectivity are met through the use of scientific method fail to recognise that subjectivity can still apply even in the research design (Cohen, 2007). For example, presenting a series of statements to children, as did this study, already presumes that the respondents have an answer that has already been set for them (Carrasco and Lucas, 2015). Whilst the use of Likert Scales (1932) and clearly worded statements (Kellet, 2011) has been carried out to increase reliability, there is still room to question reliability of the interpretation of data given the researcher designed how that information would be collected.

This research therefore wishes to emphasise the importance of acknowledging subjectivity, even when conducting methods considered objective. Given the researcher has designed the data collection instrument, managed and analysed the data, along with gaining a sense of narrative through interpretation and relation to the literature review (that helped inform the research design), an opposing argument can still be made concerning the reliability and validity of the measures used and therefore the conclusive arguments can still be questioned. The current study wishes to acknowledge this limitation and following reflecting on the limitations of the research overall, will suggest potential resolutions in the conclusion chapter of this thesis. This acknowledgment is particularly important in the context of aiming to make an identification that can be comparable to a wider population of study in order to propose appropriate solutions to practitioners and education policy.

The very complex nature of social science research requires the researcher to acknowledge that the observable, measurable reality may not be captured in its most realistic form given the observer is still coming from a subjective standpoint (Cohen, 2007). Scientific methods can therefore be less successful in their application to the study of human behaviour, where the complexity of human nature and social phenomena contrast strikingly with the order and regularity of the natural world (Cohen et al, 2011). For example, researchers often note the advantages associated with qualitative approaches, which take better account of the contextual factors potentially influencing a particular dependable outcome, which can be ignored in quantitative methods (Watson, 2003, in Elliott, 2005). The need for narrative is therefore highlighted, and this research aims to use a quantitative approach that will further enhance the emerging narrative of how attitudes to mathematics are established in early ages.

Why The Narrative of This Research Justified a Quantitative Approach

This study aims to assess the issue of poor attitudes to mathematics and numeracy in the UK (Hillman, 2014; National Numeracy, 2016a) by beginning to identify the observable factors associated with attitudes to mathematics, positive or negative, in younger individuals. This is through a carefully designed self-completion questionnaire that provides opportunities to express liking and disliking towards mathematics, which will be discussed in further detail later in this chapter. This is to be met through applying a deductive approach, observing a comparable sample of 8-9 year old pupils' attitudes, and further aims to test those attitudes against a number of observations, such as gender, ethnicity, and the school attended, in a quantifiable manner. This differs from other common methodologies in educational contexts, such as Randomised Control Trials (RCTs) (Connolly, et al 2018) that set out to assess the effects of educational interventions, or more qualitative methodologies. The comparability of the study is also of particular importance when considering the need for impartiality in assuring the sample consists of a range of abilities, in terms of schools' mathematical progress, along with an equal proportion of pupils sharing particular identities that relate to demographics, including gender, ethnicity and socio-economic status.

It is less common for an attitudinal study to understand the habits, social norms and interactions that reinforce attitudes and perceptions (Carrasco and Lucas, 2015) and this attitudinal study aims to identify rather than understand. Before attempting to understand why we have poor attitudes to mathematics in the UK, we should aim to try to and identify at what point in the educational life course do attitudes become negative or differ amongst pupils. By identifying associated factors, can we then begin to attempt to then build an understanding behind why those factors may be associated and why or how attitudes may differ.

Establishing Narrative Before Data Collection

The research questions for the current study were set before any data collection was implemented. This began through an identification of the narrative that is negative attitudes to mathematics in the UK shared by adults (Chinn, 2012; National Numeracy, 2016a) and younger adolescents who (typically) actively avoid mathematics when given the option in education after compulsory schooling (Noyes, 2007; Vorderman, 2011; Pampaka et al, 2012; Marshall et al 2016). This study aims to contribute to the narrative by addressing concerns regarding whether this issue occurs amongst younger ages, through the identification of factors associated with attitudes to mathematics in eight and nine year olds in UK primary schools. This required a quantitative approach, incorporating a research design that aims to objectively measure the patterns of interest, attitudes to mathematics, and the associated factors. Attitudes to mathematics were measured through an anonymous questionnaire inspired by previous research also concerning attitudes to mathematics (Tapia and Marsh, 2004) and Maths Anxiety (Richardson and Suinn, 1972; Hunt et al, 2011). The emerging interpretation of that data led to an argument concerning how attitudes to mathematics are influenced by external factors. This research design then formulated findings and conclusions, which allows the identification of factors associated with mathematics to be further explored through future research designs that can aim to understand why those factors are associated.

Humans all possess attitudes, and the researcher is therefore not excluded (Aliyu et al, 2014). There is therefore a requirement to use reliable and objective methods that measure the variables intended (McLeod, 2009) to capture reliable evidence (Ali and Chowdhury, 2015). This research therefore considered the range of methods available before deciding how children's attitudes to mathematics would be most objectively measured. This decision was made through the literature review, concerning the important needs of ensuring child respondents understand the nature of what is being researched (McLeod, 2009; Kellett, 2011) with their own fully informed consent and without any coercive efforts from the researcher. Furthermore, in order to establish using such measures, there has to be consideration of which research methods best meet the needs of the research question. The aims of this research are to answer the questions concerning factors associated with attitudes to mathematics and whether those factors are further influenced through teachers' views and the school attended. These aims shaped the literature review carried out along with the decision to use survey methods. A discussion of the chosen methods will take place to highlight how the strengths and limitations of survey research led to the decision to use self-completion questionnaires to measure pupils' attitudes to mathematics and contribute to the narrative of Mathematics Anxiety in UK Adults. .

Maintaining Narrative After Data Collection: The Need for Repeatability

Given the national issue that is negative attitudes to mathematics and the acknowledgment of the limitations that this research approach can lead to, there must be scope for repeatability in order to gather more evidence related to the topic discussed. The current study established a highly reliable measure of children's attitudes to mathematics and can be repeated again with a similar sample of the same population of study. Along with the measure, the methods can additionally be repeated through working with schools to establish consent, access, parental notification, and provide schools, parents and the pupils themselves, the opportunity to withdraw. By upholding confidentiality of schools, rapport between schools and the researcher can also be established and upheld by protecting the anonymity of all participants. Measures of school deprivation and progress can be found on publically accessible sources, such as governmental websites, and this information does not reveal the identity of schools. This approach was practical in attaining sufficient sizes of data in an efficient time-friendly manner through school visits and having self-completion questionnaires answered simultaneously in classrooms. This methodology not only identifies an issue, but also provides a foundation to carry out further methods with a larger sample to gather more evidence and generalise findings to the national population of young pupils. This is through a well-designed measure, cluster sampling, and using statistical methods to observe the influence of factors on pupils' attitudes to mathematics.

Strengths and Limitations of the Approach Taken

The study aimed to have a clear theoretical focus for the research to be carried out from the beginning (Riley, 2007) in order to clearly understand the need to apply particular methods of sampling, measurement and surveying (Durkheim,1982; Cohen, 2007; Ali and Chowdhury, 2015; Pham, 2018). In relation to the current study, it was of high importance that control of the data collection process was upheld by collecting data for the purposes of answering an already established research question, as opposed to allowing the data itself to inspire and work towards later established research questions (Riley, 2007). As the purposes of this study, from the outset were to identify and explain association factors of attitudes to mathematics, adopting this method allowed the research process to maintain focus on the already established research question and not move towards identifying a new question. The topic of this research is of particular interest and importance to the UK given the lack of core mathematical skills (National Numeracy, 2016a; Royal Society 2019; Vorderman, 2011; Pro-Bono Economics, 2014). Therefore establishing the research question, which is formulated through the identification of an already established pattern, is crucial to maintaining focus and of the utmost importance.

The research tools used for data collection, whilst dependent on subjective interpretation and narrative of the data characteristics (Elliott, 2005), produce quantifiable information (Ali and Chowdhury, 2015) and provide greater opportunity to establish a comparable population to be studied that in turn helps answer research questions informed by patterns identified within society (Outhwaite, 2006; Riley, 2007). The issue that is negative attitudes to mathematics is better explained through quantitative methods (Carrasco and Lucas, 2015) given it's issue on national scales, allowing to then begin to suggest how we can build an understanding behind that explanation (Smith, 1996; Kaboub, 2008) based on the evidence identified.

Although there is a varied range of research methods to choose from, a researcher's epistemological and methodological commitments constrain them from which research methods can in fact be used (Willig, 2013). The limitations of this study highlight the strengths of interpretivist methodologies that effectively set out to build an understanding of why something already exists (Rolfe, 2006). The strengths of quantitative methods being that the information gathered through scientific method can provide important insights into aspects of reality, also highlight limitations. For example, the information gathered, whilst reliable, may lack external validity when applying the findings to the complex world outside of the sample researched (Aliyu et al. 2014). That lack of validity further comes from the lack of understanding that is the result of the methodological commitments. Furthermore, this highlights the limitations of methods inspired from the natural sciences, where findings often do consist of external validity given the conditions of the observed reflect the conditions of the population studied, (Elliott, 2005; Aliyu et al, 2014). In social science, unlike natural science, every proposition that contradicts received ideas is open to the suspicion of ideological bias, clashing with social interests and the interests of dominant groups, which are bound up with silence and common sense (Bourdieu 1993:11). The measurement of social objects, such as gender, ethnicity and class for example and their effect on education can be captured by a statistical model such as logistic regression, but they cannot tell us why (Letherby, Scott and Williams, 2013).

Therefore, whilst it is believed a quantitative approach is justified in this research, it does not fail to acknowledge that any evidence found is still there to be scrutinised and may not provide a depth of understanding that a more qualitative commitment may (Rolfe, 2006). An example that can apply to this argument is Letherby, Scott and Williams' (2013) discussion on the quantifiable measurement of ethnicity as a social object causes difficulties through how we think of ethnicity subjectively before trying to measure it is an object. This issue can apply to other social objects that have been measured in this study, such as attitudes to mathematics. Whilst this research has focused on reliability of measures, it is still possible that those measures will lack validity in how well they measure the attitudes to mathematics in the outside world beyond the research (Aliyu et al. 2014). This research understands its strengths in identifying issues through observing data that relies on methods to uphold some sense of reality to that data (Smith, 1996). This is whilst understanding, however, the associated limitations. Those limitations include the ability to conclude an observable truth as a result of upholding the reliance on measurement and objectivity (Rolfe, 2006), that still consists of variables that are designed, measured and interpreted by subjective human researchers (Williams, 2009). Additionally, whilst possibly identifying relationships between variables, the methods used cannot explain why those relationships occur (Letherby, Scott and Willaims, 2013), limiting the subjective validity of what is being measured (Aliyu et al, 2014)

The decision was made to quantitatively look at the issue of children's attitudes to mathematics in school due to the evidence regarding the cultural perception of mathematics in the UK (National Numeracy, 2012; 2016). Mathematics is often associated as 'difficult' (Scarpello, 2007; Chinn, 2012; Marshall et al, 2016), 'irrelevant' (Szydlik, 2003; Muis, 2004; Macdonald, 2014) and 'male dominated' (Ireson et al, 2001; Rogers, 2003; Ernest, 2004, Beilock et al, 2010). With the concern therefore regarded as a national issue, an attempt to quantify findings is a justifiable approach, focusing on identifying factors associated with attitudes to mathematics, with a reliable sample that is comparable of its population. This therefore requires planning in research design and critical thought on the research process as a whole, in order to answer the research question reliably. This research aims to identify factors associated with attitudes to mathematics, and propose certain reasons behind those association through a discussion of literature and previous findings. It is not until evidence is produced that identifies the factors that a methodological commitment to understanding why attitudes can be pre-determined can commence. By identifying factors, we can move closer towards building appropriate methodologies that aim to understand why those factors associate with attitudes to mathematics. A range of research has previously looked at attitudes to mathematics (Tapia and Marsh, 2004; Lim and Chapman, 2013) and mathematics anxiety (Richardson and Suinn, 1972; Suinn et al, 1988; Hunt et al, 2011). This study takes inspiration from those studies by using reliable attitudinal measurement techniques, whilst also measuring external factors highlighted by additional sociological and educational theory. This research therefore aims to capture the psychological construct of attitudes to mathematics whilst identifying the social factors that influence attitudes. The originality in this study is in the attempt to quantitatively assess both the attitudes and their factors at different levels, including the pupil, classroom, and school. The previous studies referred to will be discussed later in this chapter, in order to highlight why this type of study is needed to begin developing an understanding as to how we can suggest improving our attitudes to mathematics as a nation.

Quantitative Methods and Questionnaires

Classic methods, such as questionnaires or large-scale surveys are very much associated with traditional quantitative methods and this approach can be rooted back several centuries whilst dominating the social sciences during the first half of the Twentieth century (Vehovar and Manfreda, 2008). When measuring attitudes, though many techniques are available, an appealing alternative for research with large-scale samples is ‘agree-disagree’ attitudes items (Sinnott et al, 1980) due to their reliability in eliciting responses (LaMarca, 2011). In comparison to experiments, surveys can be regarded as a more inferior design of quantitative methods (Gorard, 2003) because of their inability to provide causal explanations (Mathers, Fox and Hunn, 2009), or ‘good quality data’ due to the possibilities of response bias or nonresponse (Brancato et al, 2004). However, a focus on the social context may determine how a questionnaire is better suited to data collection (Strange et al 2003). Two reasons as to why a questionnaire would be more suitable than experimental methods, would be that the data does not already exist and that ethical constraints may prevent other, more experimental methods (Gorard, 2003).

Previous evidence has identified that attitudes to mathematics can differ from as young as ten years old, (Macdonald, 2014). However, evidence has also identified that attitudes can be established in individuals from as young as nine years old (Bloom, 2008). In the case of the current research, an original study is being conducted due to the lack of questionnaire-based research examining attitudes to mathematics in primary school pupils in the UK, between the ages of eight and nine years old. This age group is of particular importance given the evidence that attitudes can be established and changed and the fact that this age-group will soon be formally assessed through mock SATs (Gov.UK, 2019). Whilst other questionnaire studies do exist in the USA with similar age groups (Beasley et al, 2001; Beilock et al, 2010) along with UK studies with older age groups (Hunt et al, 2011), there has been a focus on maths anxiety as opposed to an observational focus on pupils’ overall attitudes to mathematics. Studies focusing more on attitudes to mathematics, establishing and validating the Attitudes Toward Mathematics Inventory (ATMI) (Tapia and Marsh,

2004) and the Scale for Assessing Attitudes towards Mathematics in Secondary Education (SATMAS) (Yanez-Marquina and Villardon, 2016) also focused on older age groups. Not only do these studies consist of different samples, but also the data collection tools consist of a high number of questions, which may be too long and too difficult to engage with when answered by younger respondents (Kellett, 2011; Mabelis, 2019). There is also the concern of attitudes to mathematics being inconsistently defined internationally and therefore failing to produce comprehensive evidence (Yanez-Marquina and Villardon, 2016). Therefore, the condition that the data does not exist, in reference to the questions and aims of the current research, is met and therefore grants reasoning to conduct survey research.

The other condition Gorard (2003) refers to, concerning the ethical constraints of research with children, can also be addressed. This is through concerning the intended aims of the current research, which is to identify factors associated with attitudes to mathematics. The emphasis on identification highlights how experimental methods, such as Randomised Control Trials (RCTs) may be inappropriate for such a study. RCTs are a popular experimental method used increasingly in education with the intentions to simply measure the progress of students subjected to an educational intervention in comparison to a control group of students continuing as normal (Connolly et al, 2018). These methods however, have come under much scrutiny amongst education researchers (Pampaka, Williams and Homer, 2016; Gorard, See and Siddiqui, 2017; Connolly et al, 2017). The criticism focuses on the method of RCTs being inappropriate for the field of education due to the bluntness in their design, which ignores context and experience, additionally the simplistic laws of cause and effect tend to be inherently more descriptive and contribute little to theory (Connolly et al, 2018). Although the premise of isolating and controlling variables is appropriate for laboratory settings, the social world does not consist of the same artificial environments (Makkreel, 2011). Whilst this holds internal validity within the confines of the experimental environment, it lacks ecological validity, which concerns the exhibited behaviour in real life situations (Greig et al, 2013). This furthermore raises moral and ethical questions when considering the treatment of humans as ‘controllable’ (Cohen et al, 2011) particularly with younger people who are already vulnerable to coercive consent (Wendler and Wertheimer, 2017). This argument is particularly applicable to the case of children and their educational opportunities.

Furthermore, the importance of context is undeniable when researching the social world that is education and this is not taken into account in the method of an RCT, questioning its suitability at all (Morrison, 2001). The repetition of RCTs aims to minimise the chances of a particular result being coincidental and rely on the experimental environment to consist of the same conditions every time, which again ignores the variating context of education (Hodkinson and Smith, 2004). For example, practitioners are unable to with the same principles of a randomised lab-based environment in everyday school conditions (Kourea and Low, 2016 in Pampaka, Williams and Homer, 2016).

In the case of the current educational research with children between eight and nine years old, an experimental approach was therefore regarded as unethical and impractical. This is because the aims of this research concerned the identification of factors associated with children's attitudes to mathematics. The emphasis on attitudes, allows an argument to be made that what is most important is the view of the respondent and therefore an observational technique such as a questionnaire would be a more appropriate measure (Mathers et al, 2009; McLeod, 2009; Ali and Chowdury, 2015). Furthermore, a controlled, laboratory-based research study does not reflect the real world or relationships in which young people exist (Greig et al, 2013) and it is the experiences of mathematics that would shape a child's attitudes to mathematics. There must therefore be an attempt to recognise the complex reality of the environment being studied, where a range of factors cluster pupils and their teachers accordingly, expecting different results to yield depending on the pupil participants themselves. Therefore, experimental methods do not necessarily capture the views of the respondent, the complex social conditions set before assessing the respondent, or the external hierarchal factors such as the educational institutions' ratings.

An observational study could therefore provide an opportunity to research pupils' attitudes to mathematics and the complex social conditions that exist before commencing the research that may influence their attitudes. Whilst words such as 'inferior' (Gorard, 2003) are used when comparing observational studies to experimental, there are still limitations to experimental designs, such as those that have been discussed. Given the data on this subject for this age group does not exist, and requires a robust ethical framework to be collected, an observational method could arguably meet the conditions of observational methods being more appropriate (Gorard, 2003), and highlights the importance of recognising the social context prior to data collection (Strange et al, 2003). Additionally, Pampaka, Williams and Homer (2016:345) make an important observation regarding the view of RCTs being the 'one and only' approach risks suppressing other methodological forms, and that we should continue to search for other methodologies and approaches.

Whilst considering the popularity of experimental methods in educational fields, this study had to consider the practicalities of working within school settings, and the prime focus being pupil attitudes and not distinctly their behaviour.

It was therefore decided that a questionnaire would provide respondents with the most opportunity to state their opinions that can be quantified and linked to other external factors. One advantage this could arguably provide is the ability for pupils to have an opportunity to express honest opinions about their experiences of mathematics. Questionnaires therefore allow respondents to express views which they may not feel comfortable expressing to the interviewer (Strange et al 2003), or in the specific case of this research, the teacher. This has proven to be problematic in past research, where children were coerced into answering questionnaires in front of peers, teachers and researchers (Mackay and Watson, 1999 in Greig et al, 2013) providing ethical issues with coercion evident in teachers saying to pupils, "'Minnie the Mouse wishes she didn't have to come to school. Are you like Minnie the Mouse – do you wish you didn't have to come to School? As she asked the questions she was unconsciously shaking her head in disapproving fashion…" (Greig et al, 2013: 125). Not only does coercion provide ethical issues, but the validity of the responses are also compromised as respondents are not likely to exhibit true behaviour if providing responses and gathering results in this way (Wendler and Wertheimer, 2017).

Questionnaire based surveys are a practical way of obtaining large amounts of data for statistical analysis (Kumar, 2007; Vehovar & Manfreda, 2008; Rolfe, 2006). This is a method that has become ever more favoured in a digital world where plentiful resources are available at a minimal cost, and where cost is a prime concern to any researcher. However, there are limitations to survey research. The validity of responses can still be questioned, even without coercion used to gather the response, due to how the respondent may feel they should respond to a statement. The results may therefore be subject to response bias, as this can occur when respondents are aware of answers portraying specific behaviours that they feel will make them look good, a phenomena that Steenkamp, de Jong and Baumgartner (2009) refer to as 'Socially Desirable Responses' (SDRs). A survey is an essential piece of kit and can act as a filter and a measuring tool; however, concerns from an interpretivist perspective address how methods such as surveys are able to measure social behaviours through simple positivist assumptions (Sprague, 2010). These simple assumptions do not necessarily acknowledge the complexity of individuals' contexts and potential reasons for providing certain responses. It is possible, for example, for a highly reliable research instrument to lack validity (Greig et al, 2013). The current research must analyse the reliability of the measure given it will not have been tested for reliability or validated previously. However, considering the aims of this study are to identify or explain, in order to contribute towards building an understanding, which may require a different method altogether, questionnaires would still be the appropriate method of data collection. Furthermore, this research intends to take the recommended steps to improve validity by using a deductive model that is theory driven and requires hypothesis testing (Greig et al, 2013). Furthermore, extra care can be taken to avoid Socially Desirable Responses (Greig et al, 2013) through having questionnaires self-administered and done so anonymously (McLeod, 2009).

Quantitative Research with Children

Extra care must be taken when working with child participants (Kellet 2011; Greig et al, 2007; 2013) due to their vulnerability as respondents (Felzmann, 2009; Wendler and Wertheimer, 2017) and their lower literacy skills, which are needed to provide reliable and valid responses (de Leeuw, 2011; Mabelis, 2019). It is also important to assume they can provide information that is both helpful and insightful when approached appropriately and data is interpreted carefully (Lobe et al, 2008). Quantitative research is less common in research with children (Kellett, 2011) due to the concerns, such as , whether they will understand the questions asked and remain engaged throughout the questionnaire (Wadsworth, 2003; Kellett and Ding, 2004; Mabelis, 2019). More so, of quantitative research that is available, samples are usually still taken from an older teenager population (Richardson and Suinn, 1972; Tapia and Marsh, 2004; Hunt et al 2011; Yanez-Marquina and Villardon, 2016), with minimum ages being between 16 and 18 years old (Scott 2003). Children can and do provide reliable responses if questioned in a manner that they can understand and about events that are meaningful to them (Kellet and Ding, 2004). The minimum age a respondent should therefore be when answering a questionnaire is dependent on the questions and topic (Wadsworth, 2003; Ghazi et al 2014; Mabelis, 2019).

The matter requires discussion considering many aspects as well as ensuring young respondents are well aware of what is being asked of them.

A simple criteria that if followed should provide reliable responses from children as young as eight years old Is that questions should be: relevant and appropriate, avoiding factual information and focusing on feelings; easy to understand with simple vocabulary; short and simple in sentences; and avoiding negative sentences (DeLeeuw, 2011; Kellett, 2011; Mabelis, 2019). Through careful consideration of this criteria and liaising with practitioners working daily in the classrooms, with this age group, a new questionnaire was designed. This questionnaire also had to be designed whilst considering the structure, format and presentation in mind and was designed in a way so that the questionnaire would appear fun and meaningful to respondents (Mabelis, 2019). This invited creativity in the design of the questionnaire by considering how certain concepts could be efficiently captured and quantified. This was also of particular importance when considering how to ensure respondents would remain engaged when answering the questionnaire. Piaget’s work on cognitive development, ultimately argued there are four stages of Development (Wadsworth, 2003). Within those four stages, the third stage known as ‘concrete operations’ is where he argued lies 7-11 year olds. Within this stage, it is said that children are capable of more logical thought, although that thought can still be inflexible (Essa 1999 in Ghazi et al 2014). The language skills of 7-12 years olds are sufficiently developed and allow for the understanding of well-designed questionnaires with consistency, provided sentences are short and the words used are carefully checked (de Leeuw, 2011). Furthermore, there have been attitudinal studies of the same topic involving younger children, at seven years old (Suinn et al, 1988) and five years old (Beilock et al, 2010) with reliable findings. This study focused on 8-9 year olds given the evidence that attitudes can be established (Bloom, 2008) within this age group and to identify whether those attitudes could differ, which has been evidenced in ten year olds (Macdonald, 2014).

Sampling

Sampling for quantitative research depends on whether or not the researcher is aiming for a probabilistic sample from which they would like to draw inferences concerning the wider population (LSE, 2019). This research came across a challenge in sampling that rised from the desire to maintain a large enough sample, and the desire to maintain a comparable sample ot the population of study. Lobe et al (2008) argue that common practice often involves sampling children by their school, which can also provide an opportunity for cluster sampling. This is particularly effective when concerning financial or time constraints along with resources to help conduct face-to-face surveying with children in their homes (LSE, 2019). Given that the aim of this methodology was to create a comparable sample of 8-9 year olds, cluster sampling by school was deemed an appropriate and effective way of attaining participants. The practicality of this method was also taken into account, as schools who were willing to take part, could also provide devolved consent for children to take part. Therefore, the decision was made to approach schools who may already be willing to work with the university and its students. In total, ten schools took part. Eight of the ten schools came from Greater Manchester, whilst other schools from Lancashire and Nottinghamshire also took part. This managed to attain the minimum desired sample size of 500 pupils where a comparable sample could be attained within a range of different schools.

Specific schools were originally approached in an attempt to ensure a range of different schools were included in the sample; this is common practice in educational research (McMillan, 1996). This was attempted for two reasons. First, the characteristics of the schools were identified and used as independent variables in the research (differing in percentage of ethnic minorities and in different areas of deprivation) and secondly, in order to generate a homogeneous sample comparable to the population of study (McMillan, 1996). Data was collected measuring the Index of Multiple Deprivation (IMD) collected from the Ministry of Housing, Communities and Local Government (2015) online, along with the percentage of pupils eligible for free school meals. Percentage of schools' pupils' eligibility for free school meals information was found on GOV.UK's (2018a) 'Compare Schools in England Service' along with the schools' maths progression scores and average score in mathematics. The percentage of ethnic minorities was calculated after data collection. This was done to avoid any form of selection bias based on pupils' gender, ethnicity, maths progress or any other trait that may wished to be measured as a potential factor associated with attitudes to mathematics.

Despite the use of a clustered sampling strategy to focus on school characteristics of the sample, the research was still not comparable to the population of study. Whilst these attempts were made, the schools who agreed to take part were from areas of higher deprivation, and as a result, the deprivation levels of the sample were higher than the national average. This was confirmed with the use of a one-sample *t*-Test where the average percentage of pupils eligible for free school meals was compared to the national average percentage. Additionally, a one-sample *t*-Test was used to confirm that the average score in mathematics of the sample was also higher than the national average. Whilst attempts were made to recruit more schools, the minimum sample size had been achieved, which will be discussed in the following section.

Determining a Suitable Sample Size

This study's minimum sample size was determined by a number of factors. Firstly, it was important to attain a comparable proportion of BAME pupils in order to assess whether the ethnicity and culture of a pupil could influence different attitudes. With BAME pupils accounting for a third of England's school population (Department for Education, 2018), and with schools having a varied range of BAME pupils, a number of schools with different proportions were selected in attempt to build a similar BAME percentage within the sample. The percentage of male to female teachers was also considered, and a number of different schools were selected in order to uphold similar proportions in the study's sample to that of the general population of primary school teachers, 85% of whom are female (Department for Education, 2016c).

It was also attempted to build a sample that was similar in levels of deprivation and mathematical proficiency, in order to resemble that of the national average. This however, became problematic when approaching schools to take part. Given the nature of this research was for a PhD thesis and therefore schools were approached by a PhD student rather than an organisation, the issue of having schools agree to take part was problematic. Negotiating access often proved difficult given the time pressures of schools and their willingness to allow time for pupils that did not directly relate to assessments. When ten schools eventually agreed the proportion of BAME pupils and male to female teachers could be achieved at the level of the sample, meaning an estimated 500 pupils would be in the sample. Whilst more schools were approached, they did not agree to take part in the study. The schools that did agree to take part in the study were often from higher levels of deprivation and had a strong pre-existing relationship with Manchester Metropolitan University due to being a provider of student placements. Additionally, schools with higher mathematical progress scores were also more likely to agree to take part. This highlights a potential sampling issue regarding social desirability, where schools may not be willing to take part in research concerning their pupils attitudes to mathematics if they were not already seen as strong in mathematics as a school. Furthermore, with the research being for a PhD thesis and having one researcher conduct the whole study, there was also an issue of insufficient time to approach a greater number of schools.

Sample size when using a Multilevel model

Multilevel Modelling is not uncommon when researching education given the nature of hierarchal clustering with schools and teachers, and their pupils respectively (Steele, 2008; Ruiz, 2015; Syyeda, 2016). This study also noted the hierarchal clustering that would exist within the data, given teacher and school characteristics would be measured and assessed as factors of pupils' attitudes. The sample size therefore also had to be considered and a minimum sample size had to be determined in order to appropriately run a Multilevel model. This was done by reviewing literature on the subject of sample size in Multilevel Modelling. A common 30/30 rule (Hox, 2010) applies, where there should be at least 30 groups with 30 units per group, be that 30 teachers with 30 pupils or 30 schools with 30 pupils. However, research discusses how there is almost more importance on the number of groups than the number of units (Maas and Hox, 2005). Given that in this research, 'groups' would be teachers and schools and 'units' would be pupils, this became problematic. Specifically, it is argued that more groups will provide less error in estimation (Maas and Hox, 2005). Van der Leeden and Busing (1994, in Maas and Hox, 2005) identified than a large number of groups (100 or more) would be needed to accurately identify group-level variance. Other studies, such as Browne and Draper, (2000 in Maas and Hox, 2005) reported similar findings. Kreft (1996, in Hox, 2010) discusses the '30/30 rule' which involves 30 group with 30 units whilst Hox (2010) argues that the number of groups should be higher than the number of units with a 50/20 rule, with a sample consisting of 50 groups with 20 units.

Given the time frame available for analysis and the study being conducted solely by a lone researcher sampling schools themselves, plans had to be made should such an appropriate number of groups not be attained. This led to the decision to perform a multiple regression that focused on pupil factors, whilst also applying a detailed bivariate analysis on teacher and school characteristics, should a minimum sample size not be attained for Multilevel Modelling. Furthermore, a Multilevel Model for teachers, schools, as well as teacher and schools simultaneously, for each of the two dependent variables, would also be used to provide the intended methodology that could be used in future studies. This will be discussed in further detail in the Multilevel Modelling section in this chapter, along with the post hoc power analysis chapter. It was therefore decided that a minimum sample size would be obtained when meeting comparable proportions of BAME pupils and Male to Female teachers. This was obtained when 10 schools took part in the research. Whilst other schools were approached, and two additional schools originally agreed, these schools declined to take part. Analysis therefore took place with 10 schools, 19 teachers and 508 pupils.

Ethics

Research in school settings, requires negotiation of access with adult gatekeepers before children can give their informed consent (Morrow, 2009). Concerning the vulnerability of child respondents (Kellett, 2011), it is important to note that this cannot be granted as permission to collect from the child, but granted as permission to invite the child to take part in the research (Market Research Society, 2014).

Informed consent was one of the first matters to be addressed prior to participant recruitment. As the children were answering the questionnaire, parental consent was not needed for every individual child as the head teachers were acting as gatekeepers and responsible adults who hold personal accountability for the well-being of children (MRS 2014). The head teachers provided, "…the permission as the responsible adult to the interviewer which allows the interviewer to invite the child/young person to participate in the project" (MRS 2014:7). However, this is not enough (de Leeuw, 2011) as the pupil should also have the right to consent in taking part. The pupil participants themselves were additionally provided the opportunity to give their informed assent, meaning they could in fact refuse to take part or withdraw at any time if they wished, as that is also a necessity when working with children (MRS 2014). To maintain good practice, an information sheet (see Appendix H) was provided to the parents of the schools who allowed pupils to take part, which also provided them the opportunity to exercise their right to withdraw their child from the study if they wished to do so. This was done through providing full transparency to the parents, along with details as to how they could make either the researcher or the school aware that they wished their child not to take part. Of the parents who exercised their right to withdraw their child from the study, they did so by contacting the school directly, meaning the researcher had no knowledge of who those parents would be.

An important part of any research involves the basic principle of respect for persons, involving: the right not to be injured or mistreated, the right to give informed consent to participate in the research, and the right to privacy, confidentiality and anonymity (Scott 2013). To avoid socially desirable responses (Steenkamp, de Jong and Baumgartner, 2009) and learning from previous studies that resulted in coercion (Mackay and Watson, 1999), it was essential that the questionnaire was completed anonymously. Respondents were informed they would answer the questionnaire anonymously via the information sheet and verbally prior to the questionnaire being given to them. Prior to accessing schools, ethical approval was granted by the university's ethics committee (see Appendix H) following an application, which provided details of the research aims and objectives along with the data collection process.

Access

Access to schools was negotiated following the approval of the university's ethics committee and the researcher obtaining a DBS certificate. Working with pupils had to be directly negotiated with school head teachers. This involved approaching schools directly and informing them of the research and its aims before asking if they would be willing to take part. In return, schools were provided with a detailed report on their own pupils' attitudes and associated factors. Schools were provided with an information sheet (see Appendix H) providing all details of the research. After agreeing to take part, head teachers provided written consent through a consent form (see Appendix H) provided, that referenced the information given prior to negotiating access. Schools were requested to inform parents of the research and the day it would take place at a minimum of two weeks prior to the visit. Parents were provided with their own information sheets (see Appendix H) providing details of the research along with their right to withdraw their child from the study by either informing the school or the researcher directly. Parents/guardians were also provided with the opportunity to discuss the research in further detail with the researcher prior to the visit, should they have unanswered questions from the information sheet.

When visiting schools, head teachers granted access to the premises and provided written consent, at which point pupils and teachers were then approached during classes. Pupils and teachers were introduced to the researcher and informed about the research process in their classrooms. Pupils were then provided with an information sheet (see Appendix H) to read, which provided simplified, but detailed information, regarding the research. This information sheet also informed them of their right to withdraw and clearly stated that the questionnaire was in no way their classwork and their teacher would not know their answers or if they refused to take part. Consent continues for the duration that the research is taking place (NSPCC, 2019), therefore the pupils were made aware that they could withdraw from the research at any time during data collection. If pupils could refuse to take part by simply not answering the questionnaire and were informed verbally that by handing their completed questionnaire to the researcher they would be consenting to take part in the research. Pupils were informed verbally and through the information sheet that if they did not wish to take part they could leave all answers blank and that the closed, unfilled booklet would be collected after data collection.

Measuring Children's Attitudes to Mathematics

Prior to structuring the data, this research depending on a theoretical framework (Fox, 2008). Attitudinal studies tend to be people focused and are most commonly used to measure people's attitudes towards and perceptions of topics (Carrasco and Lucas, 2015). Questionnaires provide an opportunity to measure directly the attitudes being studied (Mathers et al, 2009; McLeod, 2009; Ali and Chowdury, 2015). Indirect measures however, such as projective tests, have been used to avoid social desirability by attempting to make people unaware of what is being measured (McLeod, 2009). Examples such as Thematic Apperception Tests (Schacter et al, 2009) and 'Draw a Person' tasks (Beilock et al, 2010; Short et al, 2011; Syyeda, 2016) aim to infer a respondent's attitude from their interpretation of the ambiguous or incomplete stimulus (McLeod, 2009). These methods, whilst avoiding social desirability, not only pose ethical issues with respondents being unaware of what is being measured from them (McLeod, 2009), but provide more general information as they do not provide a precise measurement and often lack validity as a result (Lilienelf et al, 2000). This further limits the reliability, evidenced in their generally low internal consistency (Cronbach 1951; Jensen, 1959; Cramer, 1999) and therefore their objectivity as a measurement, which does not meet the epistemological standpoint of the current study.

Attitudes have traditionally been measured through Likert scales (Dreger and Aikin, 1957; Richardson and Suinn 1972; Brush, 1978; Plake and Parker, 1982; Suinn et al, 1988; Chiu and Henry, 1990; Beasley et al, 2001; McLeod, 2008; Hunt et al, 2011). These measures are often used but there are recognised limitations (Carrasco and Lucas, 2015), such as the limited options of being either five or seven-point scales whilst also encouraging respondents to focus heavily on one side of the scale or actively avoid extreme options as they answer similar questions continuously, questioning whether they can measure 'true' attitudes (LaMarca, 2011). Likert Scales can also be compromised by social desirability (Steenkamp, de Jong and Baumgartner, 2009; McLeod, 2009). Likert Scales however provide advantages, such as reliability and validity, which have been reinforced in the previously discussed studies (Richardson and Suinn 1972; Plake and Parker, 1982; Suinn et al, 1988; Chiu and Henry, 1990; Hunt et al, 2011) and adhere to the methodological commitments of this study.

People's attitudes are also strongly related to social and contextual factors, such as habits, values and social norms (Carrasco and Lucas, 2015), which is why it is important to identify factors that are associated when measuring attitudes.

Researching children's attitudes to mathematics is not new, and respondents have been found to be as young as five years old in quantitative studies (Beilock et al 2010). Studies commenced from as early as the 1950s with the Numerical Anxiety Rating Scale with the purpose of detecting the presence of emotional reactions to arithmetic and mathematics in university students in the USA (Dreger and Aiken 1957). Richardson and Suinn's (1972) Maths Anxiety Rating Scale (MARS), which was one of the first to generate a full multi-item scale measure that was able to successfully measure maths anxiety in undergraduate students in the USA. The 98-item MARS used by Brush (1978) received considerable popularity in education (Beasley et al, 2001). Adapted versions of the MARS have taken place, significantly reducing the number of questions, whilst maintaining the use of a reliable measure. A Factor Analysis study on the original MARS (Rounds and Hendel 1980 in Plake and Parker 1982) identified two dominant factors were in fact being measured, Mathematics Test Anxiety, and Numerical Anxiety. Plake and Parker (1982) reduced the measure to 24-items, in order to conduct their own research, which aimed to focus specifically on class related anxiety in statistics courses.

In terms of studying younger individuals, Suinn (1988) went on to further revise the original MARS (Richardson and Suinn 1972), which was a 26-item scale, consisting of five-point Likert items, for elementary students in the fourth, fifth, and sixth grade. Respondents were as young as nine years old in this study, highlighting that using young respondents in education research is not uncommon. Chiu and Henry (1990) also developed their own revised version, which was the Maths Anxiety Scale for Children (MASC), consisting of 22, four-point Likert scale items. Newstead (1998) studied maths anxiety in children of years 5 and 6 in the UK, based on a measure previously used in unpublished work (Newstead 1992) that included specific maths anxiety items, such as doing sums, to everyday activities such as playing maths games and working out the time. More recently in the UK, Hunt et al (2011) conducted a similar study to that of Richardson and Suinn (1972), and used a Maths Anxiety Scale, UK version (MAS-UK). This measure took inspiration from the original MARS but was adapted to be more applicable to students in the UK as opposed to the US, and was also used on undergraduates.

Behavioural Attitudes to Mathematics (BAM)

This research originally aimed to measure maths anxiety amongst children in KS2. Maths Anxiety measures are not uncommon, and have received much attention and development over the last four decades (Beasley et al, 2001). The measure used in this research, was very much an adapted version of Hunt’s (2011) United Kingdom Maths Anxiety Scale (MAS-UK) which was an adapted version of a an original Maths Anxiety Rating scale developed by Richardson and Suinn (1972).

However, it was soon decided that rather than measure the level of Maths Anxiety in children, it would be more appropriate to attemptto measure their attitudes to mathematics. Because the memory and cognitive processes of children between 7-12 years of age are still developing, there is a requirement for careful examination of questions used for data collection (de Leeuw, 2011). Reviewing the draft questionnaire with year 4 primary school teachers highlighted the issue that the term ‘anxiety’ may not be understood by the sample at the ages of eight or nine years old. This reflects the issue regarding whether the intended attitude is in fact being measured (Lillinfield et al, 2000; McLeod, 2009) and we can therefore not assume ‘anxiety’ is being measured if the term is not used. A decision was made to provide neutral statements that provided the respondents their own opportunity to express a ‘like’ or ‘dislike’ using terminology that practitioners advised the respondents would understand. Furthermore, the measures of maths anxiety commonly used tend to address older respondents, such as undergraduate students (Suinn and Winston, 2003; Hunt et al, 2011). Whilst some research on maths anxiety has been conducted on 11-12 year olds, this was in the USA (Beasley et al, 2001) and has remained understudied in the UK.

This ultimately led to the decision to use an adapted version of the maths anxiety measurement, Maths Anxiety Scale-UK (MAS-UK) (Hunt et al, 2011) that was used in the UK and had evidence to suggest that it is a valid measure. Hunt et al’s (2011) measure aimed to measure maths anxiety in undergraduate students. When examining the measure it was felt that many questions, if reworded, could be made applicable to school pupils. This also led to the decision to remove some questions that were not applicable whilst also condensing the questionnaire for the age group (Mabelis, 2019). Research suggests that attention spans in 8-9 year olds can be very short in comparison to adults. The Student Coalition for Action in Literacy Education (SCALE, 2014) present a formula to predict attention span that is “attention span for learning = chronical age + 1. In this case, the respondents should be expected to have an attention span of no longer than 9-10 minutes.

Like other previously validated measures (Richardson and Suinn, 1972; Suinn 1988; Tapia and Marsh, 2004) the referred measure provided different scenarios associated with mathematics and provided respondents with the option to indicate how they would feel in that particular situation. This research took the same approach as previous methods to uphold consistency within methods used to measure attitudes that are reliable and valid, whilst adapting the statements in order to resemble situations relevant to the respondents. This led to the argument that different behaviours could be exhibited in different situations regarding maths, whether that behaviour was enjoyment or anxiety. This was to avoid the expectation that the respondents should be at all anxious about maths, whilst still providing them an opportunity to say so. Furthermore, it was discussed with teachers of year 4 pupils at the pilot school that some children may not understand the word ‘anxious’, and a decision was made to therefore change the word ‘anxious’, to ‘worried’. Therefore, it was determined that the appropriate name for the piloted measure would be ‘Behavioural Attitudes to Mathematics’ (BAM).

Another adaptation was the decision to use Emojis instead of words (Danesi, 2016; O’Brien, 2016; Alismail and Zhang, 2018). It was felt that as respondents needed to feel comfortable when answering the questions, the research had to be independent and appear different to any normal school work. Therefore, by selecting a language universally understood, certainly by young people (O’Brien, 2016) and arguably more meaningful to respondents (Kellet and Ding, 2004), it would help students to respondent honestly and comfortably (Beilock et al, 2010; Kellett, 2011; Alismail and Zhang, 2018).

Questionnaires with Emojis

Emojis emerged in the digital era and continue to grow in popularity, yet there is a notable absence in literature on their use in research (Alismail and Zhang 2018). Emojis are part of a mainstream communication tool used digitally across a number of devices and have become a well-known method of communication, particularly amongst young people. Therefore, there is an argument that as we become more aware of Emojis’ usefulness for communication, we also become more aware of how they might be useful in questionnaires aimed at children.

An Emoji is a two-dimensional pictographic used in modern communication to express feelings with digital messaging (Alismail and Zhang, 2018). Considered a very modern form of communication, the frequency in use of Emojis has increased in the past 10 years and in 2015, the emoji known as “face with tears of joy” was chosen by Oxford Dictionaries to best reflect the ethos and mood of 2015 (O’Brien, 2016; Alismail and Zhang, 2018).

Bavelas and Chovil (2000) identify that visible acts of meaning for nonverbal behaviour should have four criteria:

(a) visible acts of meaning are sensitive to a sender-receiver relationship; (b) these acts are symbolic, that is, they are being used to stand for something else; (c) their meaning can be explicated or demonstrated contextually; and (d) these acts are always integrated with the accompanying words, whether their meaning is redundant or non-redundant with words.

(Bavelas and Chovil (2000:168).

As Emojis are becoming a more accepted means of communication, there is an argument that there is also room to allow the use of Emojis in research. If, by using measures known to be reliable, Emojis could be used as responses to statements or questions, then a new instrument can be implemented to a wide range of populations for whom text based answers might be more problematic when considering the various levels of literacy and ability in this age group (Mabelis, 2019). This argument can be particularly useful when considering research with young respondents who would typically be familiar with Emojis and associate them with positive means of communication. Given research has already been conducted with Emojis (Danesi, 2016; O'Brien, 2016; Fane, 2017; Alismail and Zhang, 2018); an argument can be made that such use of language would be beneficial particularly with younger ages. Given their typical familiarity with Emojis in their means of communication (McCullock, 2019) as a result of technology becoming more a part of children's everyday lives and experiences (Fane, 2017), Emojis would exhibit familiar behaviour in young pupils' real life situations (Greig et al, 2013) and therefore provide increased possibilities of measurement validity (Aliyu et al, 2014).

One important aspect of ensuring respondents are engaged is making sure that the questionnaire used to measure their responses is easy to understand (Kellett, 2011; Mabelis, 2019). Emojis are recognised as providing an advantage when ensuring participants understand the questionnaire they are answering (Alismail and Zhang, 2018). When considering young respondents, there must be more effort to ensure that the respondents understand the questions they are answering and the responses they give (Kellett, 2011). This also concerns the ethical nature of the research in ensuring respondents are aware of what is being researched (McLeod, 2009). Fane (2017) used Emojis with children to measure their perception of their own well-being, using child centred methods to collect responses as recommended by Kellet (2011).

Pilot Study

A pilot with a sample of 90 year 4 respondents (pupils), was undertaken at a primary school in Manchester, to assess the reliability of the Behavioural Attitudes to Maths (henceforth, BAM) measure. The school was chosen based on its location (Greater Manchester) and included both male and female pupils. As this school has also previously engaged with research, the Head Teacher was familiar with the ethical protocol involving external researchers. This allowed a relatively smooth access process to take place, where the school provided written devolved consent for the children to take part in the research, whilst also adhering to good practice and informing parents at least two weeks before the research took place, as requested. The children were between the ages of eight and nine years old. This age group was of particular interest for a number of reasons. A decision was made to focus on year 4 pupils based on research that has found those ages are suitable for quantitative studies (Wadsworth, 2003; Beilock et al, 2010). Evidence indicates that attitudes to maths are already established in this age group (Bloom, 2008). Research has also indicated that learner identities and attitudes are established in primary school, causing impact on later learning in secondary school (Noyes 2007).

When discussing a suitable age group, the school felt they could not justify years 5 or 6 taking part due to the pressures of SATS and felt year 4 pupils could take part without jeopardising academic needs. Therefore, in attempting to establish a cohort, that is both accessible, and theoretically justifiable as research respondents, year 4 pupils seemed a good fit for the chosen methodology. With evidence of pupils at this age being capable of logical thought (Wadsworth, 2003) and already establishing mathematical attitudes (Bloom, 2008), which then lead to differences in attitudes and ability in Key Stage 3 (Syyeda, 2016), it is appropriate for this research to attempt to identify external factors associated with behavioural attitudes to mathematics at year 4. It was therefore a methodological decision that concerned accessibility and respondents ability to elicit their attitudes that led to a focus on this particular age group

The pilot was conducted over the course of one day, where children were provided with a questionnaire and an information sheet (see Appendix H) informing them of the reason for their participation and the right to withdraw. A total of 84 children answered the questionnaire. Following their responses, a series of data analyses were conducted to assess the reliability of the measure. Factor Analysis was conducted to ensure that each section measured as intended, and further analysis took place to assess the consistency of understanding. The measure was an adapted version of Hunt et al's (2011) Maths Anxiety UK measure, originally conducted on UK undergraduate students.

This was chosen based on how recently it was used in comparison to other research, and the fact that the language used was applicable to experiences within the UK. However, the survey was adapted to be applicable to the everyday experiences of children aged eight or nine. This included removing questions that would not be applicable and rewording some questions such as multiplying one number by another, to ensure that children could answer questions that involved experiences they have most likely had in school or at home. Establishing rewording of questions was done based on feedback provided by the KS2 lead for the school pilot. The pilot was therefore to assess how reliable the adapted measure would be when answered by much younger respondents.

The measure for the pilot

Figure3 provides an overview of the response system for the five-point Likert, 20-item measure used in the pilot for this research, revised from Hunt et al's (2011) MAS-UK measure.

Each question from the pilot consisted of a 5-point Likert scale ranging from 1 to 5 with the following coding. An emoji was used for each answer, and the meaning of each emoji was explained at the beginning of the questionnaire. A copy of the questionnaire can be found in Appendix G.

1 = Very Worried

2 = Worried

3 = Not Sure

4 = Enjoy

5 = Enjoy a lot

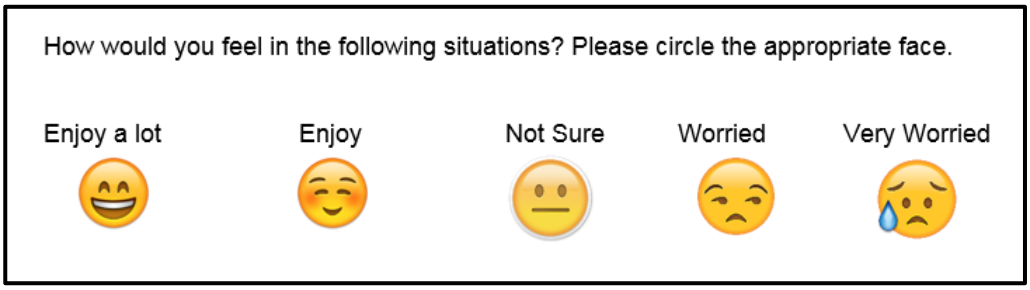


Figure 3: Behavioural Attitudes to Mathematics Response System

Figure 3 provides details for the sections of the measure. There were four sections, with a different number of questions in each section. The revised measure was influenced by the work of Newstead (1992 in Newstead 1998) to address different specific anxieties such as doing sums but also including day to day activities that can occur outside the classroom, such as working out how many sweets can be shared. The decision to revise Hunt's (2011) measure was made whilst acknowledging that many questions would not be applicable to eight and nine year olds. The measure was further inspired by the wealth of research on maths anxiety (Dreger and Aiken, 1957; Richardson and Suinn, 1972; Brush, 1978; Plake and Parker, 1982; Suinn, 1988; Chiu and Henry, 1990; Beasley et al 2001; Tapia and Marsh, 2004; Hunt et al, 2011). The previous research inspired the structure of the measure whilst statements were adapted to increase their relevance and relatability to children in year 4 of the English School System. Teachers provided this measure to a total of 84 children between the ages of 8 and 9 years old in their classroom.

Original Measure

Section 1		*Mean*	*SD*
1	Having a teacher watch you multiply 4 x 3 on paper	3.73	1.11
2	Being asked to write an answer on the board at the front of your class	3.72	1.22
3	Being asked to calculate £10 divided by four in front of your teacher	3.19	1.26
4	Being asked a maths question by a teacher in front of your class	3.96	1.07
5	Being asked to add up the number of people in a room	4.2	1.1
Section 2			
1	Taking a maths test	3.93	1.21
2	Calculating with a pencil on paper	4.3	.86
3	Being given a surprise maths test in a class	3.51	1.42
4	Being asked to calculate a percentage	2.97	1.27
5	Adding up a pile of change	4.18	1.04
6	Calculating how many days until a person's birthday	3.72	1.37
7	Being given a telephone number and having to remember it	2.91	1.47
8	Working out how much time you have left before you set off to school	3.72	1.2
9	Working out how much change you should have after buying sweet	4.06	1.05
10	Deciding how many sweets each friend can have if you are all sharing	3.98	1.12
Section 3			
1	Being asked to memorise your times table	3.76	1.31
Section 4			
1	Reading the word, "Multiplication"	4.14	1.11
2	Listening to someone talk about maths	4.24	.98
3	Reading a book that is about maths	4.05	1.19
4	Watching someone times a one digit number by a two digit	4.08	1.08
5	Sitting in a maths class	4.29	.94
6	Watching a teacher write "times table" on the board	4.15	1.08

Figure 4: Behavioural Attitudes to Mathematics Sections

An Exploratory Factor Analysis (EFA) was conducted on the whole scale, using principal axis factoring with an oblique rotation method. Whilst other factors were extracted, all but one item produced a sufficient factor loading for one whole factor. This one item was question 7 of section 2. As the EFA attempted to extract multiple factors, and as the questionnaire was presented to the respondent in four different sections, a further Exploratory Factor Analysis was also conducted on each section of the measure to ensure that each section could be regarded as a multi scale item. As a result of the exploratory factor analysis, a total of five components were extracted instead of four, separating both section 1 and section 2 into two separate measures each. Furthermore, question 7 of section 2 was found to not be a part of any measure, and was therefore removed after the factor analysis. Question 1 of section 3 was also removed, and a note was made that both questions that were removed were in fact relating to memory. Details regarding the extraction of the components can be found in appendix. After the components were extracted, an exploratory factor analysis was assessed for each extracted component to assess the reliability and validity as distinct measures.

Table 1 provides an overview of the components extracted from the EFA of each sub scale.

	Multi Scale Item Name	**Original Questions**	**Factor Loadings**	**KMO**	**Alpha**	**Mean (SD)**	**Min**	**Max**
1	Specific Tasks	S1.Q1 S1.Q5	.625 .516	0.475	0.493	7.9 (1.8)	3	10
2	In class	S1.Q2 S1.Q3 S1.Q4	.670 .759 .534		0.588	10.9 (2.6)	5	15
3	Active Maths	S2.Q1 S2.Q3 S2.Q4 S2.Q8 S2.Q10	.771 .604 .620 .523 .648	0.753	0.68	18.1 (4.1)	9	25
4	Calculatio n Tasks	S2.Q2 S2.Q5 S2.Q6 SQ.Q9	.572 .748 .576 .829		0.689	16.3 (3.1)	8	20
5	Passive Maths	S4.Q1 S4.Q2 S4.Q3 S4.Q4 S4.Q5 S4.Q6	.762 .762 .671 .720 .733 .775	0.85	0.829	25 (4.7)	10	30

Table 1: Components Extracted from EFA

Details regarding the extracted components

The following components were extracted through principal axis factoring using Cronbach's (1951) coefficient alpha to interpret the internal consistency, with .6 being the minimum value to be deemed reliable.

<u>Component 1 – Specific Tasks</u>

This 2-item scale was extracted with a questionable level of internal consistency (Cronbach, 1951). One reason for this may be that there are only two items, running a higher risk of lacking consistency. Another reason, could in fact be the number of respondents and with a higher response rate, the consistency could in fact rise. However, as there are only two items, and this had the least internal consistency, if an item is to be removed to add other questions, this would be the first.

<u>Component 2 – Maths in class</u>

This 3-item measure was extracted and interestingly, with all questions referring to actions within the classroom. This too reported questionable internal consistency at .588, with a relatively high mean of 11 and a possible maximum of 15 indicating a relatively positive attitude towards maths in class. This could be expected with a small number of items. Furthermore, with a sufficiently larger sample size, the alpha coefficient was expected to rise.

<u>Component 3 – Active Maths</u>

This 5-item scale appears to have varied questions that can arguably be connected through the verbs that imply an action has to be taken. This is therefore arguably measuring active maths, and an acceptable level of internal consistency can be has been identified at .68. If rounded, this would be regarded acceptable internal consistency.

<u>Component 4 – Calculation Tasks</u>

This 4-item scale was extracted from section 2 also, and whilst involving verbs may more specific to calculation tasks, and found an acceptable internal consistency at .689.

Component 5 – Passive Maths

The whole of section 4 in the original measure was extracted as a whole component. Looking at the questions, it could be argued that they are connected through being passive experience of maths, such as, sitting in a classroom; watching the teacher; listening to someone talk; and reading a book. Unlike components 3 and 4, which are active experiences, these experiences very much involve the opportunity to observe more. This therefore became a 6-item scale measurement. Of all measures, this was found to have the highest internal consistency of .829 implying a very reliable level of consistency. Such results can be used as evidence to argue that this 6-item scale can be deemed a reliable measure based on the population who answered, and therefore be used in further research.

Evaluation of the pilot

The pilot study was found to be successful for a number of reasons. One reason being the practicality of attaining a large number of respondents in a short space of time. This process involved attaining informed consent from the head teacher as the gatekeeper, who then provided access to pupil respondents through distributing questionnaires to teachers. Teachers then supplied their pupils with questionnaires and instructed them to ensure they did not write their names anywhere and that they should place the questionnaires face down on their desks once completed. This method ensured that the young respondents could remain anonymous whilst providing the researcher the opportunity to collect a larger sample in a shorter space of time. Along with maintaining strong ethical and professional practice, this method of data collection can be deemed useful for further research in primary schools. However, one issue that would potentially result is the young respondents feeling they have to complete the questionnaire, given that an authority figure, such as their teacher, is providing it. Previous research has used teachers to ask pupils questions directly (Mackay and Watson, 1999 in Grieg et al, 2013). As a result, it was made clear to teachers that this questionnaire is to only be answered if the children wished to answer, and that this should be made clear to them before handing it out, to avoid coercion (Wendler and Wertheimer, 2017) or socially desirable responses (Steenkamp, DeJong and Baumgartner, 2009). This was also made clear to children in an information sheet provided along with the questionnaire itself.

Piloting the measure provided the opportunity to see how children really conceptualised the questions asked. From analysing the Factor Analysis, it became clear children felt different about different areas of the questionnaire. Following the Factor Analysis, multi-item scales were computed to assess the reliability of the extracted multi-item components. Whilst most of the scales had acceptable levels of internal consistency .68; .69; .83, the alpha coefficient could rise with a bigger sample. The same argument applies when assessing normal distribution. Looking at the means and standard deviations of each of the scales (see table 1), it was found that most measures were almost normally distributed with a negative skew caused by the majority of respondents feeling very positive about mathematics. Given that this is only one cohort within one school, an argument can be made that this is not a comparable sample of the population of study, providing another reason to conduct further research.

As a result of the pilot, a further decision was made to add questions that elicit emotional responses. This decision was made as a result of reviewing the measure and noting that all items are more related to behavioural responses that are based on hypothetical situations that respondents can expect to face in their school life. Therefore, to measure attitudes fully, questions that relate more to emotional responses regarding maths should also be added. In order to prevent significantly increasing the length of the questionnaire, the BAM measure was further adapted by removing two questions from section 5, passive maths, which both focused specifically on times table over general passive maths related questions. A copy of the whole questionnaire used for the study can be found in Appendix G.

Planning the analysis post pilot

The pilot identified a reliable measure in BAM. It was therefore decided that the measure would be used for the research and a number of independent variables would be added. It was also decided that an additional dependent variable would be added, which aimed to measure emotional attitudes to mathematics, along with a measure of gender ability beliefs.

Whilst the initial aims of the research were to identify factors associated with pupils' attitudes to mathematics, there was also an aim to measure teachers' attitudes and identify if they associated with pupil attitudes. Teachers were therefore asked to answer their own questionnaire, which consisted of an adapted version of the Children's BAM and the same questions as the EAM measure, with additional questions concerning their confidence in teaching.

School characteristics were also measured using readily available information online. This included the Index of Multiple Deprivation of the area in which the schools were situated, the percentage of pupils eligible for free schools meals, and the average score in maths. All of these indicators were accessed by online government sources (GOV.UK, 2018a; 2018b). This information was entered at the pupil level and the clustering of these values will be discussed in the statistical techniques and data management sections.

Emotional Attitudes to Mathematics (EAM)

Upon reviewing the pilot study and considering the wording of the statements, it was felt that there needed to be an additional measure in order to completely capture pupils' attitudes to mathematics. The 17-item statement measuring behavioural attitudes to mathematics was based on how the respondent would react to a certain situation that involved some sort of mathematics. However, this did not concern emotional aspects of attitudes towards mathematics such as, motivation (Tapia and Marsh, 2004), which has been identified as crucial to positive learning (Bandura and Cervone, 1986; Schunk, 1991; Min Kim et al, 2014). The quality of a student's emotional life has also been identified as a factor in attitudes towards mathematics (Colomeischi and Colomeischi, 2015). This led to the decision to design another smaller, more concise multi-item scale known as Emotional Attitudes to Mathematics. This measure focuses on instinctive responses as opposed to asking the respondents to place themselves in a specific situation and then ask them to state their response based on that situation. Therefore, the measure only aims to a) measure their initial thoughts towards mathematics, and b) ensure they understand the nature of the responses and provide reliability to the designed measure.

The measure was designed in this way to address the theoretical concerns regarding children as respondents. Vygotsky's social constructivist perspective emphasises the socially interactive nature of learning (Kellett, 2011). The respondents were therefore required to learn how to answer the responses. As it was of the utmost importance that the measure was designed in a way to maintain the respondent's concentration for a short period of time, it was decided that there must be a set of rules in how the respondents could respond, that were also seen as providing an element of interactivity. This is not uncommon when considering children as respondents. Kellet (2011) discussed the new wave of participatory research that has emerged which consults with, and listens to, children by directly involving them within the research process itself. When discussing the measure with the respondents, this was done so in a way that informed the respondents of how they were required to draw their own Emojis whilst telling us their honest thoughts on how they felt regarding the subject. Therefore, the respondents had to concentrate on the statement they were reading, and then ensure that they provided the response they wished correctly, through providing the Emoji or face in the appropriate column.

The six statements were carefully selected following a review of the pilot study and considering what may not have been accurately captured. In order to capture more value of mathematics, it was felt that respondents should be provided the opportunity to state to what extent they believe mathematics to be important. This is particularly important in the context of learner identities, considering those who consider themselves to be non-mathematical (Williams, 2008) would be expected to express non-STEM identities (Macdonald, 2014), and therefore see mathematics as less important. A similar rationale influenced the decision to provide respondents the opportunity to state how much they like or do not like mathematics, however the very nature of these items were to provide clear, written language for children of this age to understand (Kellet, 2011) in order to aid reliability of the overall measure. Respondents were also asked to state how much they enjoy mathematics in class, to provide an additional opportunity to express enjoyment in the separate measure and aid concurrent validity of the new measure. The final two statements, allowed respondents to state whether they find mathematics easy or hard, to simply try and assess self-confidence more directly in comparison to the BAM measure.

The measure was designed by opting to use a five-point Likert scale response system from 'strongly agree' to 'strongly disagree'. There were six statements that respondents had to answer, all of which included five blank faces, one for each response. Respondents had to fill in one blank face per statement, which face had to be filled in the correct option and had to be the correct face that represented the answer they wished to provide (see Figure 5 below).

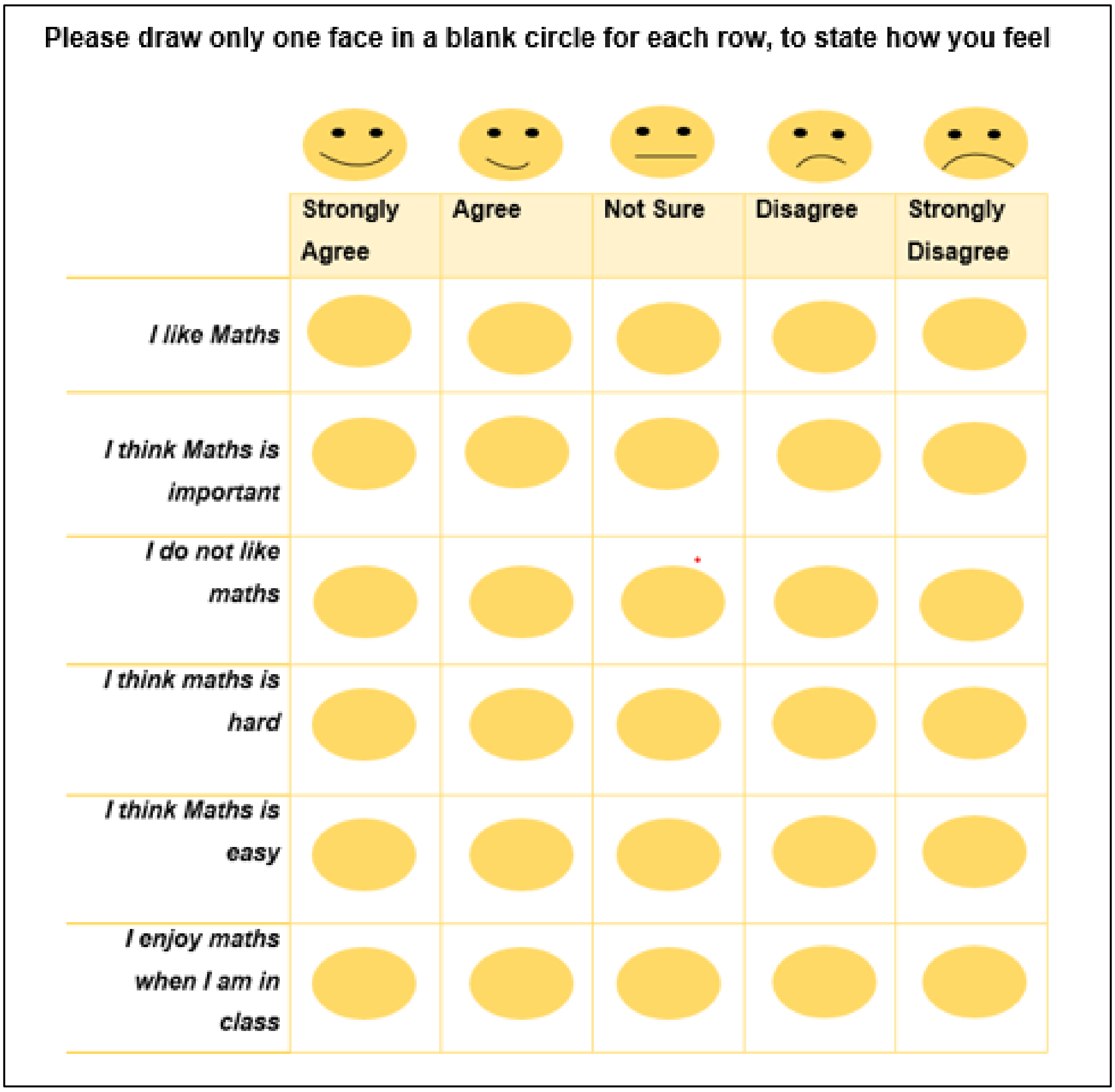


Figure 5: Emotional Attitudes to Mathematics from the Respondents' Perspective

Therefore, if a respondent wished to 'strongly agree' with a statement, they had to provide the correct face to represent 'strongly agree' and provide that face in the 'strongly agree' column for that answer.

The measure was coded by using a scale of 0-4. Four provided the most possible positive answer whilst zero provided the most possible negative answer. The negative statements were provided a scale of 0-4 as opposed to 4-0. This was to reflect the same values as the positive statements. Therefore, with some statements being reverse coded, the measure aimed to provide another layer of reliability in measuring the respondents' attitudes, by ensuring that different responses were provided for different statements. For example, if a respondent strongly agreed that they 'like maths', we could expect them to 'strongly disagree' that they 'do not like maths'. In providing these responses, along with the correct face in the correct column, the measure itself builds evidence to suggest that the respondents understood the statements throughout their answering of the measure. In doing this, when analysing the data later, any findings that may be found concerning this measure could be deemed reliable through the extensive efforts carried out to ensure that the young respondents understood and engaged in the measure throughout. Whilst there is concern about negative statements (Mabelis, 2019), consideration of psychological evidence such as Piaget's 'Concrete Operations' (in Wadsworth, 2003) and age groups of the sample's capability of logical thought (Ghazi et al, 2014) warranted the attempts to further the reliability of the measure, whilst ensuring statements remained short and worded clearly (deLeeuw, 2011; Mabelis, 2019).

Table 2 below provides an overview of the coding behind the measure.

	Strongly Agree	**Agree**	**Neither**	**Disagree**	**Strongly Disagree**
S1	4	3	2	1	0
S2	4	3	2	1	0
S3	0	1	2	3	4
S4	0	1	2	3	4
S5	4	3	2	1	0
S6	4	3	2	1	0

Table 2: The Coding of EAM

The measure was coded in such a way in order to compute a total score that measured, overall, Emotional Attitudes to Mathematics. Some statements were positively and negatively worded, whilst concerning the same issues, to ensure respondents provided different answers to each statement to show they understood the statements and the responses they provided could be deemed reliable for research. The highest possible score out of the six statements is therefore 24. A variable, consisting of the total scores, would then be used for analysis as a dependent variable when concerning factors associated with attitudes to mathematics.

Measuring Gender Ability Beliefs

The United Kingdom has somewhat attained a reputation that it is acceptable to be poor at mathematics (Epstein et al, 2010; National Numeracy, 2016a; Royal Society, 2019). Negative attitudes appear to be at the root of this overall ability (National Numeracy, 2015). Furthermore there appears to be a discourse where the perception of successful mathematicians is of 'nerdy boys' and the bright but socially inept (Epstein et al 2010), meaning that those who do not identify with such discourses, particularly girls and young women, seek to establish non-STEM identities (Macdonald, 2014). Research has also been conducted on how female maths teachers negatively affect the levels of maths anxiety and mathematics performance of female students (Beilock et al 2010). It was therefore decided that along with attitudes to mathematics; attitudes towards gender abilities must also be measured. Inspiration for this was taken from Beliock et al's (2010) study of female teachers and their effect on female students in relation to both maths anxiety and achievement although this study was completed in the USA, the method of measurement used could arguably still be used in the UK as there is nothing specific to US education.

"The combined measure of gender ability beliefs was formed by assigning a score of 1 to drawings of a boy and a score of 0 to drawings of a girl, and then subtracting the reading drawing score from the math drawing score (math drawing - reading drawing).

- *Thus, a score of <u>1</u> indicates that a child drew a boy as being good at math and a girl as being good at reading,*
- *a score of <u>0</u> indicates that a child drew the same gender for each story,*
- *and a score of <u>-1</u> indicates that a child drew a girl as being good at math and a boy as being good at reading.*
  In other words, the higher the gender ability belief score, the more children ascribed to the traditional Gender Ability Beliefs

Beilock et al (2010:1863)

This very method, known as a ‘draw a person’ task (Short et al, 2011; Syyeda, 2016), was employed for this research. However, rather than read a story to respondents, they simply had to draw a picture in a box of ‘somebody good at maths’, and again in another box of ‘somebody good at reading’. A similar technique was carried out with older pupils (Syyeda, 2016), where respondents were additionally asked to provide a brief paragraph about their relationship to maths. To ensure data could be quantified reliably, it was made explicitly to the respondents that they had to draw one person in each box and they had to indicate the gender as ‘boy’ or ‘girl’ to be clear which gender they believed to be successful at each skill.

Table 3 provides the possible scores.

Maths Drawing – Reading Drawing = Gender Ability Beliefs Score

Maths Drawing Score	Reading Drawing Score	Gender Ability Beliefs Score
Boy (1)	Girl (0)	1
Boy (1)	Boy (1)	0
Girl (0)	Girl (0)	0
Girl (0)	Boy (1)	-1

Table 3: Computing a Total Score for Gender Ability Beliefs

Pupil Characteristics

The whole measure consisted of two dependent variables; an adapted and condensed version of the UK-MAS by Hunt et al (2011), titled Behavioural Attitudes to Mathematics and a newly designed measure of Emotional Attitudes to Mathematics. A number of independent variables were added resembling the demographics of the pupils, such as gender and ethnicity. Following the literature review, it was decided that the components of attitudes to mathematics would also be measured as independent variables in order to assess whether the four components can depend on one another. A separate statement was included to measure, confidence, value and motivation. Due to the terminology of BAM, it was felt that Enjoyment had already been captured in that variable. Additionally, their learner identity was also measured by asking their favourite subject, to measure if those who valued mathematics more than others had different attitudes. A full description of each independent variable has been provided after table 4.

Table 4 provides an overview of the independent variables applicable to the respondents' individual responses.

Variable	Variable Type	Coding
Gender	Nominal	0 = Male 1 = Female
Age	Scale	8 -9
Favourite Subject	Nominal	0 = Not Maths 1 = Maths
Ethnicity	Nominal	0 – 17 (Order can be seen in figure)
Someone good at maths	Nominal	0 = Girl 1 = Boy
Someone good at reading	Nominal	0 = Girl 1 = Boy
Gender ability beliefs (computed variable)	Scale	-1 = Girl good at Maths, Boy good a reading 0 = Same gender selected for both 1 = Boy good at maths, Girl good at reading
I am good at maths I do maths at home My parents help me with maths homework	Ordinal	1 = Strongly Disagree 2 = Disagree 3 = Not Sure 4 = Agree 5 = Strongly Agree

Table 4: Independent Variables for Respondents

The questionnaire was reviewed with a Year 4 primary school teacher in order to confirm all questions would be understood. It was therefore decided after the discussion with the primary school teacher, that the variables would be presented as they are in the variable breakdown below. Respondents were clearly told they did not have to answer any questions they did not wish to and that they can simply leave any or all questions blank if they wished and the questionnaire would be quietly collected from them after all questionnaires were completed.

Gender

The first question required the respondents to add one answer ('Boy' or 'Girl') to the statement 'I am a..'. Whilst other options could have been provided for gender, at the time of designing this questionnaire it was felt that given the age of respondents and the anonymity to which they answered the questionnaire, they could simply answer the gender to which they identify or not answer the question if they felt they did not want to.

Age

Pupils were asked their age to confirm whether they were in fact 8 or 9 years old. This was due to the possibility of having pupils not of this age due to migration from certain countries where they would be of a different age at this stage of their education. If respondents were not eight or nine years old, they were not included in the data analysis. This decision was made on the grounds that the research would assess the attitudes of year 4 students between eight or nine years old in the UK.

Value

After reviewing the literature (Tapia and Marsh, 2004; Kalder and Lesik, 2011; Meece et al, 2006) concerning the importance of enjoying and valuing maths, it was decided that an interesting factor to consider would be whether the respondents regard mathematics as their favourite subject and if this has any effect on their overall attitudes to mathematics. Respondents were simply required to answer a statement by providing their favourite subject over a blank to finish the following statement: "My favourite subject is _________". This was simply coded into maths or 'other' for any subject given other than maths.

Ethnicity

The measure used for ethnicity was granted permission for use by the authors of '*The Children's Society report on Well-being'* (Rees, Bradshaw, Goswami and Keung, 2008). The measure consisted of a breakdown of different ethnicities that fall under the categories of 'White', 'Black or Black British', 'Asian or Asian British', 'Chinese' or 'Any Other' and 'Mixed'. There were seventeen options for respondents and clarification was provided on the meaning of the ethnicities before the questionnaires were distributed.

Whilst it is important to understand the differences in ethnicity amongst respondents, this variable was later recoded into dichotomous categories, 'White' and 'BME'. This decision was made based on literature (Cline et al, 2002; Department for Education, 2003; 2015; Strand, 2011; McMaster, 2017), which identified that the main difference lies between White and 'BME' groups, and therefore this relationship would continue to be explored in this project based on the majority of the sample being white and the remaining respondents sharing a wealth of ethnicities.

Original Variable		**New Variable**	
Value	**Label**	**Value**	**Label**
	White	1	White
1	British		
2	Irish		
3	Any Other White Background		
	Asian or Asian British	0	BME
4	Indian		
5	Pakistani		
6	Bangladeshi		
7	Any other Asian Background		
	Black or Black British		
8	African		
9	Caribbean		
10	Any other Black background		
	Chinese or Any other		
11	British Chinese		
12	Chinese		
13	Any Other		
	Mixed		
14	White and Asian		
15	White and Black		
16	White and Chinese		
17	White and any other		

Table 5: Overview for Recoding Ethnicity

Confidence

As discussed when introducing value, a variable to directly measure pupil self-confidence was implemented following the review of literature concerning children's abilities to understand statements (Kellett, 2011) and considering whether the four components of attitudes to mathematics can be dependent on one other (Tapia and Marsh, 2004). In order to try and capture the respondents' confidence in mathematics, they were asked to state their response on a five point Likert scale, the degree to which they agreed they were 'good at maths'. This, along with the other two questions in the same section, were recoded into dichotomous categories of 'Agree' and 'Disagree'. This was because when analysing the distribution and testing for parametric assumptions, confidence levels amongst the sample could not be established when using the desired dependent variables and the five responses for each statement die to the lack of distribution amongst each response. By dichotomously coding the response, this was rectified.

Motivation

This variable was introduced for the same reason as self-confidence, above. This statement was intended to capture the respondents' perception of whether or not they use their maths skills at home and not just in school. Doing maths homework elicits a form of extrinsic motivation Ryan and Decci, 2000) and in order to capture motivation, it was decided that pupils would be required to respond to the statement, 'I do Maths at Home'. This was recoded like the statement, "I am good at maths".

Parental Help

As this research could not capture parental attitudes for ethical reasons, pupils were asked how much support they felt they received from parents with mathematics homework. Like the previous statement, this was also designed to capture whether the respondent feels they do not only use their maths skills in the classroom. The decision to add this statement and the previous statement, stemmed from the discussion amongst the literature discussing the importance of parental support (Fan and Williams, 2010). This was captured by having pupils respondent to the statement ‘My parents help me with maths homework’. This was also recoded like the two previously discussed variables.

Table 6 provides an overview of how the three variables from section six were recoded.

Original Variable I am good at maths I do maths at home My parents help me with maths homework		**New Variable** I am good at maths I do maths at home My parents help me with maths homework	
Value	Label	Value	Label
1	Strongly Agree	1	Agree
2	Agree		
3	Not sure	Missing	Missing
4	Disagree	0	Disagree
5	Strongly Disagree		

Table 6: Recoding for Section 6

Each variable was coded dichotomously with ‘not sure’ being removed from the analysis, as it can be argued that ‘not sure’ cannot be regarded as a valid response when comparing those who agreed and disagreed (Treiman, 2009).

Dependent Variable 1: Behavioural Attitudes to Mathematics (BAM)

Variable	**Variable Type**	**Coding**
Section 1: Specific Tasks Having a teacher watch you multiply 4 by 3 on paper Being asked to add up the number of people in a room	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree

Section 2: Maths in Class Being asked to write an answer on the board at the front of your class Being asked to calculate £10 divided by four in front of your teacher Being asked a maths question by a teacher in front of your class	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree
Section 3: Active Maths Taking a maths test Being given a surprise maths test in a class Being asked to calculate a percentage Working out how much time you have left before you set off to school Deciding how many sweets each friend can have if you are all sharing	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree
Section 2: Calculation Tasks Calculating with a pencil on paper Adding up a pile of change Calculating how many days until a person's birthday Deciding how many sweets each friend can have if you are all sharing	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree
Section 5: Passive Maths Listening to someone talk about maths Reading a book that is about maths Watching someone times a one digit number by a two digit number Sitting in a maths class	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree

Table 7: Behavioural Attitudes to Mathematics Overview

The BAM scale consisted of seventeen statements in total, originally aimed to measure five separate concepts. For this project, it was decided to use all five concepts collaboratively as one dependent variable to test for difference and relationships between the independent variables discussed. This is one of the two dependent variables to be used in measuring children's attitudes to mathematics. As discussed previously, respondents were required to circle the Emoji that they felt best represented their response to the seventeen statements.

Dependent Variable 2: Emotional Attitudes to Mathematics (EAM)

Variable	Variable Type	Coding
I like maths I think maths is important I think maths is easy I enjoy maths when I am in class	Ordinal	(Positive) 0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree
I do not like maths I think maths is hard	Ordinal	(Negative) 4 = Strongly Disagree 3 = Disagree 2 = Not Sure 1 = Agree 0 = Strongly Agree

Table 8: Emotional Attitudes to Mathematics Overview

The EAM consisted of six statements intended to measure their initial feeling towards maths. Two of the six statements were negatively worded and purposefully recoded to ensure different answers were provided to elicit a similar response and ensure the sample as a whole reliably understood the newly designed measure. As discussed previously, respondents were required to draw a face to represent their response for each statement, drawing a total of six faces.

Teacher Characteristics (Clustering Variables: Level 2)

Teachers were asked to complete a questionnaire regarding their attitudes to mathematics. These responses were inputted with pupil responses to act as a potential factor associated with a pupil's attitude to mathematics.

Teachers' Maths Anxiety

Teachers' attitudes were measured through two separate measures. The first to be discussed, was an adapted version of Hunt et al's (2011) MAS-UK measure, in order to assess whether teacher anxiety negatively affected pupils' attitudes to contribute to the evidence previously collected by other studies (Beilock et al, 2010).

Teachers' responses were inputted for each of their pupils in order to recognise the variable as the pupil's teacher's attitude, which is why these variables are regarded as clustering variables.

Variable	**Variable Type**	**Coding**
Section 1 – Being Asked by Pupils Being asked to write an answer on the board at the front of your class Being asked to calculate £644 divided by four in front of people Being asked a maths question by a pupil in front of a class Being asked to add up the number of people in a room	Ordinal	1 = Not at all Anxious 2 = Not Anxious 3 = Not Sure 4 = Anxious 5 = Very Anxious
Section 2 – Demonstrating	Ordinal	1 = Not at all Anxious 2 = Not Anxious

Being asked to show something about maths on the board in front of your class Being asked to show how to calculate a percentage to your pupils Being asked a maths question by a pupil and demonstrating how to answer it		3 = Not Sure 4 = Anxious 5 = Very Anxious
Section 3 – Confidence Taking a maths test yourself Being asked to calculate a percentage yourself Working out how much time you have left before you set off to work Deciding how much money each person owes you after you buy something that you are all sharing	Ordinal	1 = Not at all Anxious 2 = Not Anxious 3 = Not Sure 4 = Anxious 5 = Very Anxious
Section 4 – Practical Cognition Calculating with a pencil on paper Adding up a pile of change Calculating ow many days until a person's birthday Working out how much change you should have after buying something	Ordinal	1 = Not at all Anxious 2 = Not Anxious 3 = Not Sure 4 = Anxious 5 = Very Anxious
Section 5 – Passive Maths Listening to someone talk about maths Watching someone multiply a one digit number by a two digit number Sitting in a maths class as a student Observing a colleague in their class teach maths	Ordinal	1 = Not at all Anxious 2 = Not Anxious 3 = Not Sure 4 = Anxious 5 = Very Anxious

Table 9: Teacher Maths Anxiety Overview

This 19-item scale was adapted from the pupils' Behavioural Attitudes to Mathematics and designed more to reflect the influential measure, UK-MAS by Hunt et al (2011). This also consisted of the original coding that examined how concerned a teacher would be in certain situations, with the option to say they are not at all anxious. A total variable was computed by collaborating all nineteen items, creating a scale measure of Teachers' Maths Anxiety.

Variable	**Variable Type**	**Coding**
I am good at maths I do maths at home I believe I am good at teaching maths	Ordinal	1 = Strongly Disagree 2 = Disagree 3 = Not Sure 4 = Agree 5 = Strongly Agree

Table 10: Teacher's Perception of Mathematics Ability Overview

Teacher Self Confidence and Motivation

The following three variables measured aspects of teachers' attitudes where teachers had a five-point Likert scale from 'Strongly Agree' to 'Strongly Disagree' to elicit their response.

Teacher Self Confidence

This question was used in the questionnaire with the intention to capture the teachers' confidence in their own maths abilities. This was presented through the statement 'I am Good at Maths' was intended to be used as an independent variable to test with pupils' attitudes to mathematics overall.

Motivation

This statement was presented as ‘I do maths at home’. This question was used in order to assess whether the teachers believe they use their maths skills at home and to test whether this in any way affected pupils’ attitudes.

Confidence in teaching mathematics

This statement was presented as ‘I am Good at teaching mathematics’. It was believed that a teacher could be confident in teaching the mathematics they teach whilst not being confident in mathematics in general, which is why this question was also asked. It was also of interest to see if a teacher’s confidence in teaching affects pupils’ attitudes.

Teachers’ Emotional Attitudes to Mathematics (TEAM)

Like the variable measuring, pupils’ emotional attitudes, this variable also intended to measure the same aspects, including enjoyment and value.

Variable	**Variable Type**	**Coding**
I like maths I think maths is easy I enjoy teaching maths	Ordinal	4 = Strongly Disagree 3 = Disagree 2 = Not Sure 1 = Agree 0 = Strongly Agree
I do not enjoy teaching maths I think maths is hard I do not like maths	Ordinal	0 = Strongly Disagree 1 = Disagree 2 = Not Sure 3 = Agree 4 = Strongly Agree

Table 11: Teacher Emotional Attitudes to Mathematics Overview

This measure was intended to be used as an independent variable to test for a relationship between TEAM and pupil attitudes. The measure consisted of six items, four being the same as the pupil measure, whilst also adding questions regarding whether they enjoy teaching maths. The six statements collaboratively compute a scale variable, with three statements worded negatively and reverse coded deliberately to further ensure teachers provided different responses that elicit the same view and provide evidence of reliability in teachers understanding the measure.

Whilst other studies have measured teachers' attitudes using separate independent scales (Beilock et al, 2010; Thiel, 2010), it was important for this study to focus on pupil attitudes. The designing of questionnaires therefore required a focus on pupils' questionnaires and in order to maintain consistency in how attitudes to mathematics were measured, in regards to the perspective of this study, it was decided that teachers would answer similar attitudinal measures to their pupils. A total of 19 teachers, with 508 pupils respectively, answered the questionnaires for this study. A copy of the teacher questionnaire can be found in Appendix G.

School Characteristics (Clustering Variables: Level 3)

Details regarding the school were additionally collected as independent variables to test for association with pupils' attitudes to mathematics through bivariate analysis, with the view to further analyse relationships via Multilevel Modelling.

Variable	**Variable Type**	**Coding**
% Free School Meals (FSM)	Ordinal	3.1 4.6 7.5 12.7 20 20.9 27.4 28.5 57.2
School IMD Decile (1 = Most Deprived, 10 – least deprived)	Ordinal	1 (Most Deprived) 3 5 6 7
MPS2	Ordinal	-1 = Below Average 0 = Average 1 = Above Average

		2 = Well Above Average
Average Score in Maths (ASM)	Ordinal	101 104 105 106 109
Maths Progression Score (MPS)	Scale	Mean = .89 Median = 1.2 Mode = 1.2 Range = 7.9 Min = -4 Max = 3.9

Table 12: School Variables Overview

Percentage of Pupils Eligible Free School Meals (FSM)

The percentage of pupils eligible for free school meals for the school was gathered from the GOV.UK's (2018a) 'Get information about Schools' service, which is publicly accessible. Each respondent from a particular school was assigned the percentage applicable to the school and the percentage does not in fact indicate whether or not they are eligible for free school meals, which is why this variable must be treated as a school clustering variable.

Maths Progress Score

This variable provides a raw score that indicates the progression of the school specifically in mathematics, which has been derived from GOV.uk's (2018b), 'Find and compare Schools in England' Service, which provides a calculation of the schools' pupils' progress from Key Stage 1 to Key Stage 2.

Maths Progress Score 2 (MPS2)

This variable takes into account the category that each school falls in from 'well below average' to 'well above average' and was also taken from the GOV.uk's (2018b), 'Find and compare Schools in England' Service.

Average Score in Maths

This variable provide an average calculated score in mathematics, which is also publicly accessible through GOV.uk's (2018b) 'Find and compare Schools in England' Service. This score displays how well pupils did in the Key Stage 2 maths test and the expected standard score is 100.

Statistical Techniques

Univariate Analysis

As a rule, a prior stage of statistical analysis and interpretation of findings is establishing the sample's comparability of the population from which it was collected (Mirela-Cristina, 2013). Variables were assessed individually and compared to the population of study in order to deem whether the sample could be deemed comparable of year 4 pupils in the UK. This included a comparison of gender proportion, ethnicity proportion, along with comparison of the samples' deprivation levels and maths progression scores in comparison to the population of study. Data was analysed initially through univariate analysis to assess the distribution of the data, using the scale dependent variables to determine how normally distributed the data was overall. Independent variables were also analysed to assess the distribution of data. Some variables were cleaned and recoded when few groups provided a particular answer. For example, the original 17-option measure for Ethnicity was recoded into White and BME due to the overwhelming majority (90%) being white and the rest of the sample being a wide variation of different minority ethnicities. This also aligned with the research questions and contributing to ongoing theory, that compare white pupils to BME pupils overall.

Reliability and Validity

The two dependent variables additionally were analysed to assess the reliability and validity as measures. Reliability analysis was conducted using Cronbach's Alpha (1951) coefficient, interpreting a score between 0 and 1 with 0.6 regarded as sufficiently reliable. For validity, the average variance extracted was calculated by analysing the factor loadings of a Confirmatory Factor Analysis of the dependent variables in SPSS. The loadings were then inputted into Microsoft Excel, in order to be squared and then the sum of the squared loadings was divided by the number of items. This was done to produce a value between 0 and 1, with 0.5 being the minimum value to indicate convergent validity, also known as the Forner-Larcker Criterion (1981). Results of the reliability and validity of measures will be discussed in the following chapter.

Bivariate Analysis

Following univariate analysis, the independent variables were individually tested against the two dependent variables. This was carried out to assess how the independent variables related to the dependent variables, without considering the influence of additional independent variables. This then provides an identification of how those relationships may differ when adding the influence of additional independent variables in multivariate analysis.

Parametric assumptions were tested before carrying out any bivariate analysis to ensure the appropriate tests were used. The parametric assumptions carried out to determine the appropriate test included establishing confidence intervals amongst the sample according to each grouping within the dependent variable, ensuring those groups were homogenous through a Levene's test and using Q:Q Plots to confirm normal distribution amongst samples. In the case of testing for relationships, scatterplots were used to assess the distribution of the data in order to identify homoscedasticity and linearity.

Bivariate analysis consisted of both tests for differences and relationships and table 13 below provides an overview of each test carried out.

Independent Variable	(BAM)	(EAM)
Gender	Mann-Whitney*	Mann-Whitney*
Favourite Subject (Value)	*t*-Test***	Mann-Whitney***
Ethnicity	*t*-Test	*t*-Test
I am good at maths (Confidence)	TBC***	Mann-Whitney***
I do maths at home (Motivation)	*t*-Test***	Mann-Whitney***
Parental Help	ANOVA	ANOVA
Someone good at maths	*t*-Test*	*t*-Test*
Someone good at reading	*t*-Test	*t*-Test
Gender Ability Beliefs	ANOVA	ANOVA
I am good at maths(T)	ANOVA***	ANOVA***
I do at maths at home(T)	ANOVA***	ANOVA***
I believe I am good at teachings maths (T)	ANOVA***	ANOVA***
BATM (T)	Spearman' Rho***	Spearman' Rho ***
EATM (T)	Spearman' Rho ***	Spearman' Rho **
% Free School Meals (S)	ANOVA ***	ANOVA**
School IMD Decile (S)	ANOVA***	ANOVA***
Maths Progress Score (S)	Spearman' Rho	Spearman' Rho
MPS 2 (Averaged) (S)	ANOVA***	ANOVA***
Average Score In Maths (S)	ANOVA***	ANOVA***
	* <.05 **<.005	*** <.001
	(T) Teacher Answer	(S) School Groupings

Table 13: Bivariate Analysis Overview

Multivariate Analysis

The main purpose of this research is to identify factors associated with attitudes to mathematics. In order to do so with a reliable sample and produce generalisable findings, it was decided that multivariate statistical models would best represent the attitudes and how they affected of pupils. Multivariate models allow consideration of the influence of multiple factors, therefore considering females may differ in ethnicity, which may result in different attitudes. This was of particular importance when considering generalising arguments that would be made following the analysis, and by producing findings that consider factors collaboratively, a more accurate argument can be made.

Multiple Regression

Multiple regression models simply assume that all variables are measured at the same level and are independent of each other and therefore do not take into account the group effects, which violates such assumptions (Steele, 2008). It was therefore decided to assess the influence of multiple pupil characteristics simultaneously through multiple linear regression. A regression model was ran twice, one for each dependent variable.

Although there is a wide range of research tools available, multiple regression provides the opportunity to determine the effect of more than one independent variable on a dependent variable (Guarav, 2010). For multivariate analysis, a series of models were built to test the relationships between a number of independent variables with the dependent variable, for both dependent variables. Models were built according to the clustering of variables, building a total of three multiple regressions for both dependent variables.

Each multiple regression aimed to test the overall fit of the model and whether the next model, containing a higher level of clustering variables, is a better fit than the model without. The regressions also aim to predict the effect each independent variable has on the dependent variable when controlling the influence of other additional independent variables.

Table 14 below provides an overview of the models developed through influence of literature and the hierarchal nature of the data. Originally, it was anticipated that a Multilevel Model would be used to assess the influence of the clustering variables. However, it was established that the data was insufficient to perform such tests, given the clustering variables were fewer than required to perform an appropriate mixed effects model. This therefore led to the decision to perform a multiple regression for this research, and a power analysis to determine the sample size needed to identify any effect with a model that acknowledges hierarchal clustering.

Model	**Independent Variables to be used**
Model 1	IVs at the pupil level
Model 2	IVs at the pupil and teachers' level
Model 3	IVs at the pupil school level.
Model 4	IVs at the pupil, teacher and school level

Table 14: Overview of Multiple Regression Models

The third model addressed the final research question, which concerned how all independent variables at the level of respondents, teachers and schools influence pupils' attitudes to mathematics. The models aim to address the theory that attitudes to mathematics are affected by a number of factors that also go beyond the control of the pupils. The model aims to address the theory that in order to understand how attitudes to mathematics are established, there must be a recognition of the important influence teacher attitudes and the overall progress of the schools attended. The multiple regression models confirm that they as models are a good fit to identify associated factors with attitudes to mathematics.

Multilevel Model

When considering the building of multivariate models that included external factors such as teachers' attitudes and schools' deprivation levels, it was acknowledged that the data would be subjected to hierarchal clustering. The clustering of multiple pupils in one teacher's classroom that could be further clustered with multiple teachers within a school, must be considered when analysing the relationship between such factors. Pupils are learning in classes and the characteristics of one teacher are likely to influence the pupils' attitudes and we would therefore expect the attitudes of pupils in the same class to be more alike than pupils from different classes (Steele, 2008). These variables must therefore be recognised as clustering variables and not be regarded as the same as variables that differ from pupil to pupil. Failing to recognise this issue could lead to significantly underestimating the standard errors of the estimated regression coefficients (De Leeuw and Meijer, 2008). Therefore, a Multilevel Model was deemed more appropriate, as has been demonstrated in other research (Ruiz, 2015), as it could assess the relationship between independent variables ascribed to the pupil individually, such as gender, whilst considering the potential relationship between a clustering variables such as a teacher's attitude on the same dependent variable. Multilevel Modelling is a common methodology in education (Ruiz, 2015; Syyeda, 2016) given the nature of hierarchal clustering amongst pupils in classrooms with one teacher and multiple teachers in one school (Steele, 2008).

Figure 6 below provides a visual aid for the clustering within the data.

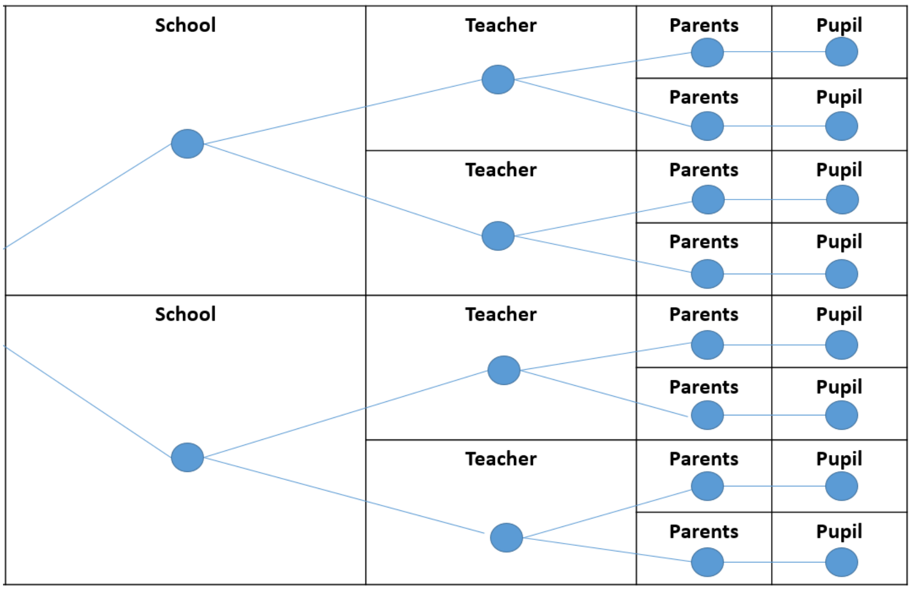


Figure 6: The hierarchal clustering of the data

This research managed to capture measures at the school and teacher level. However, due to sampling at the school level, and adhering to the ethical guidelines of the university and schools, parents could not take part in this research in order to maintain anonymity of the child respondents. Whilst parental attitudes would have been desirable, in order to uphold the ethical nature of this research, a decision was made to design a question that the pupils would be asked in order elicit how much support they feel their parents provide with mathematics homework. This will be used as potential factor of pupils' attitudes to mathematics.

Post Hoc Power Analysis: Calculating the Design Effect

Attempts were made to carry out Multilevel models when considering the clustering of teachers and of schools. In most cases, it was found that there was no variation in attitudes to mathematics between the clustering variables. However, calculations of intraclass correlation coefficients and conducting post hoc power analysis identified that the sample was not a suitable size for such models to be tested (Rutterford et al, 2015). A post hoc power analysis was carried out to estimate the design effect of schools to pupils' attitudes (Donner, Birkett and Buck, 1981, in Rutterford et al, 2015). The post hoc power analysis provided estimates of the needed sample size to test models with the same clustering as the data in the current research.

By calculating the design effect, we can use it to multiply by the sample size in order to estimate an appropriate sample size where a Multilevel Model can accurately estimate how much affect the school attended has on pupils' attitudes. In other words, calculate the requirements for a simple random sample (Lohr, 1999). This was done with the following equation designed by Donner, Birkett and Buck (1981, in Rutterford et al, 2015).

$$\boldsymbol{DE = 1 + (n - 1)\rho}$$

Below is an example, from the analysis chapter, of a calculation ofthe required sample size when clustering via schools.

Where: n = average clustering size (508/11 = <u>46.18</u>) and; p = ICC (0.04)

- ❖ $DE = 1 + (46.18 – 1)*.04$
- ❖ $DE = 1 + 45.18 *.04$
- ❖ $DE = 1 + 1.81$
- ❖ $DE = 2.81$

Data Management

Data was collected via paper questionnaires, which were anonymously answered by year 4 pupils of various schools across Greater Manchester, Lancashire and Nottinghamshire. Pupils responded to the questionnaires during class times, and did so without a teacher or parent. A Disclosure Barring Service (DBS) form was completed prior to engaging schools to take part in the research in order to ensure the researcher could be present with pupils without teachers. Each pupil was provided with a questionnaire, titled "Research Helper Booklet". Before answering the questionnaire, pupils were provided with information sheets informing them of their right to withdraw and their anonymity. It was also clearly stated to pupils that the booklet was not classwork and they did not have to complete it. If they did not wish to complete the questionnaire, or any individual answer, they simply left the questions unanswered and closed the booklet. Once questionnaires were completed, pupils were instructed to close their booklet and they were collected. Teachers did not have any influence or interaction with the pupils' questionnaires.

School ID	Teacher ID	Pupil ID
1	11	111
2	12	121

Table 15: ID System for Respondents

Summary: Linking the Theoretical Framework and Methodological Framework

Tapia and Marsh's (2004) ATMI provided evidence to suggest that measuring attitudes requires an attempt to measure four key components. This provided challenges for the current research where attitudes were being measured in younger ages, and therefore a condensed attitudinal measure was required to provide justification that the attention of respondents would be upheld throughout the questionnaire. Furthermore, as previous research on children's attitudes to mathematics of this kind had not been conducted before, it was also important to attempt to use previously validated measures in the UK that could then be adapted to meet the understanding of younger ages. This therefore presented the opportunity to elicit enjoyment through the use of Emojis and Likert scales where respondents could state their enjoyment of particular tasks. As particular tasks involved aspects of confidence, such as completing maths tasks in front of teachers and peers, value and motivation were both measured as both as independent variables, and were also part of a multi-item dependent variable, Emotional Attitudes to Mathematics. This was done in order to attempt to clearly measure the concepts distinctively whilst maintaining a reduced questionnaire suitable for the sample.

To uphold consistency, teachers answered a similar questionnaire to pupils. The main aim of this however, was to identify if any teacher attitudes were associated with pupil attitudes, given the evidence discussed in the literature review relating to this issue. The influence of teacher attitudes was observed through bivariate analysis and Multilevel Modelling. School Characteristics were measured via public accessible sources and there influence was observed through bivariate analysis and Multilevel Modelling.

This research provides a methodology that considered the key aspects of quantitative research such as measurement, and repeatability (Aliyu et al, 2014). In addition, the research aimed to maintain impartiality with the balanced use of clear terminology to elicit responses, using well known, visible acts of meaning (Bavelas and Chovil, 2011) such as Emojis to elicit those responses. The measurement can be upheld with the use of validated external factors and reliable techniques for attitudinal measurement along with the evidenced high reliability of the dependent variables (Cronbach, 1951). The repeatability can be upheld through the use of cluster sampling that efficiently gathered a sample, and reliably measured pupils attitudes whilst additionally observing the influence of external factors with specifically designed statistical techniques that can be repeated with a similar sample of study, to build more evidence of the influences of attitudes to mathematics in children.

Chapter 4: Assessing the Sample

Introduction to Chapter

This chapter focuses on individual variables and where necessary, demonstrates methods of data cleaning and recoding to make bivariate analysis more appropriate. The sample will first be assessed to identify whether it is comparable of the population of study. The variables measuring pupils' attitudes to mathematics will then be analysed to assess reliability and validity, in order to answer Research Question 1 (*Can we use questionnaires to reliably measure pupils' Attitudes to Mathematics?)*.

Assessing the comparability of the sample

Variables were analysed individually to assess the distribution of the data. This included using measures of central tendency (Mean, Standard Deviation) with scale variables such as the dependent variables measuring attitudes to mathematics, to assess whether there is a need to clean the data in order to ensure approximately normal distribution and meet one of the assumptions of parametric testing. This section will include three distinct levels: the pupils, the teacher and the schools.

School Characteristics

In a sample of 508 respondents, a total of eleven schools took part in the data collection. Table 16 shows the difference in size collected with some schools having larger classes than others. Other matters, such as parental right to withdraw their child, prevented more respondents from taking part in certain schools. This must be taken into account when assessing any potential differences in attitudes to mathematics according to school groupings.

School ID	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***9***	***10***	***11***
Frequency	*69*	*57*	*28*	*47*	*59*	*28*	*58*	*55*	*53*	*54*

Table 16: Sample Sizes Per School

Percentage of BME respondents at the School Level

Figure 7 provides an order of the distribution of schools according to the percentage of respondents who were BME labelled to the ID of the school, indicating a wide range from 0 to 89.8 percent. This sample includes schools with a varied range of ethnic diversity in order to provide a comparable population that also acknowledges the difference in diversity amongst individual schools.

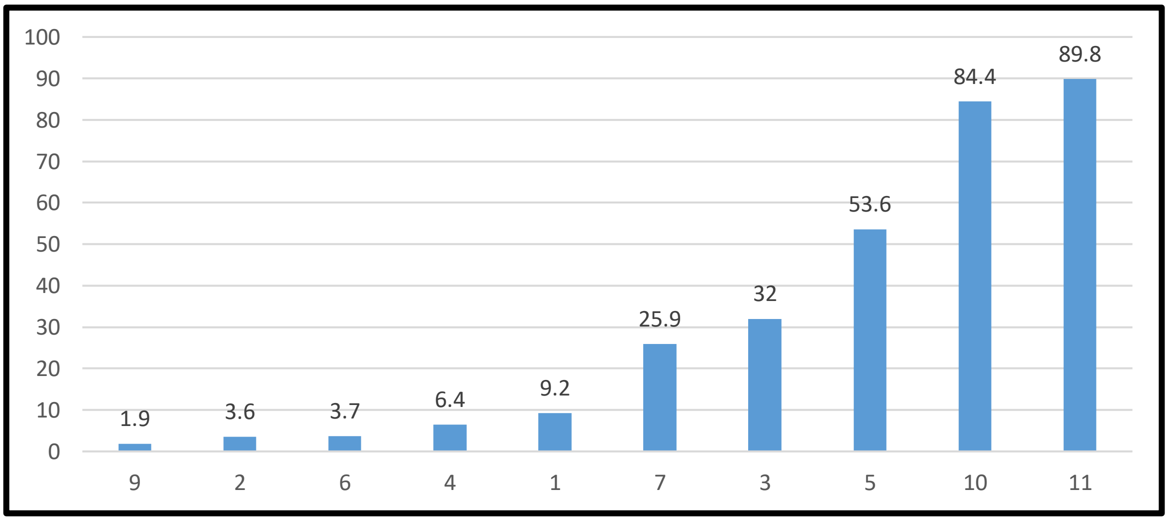


Figure 7: Distribution of BME Pupils Per School

Figure 7 provides a visual for the difference in percentage of BME pupils per school. This must also be taken into account when identifying differences in attitudes associated with school groupings.

Percentage of Free School Meals

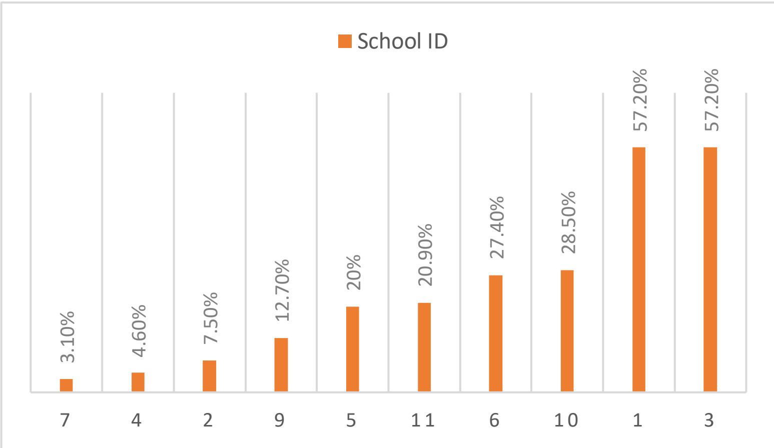


Figure 8: Bar Chart for Percentage of Free School Meals

One Sample *t*-Test	
Sample Average	23
National Average	13.7
Mean Difference	9.3
P Value	.000

Table 17: One Sample T-Test for Sample Average Percentage of Free School Meals.

Figure 8 provides an order of the distribution of schools according to the percentage of pupils eligible for free school. Table 17 indicates a wide range of deprivation within the sample by having schools take part with varying eligibility, from 3.1 to 57.2, with an average of 22.9% reported for the overall sample. This is significantly higher (p<.000) as reported in the one sample *t*-Test, than the national average, reported to be 13.7% (Department for Education, 2018).

Average Score in Maths

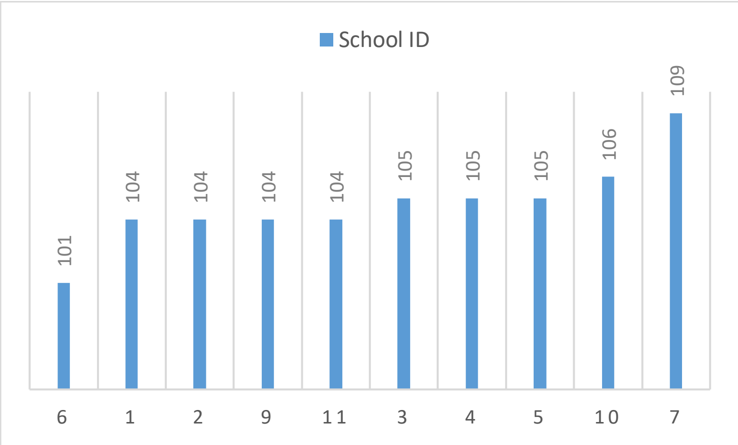


Figure 9: Bar Chart for Average Score in Maths

One Sample *t*-Test	
Sample Average	104.9
National Average	104
Mean Difference	.9
P Value	.000

Table 18: One Sample T-Test for Sample Average Score in Maths

Figure 9 provides a visual distribution of the average score in mathematics per school. The range consisted between 101 to 109, with an average score of 104.9 reported for the overall sample. This is significantly higher (p<.001) than the nationally reported average (104) for the same school year (Department for Education, 2019). This must therefore be taken into account when reporting maths abilities of the ample or discussing school characteristics.

Maths Progression Score

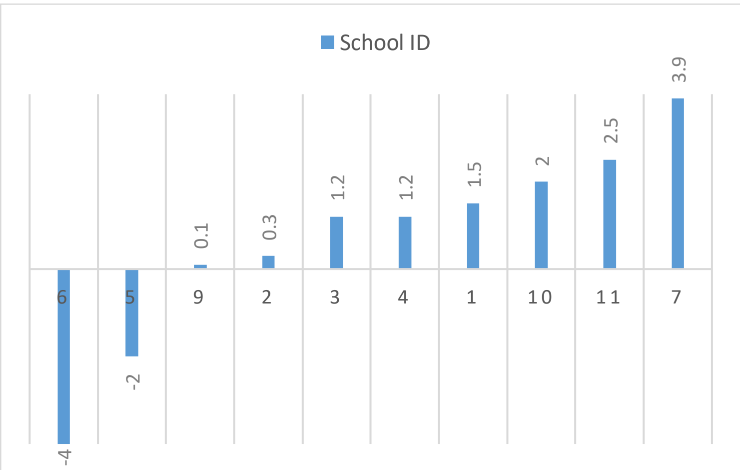


Figure 10: Bar Chart for Maths Progression Score

One-Sample *t*-Test	
Sample Average	.9
National Average	0
Mean Difference	.9
P Value	.000

Table 19: One Sample T-Test for Sample Average Maths Progress Score

Figure 10 provides a visual distribution for the maths progression score per school. A school can be awarded a score between -4 and 4. A score of 0 implies the national average progression and therefore a score above 0 would indicate 'above average'. The figure indicates that only two of the ten schools fall below the national average. Furthermore, the average progression score for the sample was .9. A one-sample *t*-Test identified the sample average was significantly higher than the national average ($p<.001$). The sample provided a wide range of scores from -4 to 4.9. This provides an indication that the sample consists of schools with 'well below average' and 'well above average' progression scores.

Teacher Characteristics

Teacher Gender

The teacher gender of the sample was heavily skewed towards females, with 431 respondents having a female teacher and 77 with a male teacher. Specifically, 85% of the sample had female teachers. This is however, close to the reported figure for the UK, which is 82.4% female (BESA, 2019).

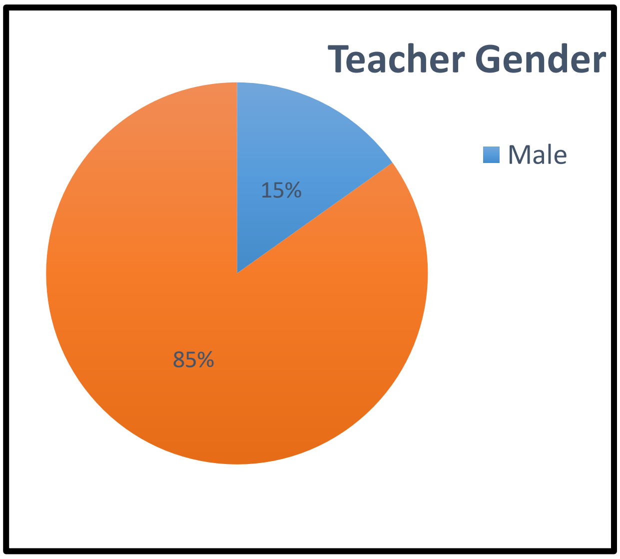


Figure 11: Pie Chart for Teacher Gender.

Teacher Confidence and Motivation

	Confidence	**Motivation**	**Confidence in teaching maths**
Strongly Agree	19%	19%	19%
Agree	45%	57%	69.2%
Not Sure	29.5%	24%	11.8%
Disagree	6.6%	0%	0%

Table 20: Descriptive Statistics for Teacher Variables

The majority of teachers indicated confidence in mathematics abilities and in teaching mathematics, whilst also indicating motivation. Only 6.6% of teachers disagree that they were not good at maths (confidence), which could help explain the significantly higher average score in maths and maths progression scores at the school level.

Teacher Attitudinal Measures

The measure of central tendency for the teacher attitudinal measures indicate a positive skew in teacher anxiety with the majority of respondents teachers reporting higher levels of maths anxiety. This provides contrasting results to the descriptive statistics for teachers' confidence and motivation. Additionally, the EAM measure reporting normal distribution with the mean score of 16.7 almost directly in the range of scores.

	BAM	**EAM**
Mean	32.7	16.7
Median	35	17
Mode	35	15
Std. Deviation	8.6	3.4
Range	32	16
Minimum	19	8
Maximum	51	24

Table 21: Measures of Central Tendency for Teacher Attitudinal Measures

Pupil Characteristics

Gender

The sample was almost 50:50 in terms of the ratio of male to female respondents with 243 male respondents and 252 female respondents. This provides less risk of bias when considering attitudes to mathematics and how they may be influenced by a particular gender.

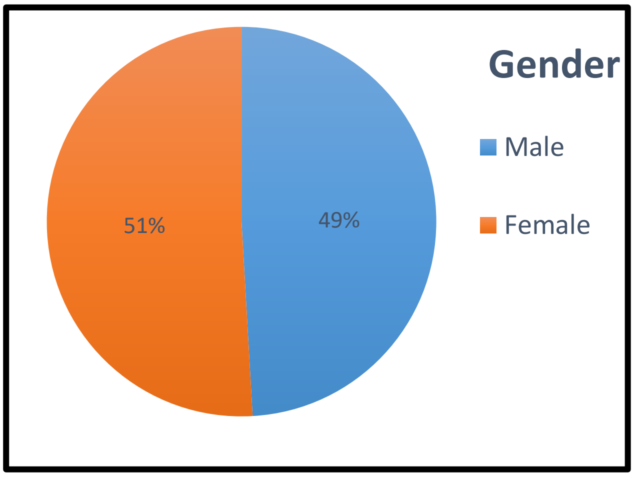


Figure 12: Pie Chart for Pupil Gender.

Favourite Subject (Value)

Pupils were asked to write their favourite subject and this was simply categorised dichotomously to Maths and Other. Of the 494 who responded, 189 stated that their favourite subject was mathematics. Figure 13 highlights how almost 40% of the sample indicated mathematics to be their favourite subject.

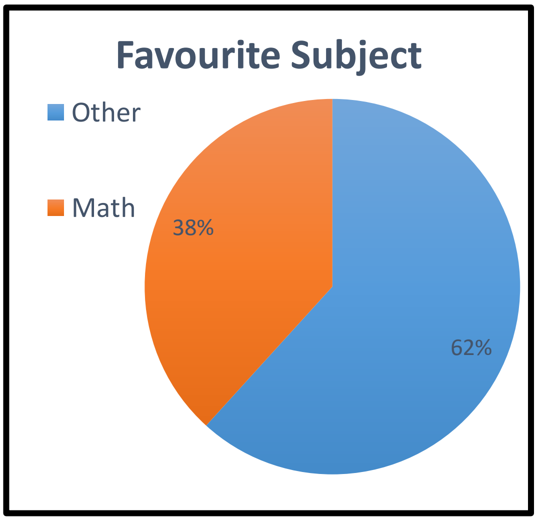


Figure 13: Pie Chart for Pupil Favourite Subject.

Ethnicity

Figure 14 provides a visual distribution of the recoded variable, Ethnicity. Due to the range in groups, it was decided to dichotomise the groups into White and Black and Minority Ethnic (BME). 31% of the sample were found to identify as BME, which is close to the nationally reported percentage of 33% (Department for Education, 2018). Specifically for this sample, of the 482 who answered, 148 stated they were of some BME ethnicity.

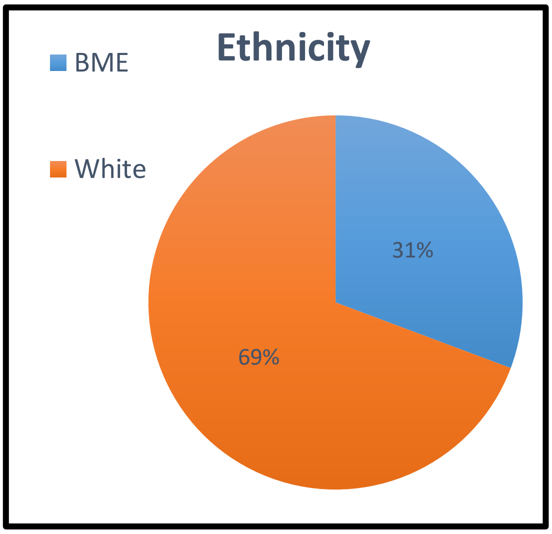


Figure 14: Pie Chart for Pupil Ethnicity.

Comparing the sample to the population of study

Cluster sampling was used to maintain comparability, which is a common procedure in educational research (McMillan, 1996). However, the schools that agreed to take part in the study also impacted on the comparability of the sample. The majority of the schools that consented to take part in research were from more deprived areas. This was identified when collecting publicly available data that measured deprivation through percentage of pupils eligible for free school meals. The deprivation of the sample was widely distributed, with a range of schools' pupils eligible for free school meals between 3.1% and 57.2% amongst the 11 different schools. The sample consisted of a range of different deprivation levels; however the average percentage of free school meals was 23%, significantly higher than the nationally reported rate, which is 13.5% (Department for Education, 2018). There must therefore be consideration that deprivation levels of the sample are higher than the average deprivation levels of a primary school in the UK. Abilities in mathematics was also considered when sampling schools. The average score in mathematics at the school level ranged from 101 to 109, indicating a wide range of abilities. The average score in mathematics for the sample was 104.9. This was significantly higher than the nationally reported average score in mathematics nationally, at 104. The sample, whilst more deprived than the national average, also consisted of schools with higher average mathematics scores than the national average. This must also be taken into account when comparing school characteristics. Figure 15 provides the national average mathematics scores are computed to be 0, taken from the Department for Education (2018) and compares the sample average mathematics progression scores, which was analysed via a box plot in IBM SPSS Statistics.

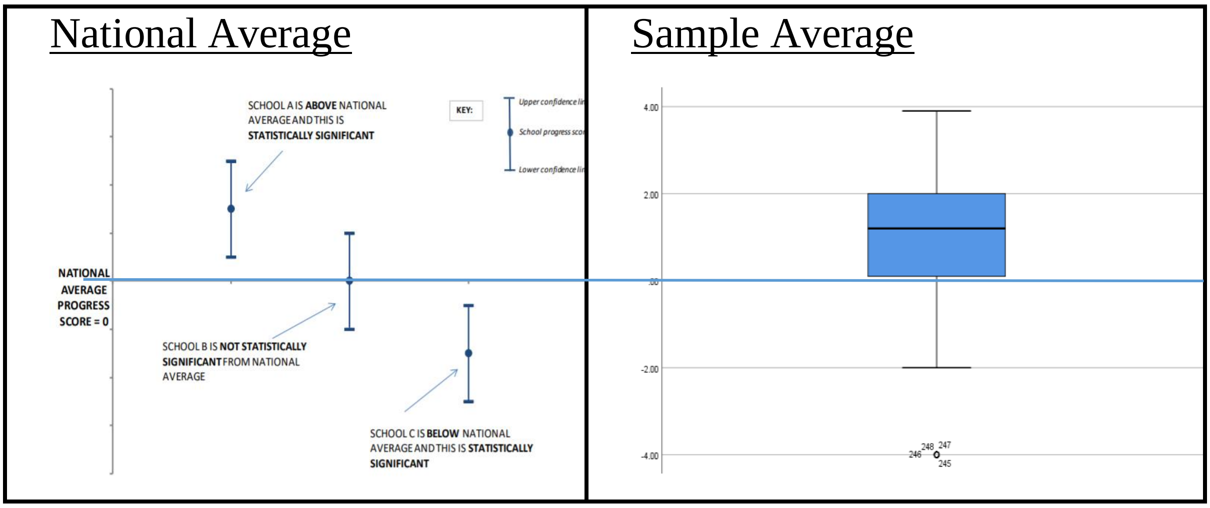


Figure 15: Comparison of Mathematics Progression Scores

The comparability of the sample was also assessed by comparing groups such as gender and ethnicity and comparing it to the population of study. For example, the Department for Education (2018) reported that 33% of KS2 pupils are from a minority ethnic background, with the percentage of the current study being 31%. In addition, the gender proportion was closely split with 49% male and 51% female. The percentage of female teachers in UK primary schools was reported to be 82.4% (BESA, 2019), which is slightly less than the sample with 85% of pupils' teachers being female. The sample can therefore be deemed comparable of the population of study. However, the deprivation levels are significantly higher than the national average, as are the mathematics abilities at the school level and these factors must therefore be acknowledged when reporting particular findings associated with school characteristics.

Self-Confidence

Pupils were asked to state their response to the statement, "I am Good at Maths". Table provides details for the percentage of respondents for each answer. 'Strongly agree' and 'Agree' were the most common answers (79.9% in total) with 'Disagree' and 'Strongly Disagree' being the least popular, indicating confidence amongst the sample.

I am Good at Maths	**Percent**
Strongly Agree	40.8
Agree	33.1
Not Sure	16.8
Disagree	5.3
Strongly Disagree	4.1

Table 22: Frequencies for Self-Confidence

Motivation

Pupils were asked to state their response to the statement, "I do Maths at Home". 'Strongly Agree' and 'Agree' were the most common with over 60% of the sample agreeing they do maths at home. 'Disagree' and 'Strongly Disagree' were the least popular answers.

I do Maths at Home	**Percent**
Strongly Agree	37.7
Agree	26.4
Not Sure	14.1
Disagree	9.4
Strongly Disagree	12.3

Table 23: Frequencies for Motivation

Parental Help

Pupils were asked to state their response to the statement, "My Parents help me with Maths Homework". 'Strongly Agree' and 'Agree' where the most popular answers with over 50% of the sample agreeing that their parents help. However, 'Strongly Disagree' was also rather high, indicating variability within the sample.

My Parents help me with Maths Homework	**Percent**
Strongly Agree	34
Agree	24.3
Not Sure	8.2
Disagree	10.3
Strongly Disagree	23.3

Table 24: Frequencies for Parental Help

The Study's Core Focus: Pupils' Attitudes to Mathematics

Behavioural Attitudes to Mathematics

Table 25 provides the measures of central tendency for each of the five sub scales and the whole measure. With a maximum possible score of 68, the average response for the sample was 47.9, indicating that the majority of the sample have positive behavioural attitudes to mathematics.

Section		**Specific Tasks**	**Maths in Class**	**Active Maths**	**Calculation Tasks**	**Passive Maths**	**Whole Scale**
N	Valid	498	498	477	493	493	439
	Missing	10	10	31	15	15	69
Mean		5.9	7.3	10.3	11.6	12	47.9
Median		6	7.5	11	12	13	48
Mode		7	9	11	16	16	44
Std. D		1.8	3.2	3.4	3.6	3.5	11.7
Range		8	12	16	16	16	47
Minimum		0	0	0	0	0	21
Maximum		8	12	16	16	16	68
CA		NA	.704	.63	.71	.74	.89
AVE		NA	.63	.47	.53	.57	.37

Table 25: Measures of Central Tendency, Reliability and Validity for BAM Scales.

Table 25 also displays the measures of internal consistency, using Cronbach's Alpha. The score for the whole scale was .89 indicating high reliability for the measure of behavioural attitudes to mathematics. This was also the case for the sub-scales, with each section yielding a score of internal consistency of above .6, aside from section 1 as it is two-item scale. The average variance extracted providing evidence to suggest the whole scale lacked convergent validity and therefore suggests the 17 items do not measure attitudes to mathematics collaboratively well. Looking at the sub scale, it can be seen that section 3 does not yield an average variance extraction of above the minimum score of .5 to suggest convergent validity (Forner and Larcker, 1981), however, sections 2, 4 and 5 are above the minimum, explaining the lack of validity for the whole scale.

Figure 16 provides a visual for the distribution of the 17-item scale. With a mean value of 47.9 and standard deviation of 11.7 it can be estimated that approximately 68% (1sd) of the sample consists of a score ranged between 36.2 and 59.6.

Section (Statement)	**Loading for BAM (Whole Scale)**	**Sub Section Loading**	**KMO**
Specific Tasks		NA	NA
(S1)	.599		
(S2)	.550		
Maths in Class			.661
(S1)	.597	.797	
(S2)	.647	.752	
(S3)	.703	.829	
Active Maths			.701
(S1)	.680	.729	
(S2)	.567	.690	
(S3)	.614	.725	
(S4)	.430	.595	
Calculation Tasks			.730
(S1)	.648	.689	
(S2)	.625	.809	
(S3)	.526	.653	
(S4)	.653	.764	
Passive Maths			.766
(S1)	.629	.806	
(S2)	.592	.714	
(S3)	.711	.740	
(S4)	.545	.762	
Whole Scale			.924

Table 26: EFA of BAM and BAM Sub Scales

The exploratory factor analysis of the BAM measure indicated that each of the sections had factor loadings that provided evidence to suggest the statements measure aspects of the intended component. Furthermore, with the EFA of the whole measure also indicating this, the whole BAM will be used as a dependent variable measuring pupils' attitudes to mathematics for analysis in the current study.

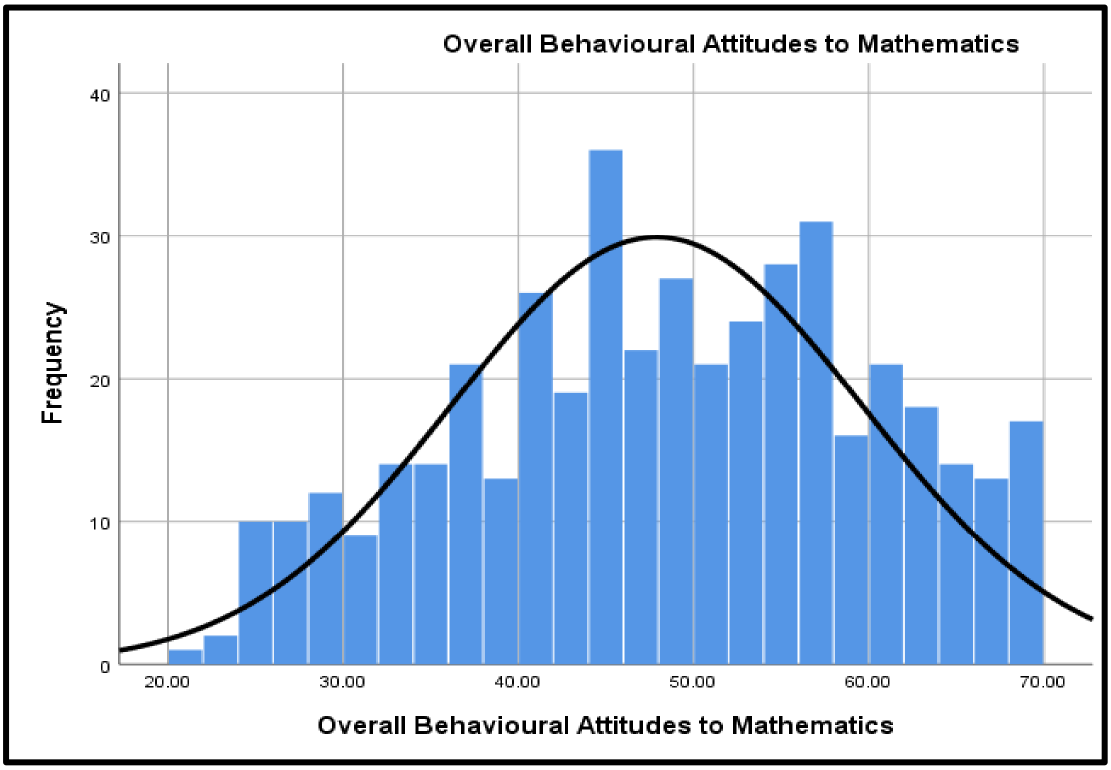


Figure 16: Histogram for 17-item scale

Furthermore, calculations of two standard deviations would approximate that 95% of the sample consists of a score between 24.5 and 70.3. As indicated in table 12, the maximum score was 68. This provides evidence of a negative skew due to the clustering of responses towards the higher end of the scale. The mode answer of 44 does fall within the middle of the range, which further indicates the nature of the skew is due to a wider range of responses towards the lower end of the scale. Whilst this provides evidence to suggest views towards mathematics are positive within the sample, further findings must be treated with caution when inferring any potential significant associations.

Figure 17 provides histograms for each of the five components. By visualising the figure, the negative skew can be seen consistently amongst the five components, highlighting the reasoning behind the skew of the 17-item scale.

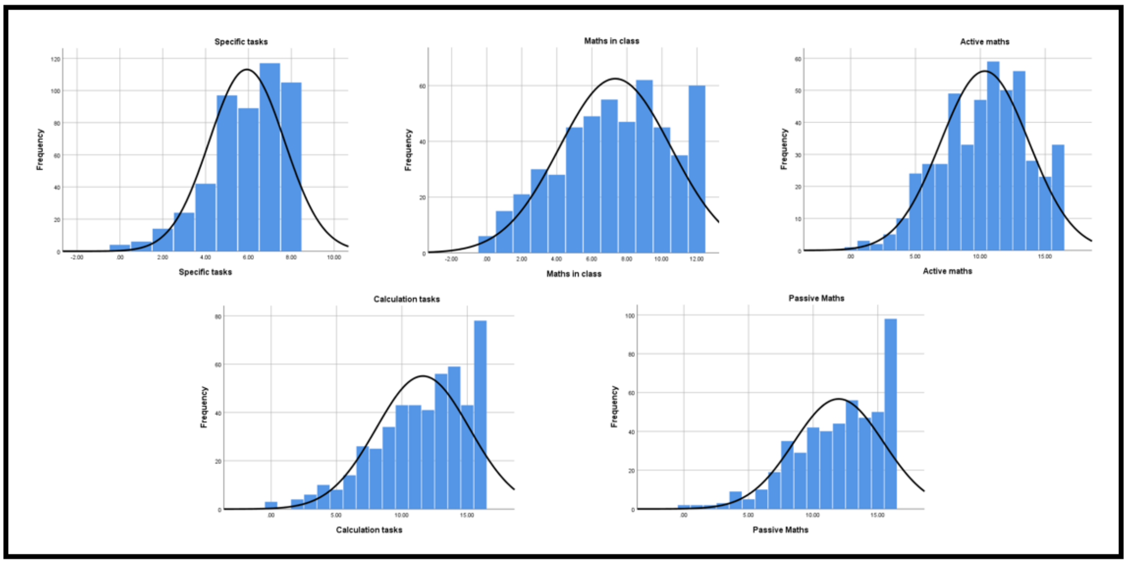


Figure 17: Histograms for all five BAM subscales

Emotional Attitudes to Mathematics

Emotional Attitudes to Mathematics		
N	Valid	450
	Missing	58
Mean		18.5
Median		19
Mode		24
Std. D		4.2
Range		16
Minimum		8
Maximum		24
CA		**.83**
AVE		**.55**

Table 27: MOCT for EAM

EAM	Loading	KMO
S1	.867	.767
S2	.544	
S3	.737	
S4	.800	
S5	.789	
S6	.654	

Table 28: EFA of EAM

The measures of central tendency in table 27 and histogram in figure 27 indicate a strong negative skew with the mean reporting rather high at 18.5 in a range of 8 to 24. The mode answer was also 24, indicating the strength of the skew due to a the vast majority of the sample having positive emotional attitudes to mathematics. A potential reason to this could associated with sampling, given that the average maths progression scores and average scores in maths were significantly higher than the national average. This must therefore be taken into account when assessing any potential associations.

The Cronbach's Alpha (1951) statistics and computed average variance extracted provided evidence of high reliability and sufficient validity for the six item measure. This provides evidence to suggest that the six items collaboratively measure attitudes to mathematics well and do so consistently.

The Exploratory Factor Analysis of EAM extracted one component. With a KMO value of .767 indicating sufficient sampling adequacy for factor analysis, along with evidence of reliability and validity, this can be deemed a reliable measure of pupils' attitudes to mathematics.

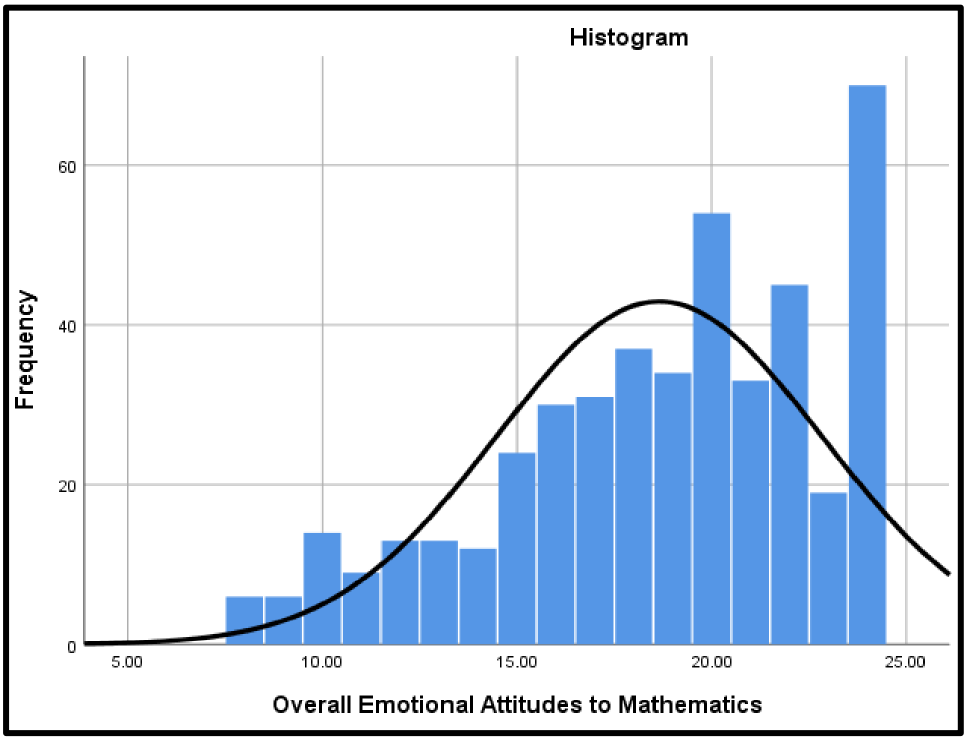


Figure 18: Histogram for EAM

The histogram of EAM provides a similar visualisation to that of the histogram for BAM in Figure 16. We can see a negative skew due to the wider range of lower EAM scores and the majority of pupils eliciting positive scores. As this coincides with the BAM measure, we can argue that pupils answered both scales consistently and this will be discussed in more detail in the following subchapter.

However, as there is a skew, and with calculations of two standard deviations approximating that 95% of the sample elicited scores between 10.1 and 26.9 with a possible maximum score of 24, the data on this occasion cannot be deemed normally distributed in regards to the EAM measure and findings must therefore be treated with caution. This is further supported with mode answer in fact being the maximum score, 24.

Discussing Reliability and Validity for Pupils' Attitudes to Mathematics

Measure	Cronbach's Alpha	Average Variance Extracted	Verdict
BAM	.89	.37	High Reliability Low Validity
EAM	.83	.55	High Reliability Sufficient Validity

Table 29: Reliability and Validity for Pupils' Attitudes to Mathematics

When analysing both dependent variables, the reliability was calculated using a Cronbach's Alpha (1951) test on IBM SPSS Statistics and Convergent Validity was assessed using the Forner-Larcker Criterion (1981) through calculating the average variance extracted in Microsoft Excel. Whilst both scales provided highly reliable measures of attitudes to mathematics, the BAM scale did not indicate sufficient validity. Whilst the measure will still be used in the analysis to identify associated factors, findings should be discussed with caution in regards to how valid the measure is. Looking in further detail identified that sections 2 and 5 were valid constructs and should therefore be considered as the stronger subscales of the whole scale. Given the high reliability of BAM, Null Hypothesis 1a is therefore rejected with caution due to the lack of evidence of validity.

The six-item scale for EAM designed for this study indicated both high reliability and sufficient validity and can therefore be regarded a good measure of attitudes to mathematics. Null Hypothesis 1b is therefore rejected. The advantages of 'draw a person' tasks, such as validity, are further highlighted in this measure, as it can be argue that having pupils directly participate in the research by instructing them to provide answers in a specific way and drawing the Emojis rather than circling them provides a discussion as to whether this improves the validity of the measure. There must also be discussion on the comparisons of the two separate measures, with the BAM measure having significantly more items than the EAM measure.

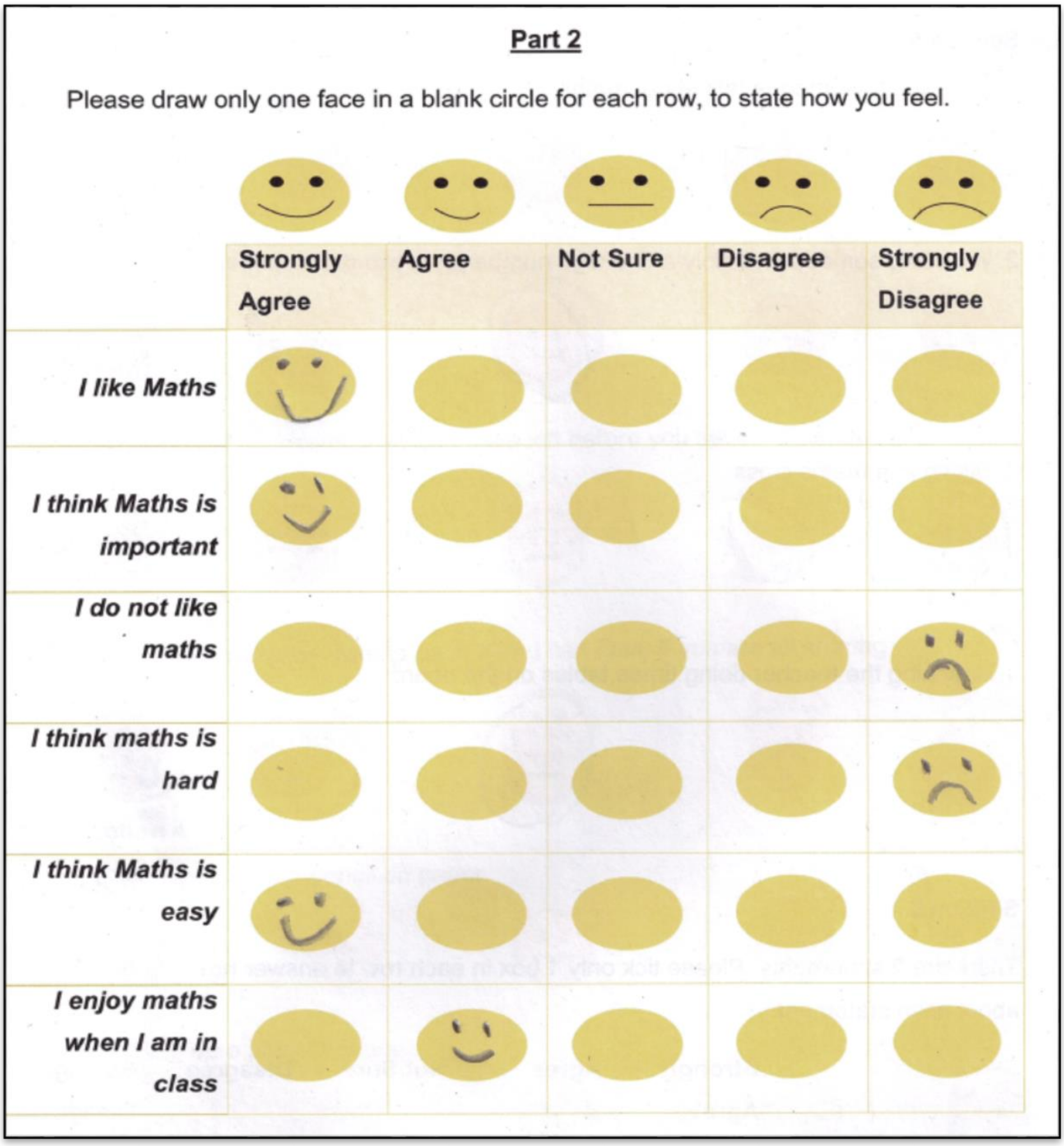
Measuring and Assessing Pupils' Overall Attitudes to Mathematics

It was identified early that the vast majority of the sample had positive attitudes to mathematics. With two separate scales measuring attitudes to mathematics, both scales had negative skews due to the wider range at the higher end of the scale, having significantly more respondents. This was the case for both behavioural attitudes to mathematics, where individuals answered how they felt about carrying out mathematical tasks in different scenarios, and emotional attitudes to mathematics, where individuals had to draw the face that appropriately responded to how they felt in general about mathematics. This provides evidence to suggest that pupils in Year 4 tend to have positive attitudes to mathematics. Previous research has also identified that attitudes to mathematics are established at around this age (Bloom, 2003; Beasley et al, 2001; Beilock et al, 2010). Furthermore, the Cronbach's alpha tests carried out to measure the internal consistency of both measures yielded 'very reliable' scores indicating that the pupils consistently understood the statements when answering the measures (Cronbach, 1951). The measures, therefore, successfully met the epistemological aims of the research and can be deemed reliable evidence for assessing pupil attitudes to mathematics. Previous research also supports the reliability of respondents' understanding and capability to take part in research at this age range (8-9 years) (Bloom, 2003; Wadsworth, 2003; Beilock et al, 2010; Ghazi et al, 2014).

The decision to use Emojis as methods of response contributed to the evidence supporting the argument that Emojis are beneficial world when questioning young respondents who are 'natives' of the digital world and its modes of communication (Danesi, 2016; O'Brien, 2016; Alismail and Zhang, 2018). The Behavioural Attitudes to Mathematics measure provided a highly reliable seventeen-item scale that measured aspects of pupils' attitudes to mathematics concerning scenarios in the classroom, in front of a teacher and aspects of motivation. With a comparable sample of a pupil population in Year 4 KS2 UK primary schools, and evidence of high reliability, this measure provides reliable evidence regarding pupils' attitudes to mathematics, along with evidence of a reliable methodology to measure young children attitudes of this age. This contributes to the discussion of research methods in education contexts, and contexts involving young children, where respondents can be reliably questioned and contribute to the furthering of the knowledge of children's attitudes. This is arguably important in the context of aiming to understand children by directly involving them in the research process (Kellett, 2011). Furthermore, using additional methods such as clear, concise statements to ensure understanding of the questions (Mabelis, 2019) and visible acts of meaning (Bavelis and Chovil, 2000) enables respondents to provide responses they also clearly understand (Alismail and Zhang, 2018).

The Emotional Attitudes to Mathematics, whilst also using the concept of Emojis as methods of response, additionally required pupils to draw the response they felt represented their feelings towards a particular statement and in the accurate responses box that the chosen Emoji should be answered. This measure was also found to be highly reliable (Cronbach, 1951) and can be regarded as a reliable measure for emotional aspects of children's attitudes to mathematics, concerning enjoyment, confidence and value. The six-item statement provided additional evidence to suggest that by directly involving pupils in the research, and giving them a set of tasks to complete the questionnaire, is beneficial to improving the engagement of the young respondents, and the quality of the data (Kellett, 2011). Asking respondents to draw people has been successful in other academic research in both young (Beilock et al, 2010) and older people (Syyeda, 2016).

Figure 19 below provides a screenshot of a pupil answering the measure. This figure provides an example of a respondent demonstrating a high understanding of the measure. Here, the respondent has drawn the correct Emoji to provide their response, whilst additionally providing the correct Emoji for the opposite statement that is reflecting the same attitude. This can be seen in the statements "I like mathematics" and "I don't like mathematics". The respondent has provided the same answer through answering two statements and doing so by providing the correct drawing to indicate the answer. The Cronbach's Alpha score provides evidence to suggest that having pupils directly participate in the research through answering responses in a more interactive nature increases engagement and their reliability as respondents (Kellett, 2011).



Part 2

Please draw only one face in a blank circle for each row, to state how you feel.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
I like Maths					
I think Maths is important					
I do not like maths					
I think maths is hard					
I think Maths is easy					
I enjoy maths when I am in class					

Figure 19. Example of Emotional Attitudes to Mathematics Answer

Assessing pupils' attitudes to mathematics individually, and before considering the effects of additional factors, provides insight into how a comparable population of Year 4 pupils in the UK feel towards mathematics. Measuring how pupils feel overall about mathematics can provide an indication of how attitudes appear amongst the Year 4 population generally. Poor attitudes to mathematics are discussed more when concerning adults (Chinn, 2012; National Numeracy, 2016; Hunt et al, 2016) whilst some research has acknowledged poor attitudes exist prior to school-leaving age because of the lack of students opting to study mathematics further (Noyes, 2007; Scarpello, 2007; Hillman, 2014; Marshall et al, 2016).

It is, therefore, beneficial to assess how KS2 pupils feel towards mathematics and, looking at the current study's sample of Year 4 pupils, it can be assumed that prior to SAT examination procures, pupils have positive attitudes to mathematics. This provides evidence to suggest that poor attitudes may begin to become more prevalent later in the educational life course. The reliability in the current study's evidence can be drawn from the two distinct highly reliable measures that both provide the same evidence of negative skews. The consistency in this finding can help support the argument that the sample reliably understood the attitudinal questionnaire and therefore can be reliably regarded as a sample with positive attitudes towards mathematics.

Chapter 5:

Assessing the Influential Factors

Introduction to Chapter

This Chapter discusses the data analysis that took place when assessing the influence of factors on pupils' attitudes to mathematics. Bivariate analysis will be used to answer the hypotheses generated from Research Questions: 2 (*Do pupil Characteristics influence pupils' Attitudes to Mathematics?*), 3 (*Do Teacher Characteristics influence pupils' Attitudes to Mathematics?* and 4 (*Does the school attended influence pupils' Attitudes to Mathematics?*). The bivariate analysis consists of testing for relationships and difference, depending on the measurement of the independent variable, with two separate dependent variables: Behavioural Attitudes to Mathematics and Emotional Attitudes to Mathematics.

Multivariate analysis will be used to answer the hypotheses generated from Research Questions, 5 (*Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes to Mathematics?*), 6 (*Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics?*) and 7 (*Do demographic factors, confidence, value and motivation and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics and factors associated with the school studied?*).

A series of tests were completed to assess whether the characteristics of pupils, teachers and schools were in any way related to pupils' attitudes to mathematics. A series of bivariate models were built for both dependent variables. Prior to conducting any tests, the data was cleaned to maximise the normality of the distribution within the data

Influence of Pupils' Characteristics on Attitudes to Mathematics

Tables 29 and 30 provide an overview of the bivariate analysis carried for each of the two dependent variables. The tables provide information regarding the test carried out (following parametric assumption testing), along with *p* values for the test, the mean ranks, the mean differences and the sample size included in the analysis.

A series of parametric assumption tests were ran to assess whether the data met assumptions required for parametric testing. The parametric assumptions involved examining confidence levels, normality and homogeneity. Confidence levels were assessed by visualising box plots and assessing whether the quartiles either side of the median reported attitude for each group overlapped. Interpretation of confidence intervals was also assessed. For normality, Q:Q plots were visualised and interpreted to conclude whether the data was normally distributed according to the groupings when focusing on the dependent variable.

For tests for difference, Homogeneity was assessed by using a Levene's test to test for homogeneity of variances according to the groupings when focusing on the dependent variable. Concluding homogeneity of variance was done so by interpreting the *p* value yielded from the test and determining that any *p* value $<.05$ would indicate heterogeneity amongst the groups (groups are not homogenous). If any of the three parametric assumption were not met a non-parametric test was ran.

For tests for relationship, normality was assessed by visualisation and interpretation of Q:Q plots along with a scatterplot to assess for linearity and homoscedasticity.

IV	N	Mean (Mean Rank)	Mean Difference	df	Sig.
Gender (M)	432		32.18	430	**.007**
Male	207	(233.26)			
Female	225	(201.08)			
Favourite Subject (T)	433		6.35	431	**.000**
Other	271	45.5			
Maths	162	51.85			
Ethnicity (T)	421		.1.49	219	.230
BME	124	49.23			
White	297	47.74			
I am good at maths	359		149.25	357	**.000**
(M)	33	(44.47)			
No	326	(193.72)			
Yes					
	371				
I do maths at home (T)	94	40.56	10.53	369	**.000**
No	277	51.09			
Yes					
Parental Help (T)	396		2.25	394	.061
No	146	49.73			
Yes	250	47.48			
Good at maths (T)	421		2.48	419	**.031**
Girl	183	46.68			
Boy	238	49.16			
Good at reading (T)	411		.06	409	.962
Girl	252	48.14			
Boy	159	48.2			
Gender Ability Beliefs	410		NA	407	.123
(A)	66	45.42			
-1 (M=G; R=B)	207	48.74			
0	137	48.46			
1 (M=B; R=G)					
Gender – Someone good at Maths (A)	415	48.16	NA	415	**.000**
Male – Female good	28	44.36			
Male- Male good	168	50.91			
Female – Female Good	153	47.27			
Female – Male Good at	66	44.86			

Table 30: Tests for Difference for BAM with Pupil Characteristics

IV	**N**	**Mean (Mean Rank)**	**Mean Difference**	**df**	**Sig.**
Gender (M)	440		40.44	438	**.001**
Male	209	(241.73)			
Female	231	(201.29)			
Favourite Subject (M)	439		96.69	437	**.000**
Other	263	(181.24)			
Maths	176	(277.92)			
Ethnicity (T)	430		-.44	428	.320
BME	129	18.41			
White	301	18.85			
I am good at maths (M)	369		7.33	367	**.000**
No	26	12.62			
Yes	343	19.95			
I do maths at home (M)	379				
No	88	(158.18)	41.44	377	**.002**
Yes	291	(199.62)			
Parental Help (T)	406		1.46	404	**.001**
No	143	19.67			
Yes	263	18.21			
Good at maths (T)	435		.82	433	**.043**
Girl	186	18.15			
Boy	249	18.97			
Good at reading (T)	424		.38	422	.368
Girl	262	18.45			
Boy	162	18.83			
Gender Ability Beliefs	423		NA	420	.629
(A)	65	18.12			
-1 (M=G; R=B)	215	18.67			
0	143	18.66			
1 (M=B; R=G)					
Gender – Someone Good at Maths (A)	427	18.64	NA	427	**.000**
Male – Female Good	27	17.89			
Male – Male Good	175	19.63			
Female – Female Good	157	18.24			
Female – Male Good a	68	17.32			

Table 31: Tests for Difference for EAM with Pupil Characteristics

Interpretation of tables

Gender

The Mann-Whitney test identified a significant difference between male and female pupils, and their behavioural attitudes to mathematics. Specifically, males reported a higher mean rank of 233.26 in comparison to females with 201.08 (p =.007). This provides evidence to suggest gender does effect attitudes to mathematics. This was also the case with Emotional Attitudes (p=.001), providing evidence to suggest that male pupils have significantly more positive attitudes towards mathematics than female pupils do. Null hypotheses 2a is therefore rejected.

Favourite Subject (Value)

For Behavioural Attitudes, the *t*-Test identified a significant difference between pupils who stated their favourite subject to be maths and pupils who did not indicate their favourite subject to be maths (p =.000). Those who stated maths, had a significantly higher mean rank than those who did not state maths. This finding was echoed with Emotional Attitudes (p =.000), providing evidence to suggest that pupils whose favourite subject is maths have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths. Null Hypothesis 2d is therefore rejected.

Testing Gender with Favourite Subject

Pupil's Favourite Subject	Male	Female
Other	128 (53.3%)	173 (70%)
Males	112 (46.7%)	74 (30%)
N = 487 Chi Square = 14.393 (df=1) p = .000		

Table 32. Testing Gender with Favourite Subject

The Chi Square test identified a significant association between gender and favourite subject Males were found to be more likely to state maths to be their favourite subject (46.7%) in comparison to females (30%). Although the Chi Square value is low, (Chi Square = 14.393), this provides evidence to suggest that males are more likely to value maths than females and provides possible reasoning behind why males have more positive attitudes.

Self-Confidence

The Mann-Whitney test identified a significant difference between those who believed they were good at maths and those who did not for behavioural attitudes (p=.000) and emotional attitudes (p=.000). Those who did believe they are good at maths had a significantly higher average than those who did not, providing evidence to suggest that pupils who believe they are good at maths have significantly more positive attitudes to mathematics. Null Hypothesis 2c is therefore rejected.

Motivation

For behavioural attitudes, the t-Test identified a significant difference between those who believed they do maths at home and those who did not (p=.000). Those who did believe had a significantly higher average than those who did not, providing evidence to suggest that pupils who believe they do maths at home have significantly more positive attitudes to mathematics.

For emotional attitudes, the Mann-Whitney test identified a significant difference between those who believed they do maths at home and those who did not (p=.000). Those who did believe had a significantly higher average than those who did not, providing evidence to suggest that pupils who believe they do maths at home have significantly more positive attitudes to mathematics.

Null Hypothesis 2e is therefore rejected.

Parental Help

For Emotional attitudes to mathematics, the t-Test identified a significant difference between those who stated their parents help them with homework and those who did not

(p=.001). Null Hypothesis 2f is therefore rejected. Those who believed they do not receive help had a significantly higher average EAM score than those who did believe they receive help, providing evidence to suggest that pupils who receive help have significantly more negative attitudes to mathematics than those who do not receive help. For behavioural attitudes to mathematics however, there was no significant difference (p=.061).

Someone good at maths

The *t*-Test identified a significant difference in behavioural attitudes to mathematics between those who stated males were good at maths and those who stated females were good at maths (p=.031). Those who stated boys are good at maths had a significantly higher average BAM score than those who stated girls. This was also the case for emotional attitudes to mathematics (p=.043), providing evidence to suggest that pupils who believe boys are good at maths have significantly more positive attitudes to mathematics.

Gender – Someone good at maths

The ANOVA test identified a significant difference between genders and the gender they indicated to be good at maths (p=.000). Males who indicated males to be good at maths had the highest overall BAM score, and significantly higher than females who indicated females to be good at maths (p=.043).

For Emotional Attitudes to Mathematics, the ANOVA test identified a significant difference between genders and the gender they indicated to be good at maths (p=.000). Males who indicated males to be good at maths had the highest overall EAM score, and significantly higher than females who indicated females to be good at maths (p=.025).

All other variables (Ethnicity, someone good at reading and gender ability beliefs) were not significantly associated with pupils' attitudes to mathematics. Null hypotheses 2b and 2g are therefore accepted. Of the seven null hypotheses outlined for Research Question 2, five were rejected. Pupils' characteristics, such as gender, self-confidence, motivation, value of mathematics positively influence pupils’ attitudes to mathematics, whilst parental help was found to provide a negative influence.

Discussing Pupil Characteristics

Gender

The two Mann-Whitney tests carried out to assess the difference in attitudes to mathematics between males and females identified that males had significantly more positive attitudes to mathematics than females when testing both behavioural and emotional attitudes to mathematics. This contributes to the already existing evidence of males having more positive attitudes to mathematics than females (Mutodi and Nigorande, 2014), including self-confidence (Fennema and Peterson, 1985; Karimi and Venkatesan 2009; Dowker, Bennet and Smith, 2012) and furthermore, from a young age (Beilock et al, 2010). The impact of this difference could suggest the reasoning for the underrepresentation of females in STEM related disciplines and careers (Macdonald, 2014; Bilton, 2017; McMaster, 2017). Evidence has also shown that females have advantages in reading (Breda and Napp, 2019), which may relate to issues such as non-STEM identities (Macdonald, 2014) due to the the polarisation of literary and scientific intellectualism (Snow, 1959) which often link to gender ability beliefs (Beilock et al, 2010). This also has led to suggestions for potential reasoning for the gender pay gap in STEM careers (Breda and Napp, 2019).

Other studies has already indicated more positive attitudes in male pupils than female pupils between years 3 and 5 in KS2, including issues relating to confidence not increasing with ability (Dowker, Bennet and Smith, 2012). However, the impact on attainment is still yet to be linked evidentially, but can be reflected in the progress scores at primary schools, where female pupils exceed males in all subjects except mathematics (Department for Education, 2016). Whilst there is evidence to support that females’ aptitude for mathematics is similar to males, they are more susceptible to mathematics anxiety (Geist, 2010) and this has been linked to averting testing and social comparison with peers (Haynes et al, 2004, Miller and Bichsel, 2004). This has led to the argument that a gender gap in mathematics achievement would more likely be the result of increased chances of developing negative attitudes towards mathematics over differing levels of ability (Ashcraft, 2002; Hopko et al, 2003 in

Geist, 2010). Furthermore, with the additional influence of parents (Eccles, 1993), teachers, peers or siblings (Beilock et al, 2010; Mpho, 2018), there is also a need to consider how females can be socialised into disliking mathematics (Geist and King, 2008).

A potential reason behind this could be the issues discussed concerning the influence of teachers and parents. Vorderman (2011) highlights how less than 5% of primary school teachers have a mathematics background. There is additional research that has highlighted higher levels of mathematics anxiety in female teachers, with over 90% of female teachers having high levels of mathematics anxiety (Beilock et al, 2010) and this can be transferred to female pupils through emulating their female teachers' behaviour (Perry and Bussey, 1979; Bussey and Bandura, 1984; Smith and Hogg, 2008). This can establish negative learner identities (Noyes, 2007) and more specifically non-STEM identities (Macdonald, 2014). The impact of establishing such identities is evident in previous studies where females' value of mathematics has been more negative than males (Eccles et al, 1984; Parsons et al, 1984; Wigfield and Eccles, 1992; Beilock et al, 2010; Mutodi and Ngirande, 2014) and this leads to a lack of engagement and poor performance (Meece et al, 2006). This eventually results in avoiding the subject once it is no longer compulsory (Hillman, 2014; Marshall et al, 2016). If this is a particular issue for females, and related to their underrepresentation in STEM related disciplines (McMaster, 2017), then there has to be consideration of how the impact of changing attitudes would be a sufficient solution (National Numeracy, 2016a).

Favourite Subject (Value)

The *t*-Test for favourite subject and behavioural attitudes to mathematics identified a significant difference between those who stated their favourite subject was mathematics and those who did not. This was echoed when also testing for difference with emotional attitudes to mathematics. This finding provides not only further evidence to suggest that the BAM and EAM measures are reliable by expecting that those whose favourite subject is mathematics to naturally have more positive attitudes, but also further evidence concerning the impact of valuing mathematics. Those who specifically stated their favourite subject is mathematics had significantly higher scores than those who stated any other subject. This provides evidence to suggest that valuing mathematics leads to an increasingly positive attitude to mathematics in both behavioural and emotional ways.

Value has already been identified as a crucial component in building a positive attitude towards mathematics (Tapia and Marsh, 2004) as it impacts self-confidence (Bandura, 1977). Value, however, must further be recognised as a factor that can be strongly affected through parental influence (Eccles, 1993; McMaster, 2017) and further through the relationship between pupil and teacher (Garner and Stowe, 1993; Attard, 2013). When looking at the variable individually for pupils' favourite subject it was found that 38% of the sample indicated their favourite subject to be mathematics. This shows a significant proportion of students who value mathematics positively, which is particularly important when considering the prevailing negative attitudes to mathematics in the UK (National Numeracy, 2016) and particularly with adults (Chinn, 2012; Royal Society, 2019). Value leads to positive attitudes, and attitudes have been linked to attainment in previous studies (Mayes, Chase, & Walker, 2008; Zaskis, 2011; Feldhaus, 2014). The Chi-Square test additionally identified that males were significantly more likely to indicate that mathematics was their favourite subject. This provides grounds to suggest that, from as young as 8 years old, males are more likely to have positive attitudes and value mathematics in comparison to females. This additionally provides further evidence on the issue of attitudes and the positive impact on attainment expected (National Numeracy, 2016a), as females have been found to have less confidence as they improve in their mathematical abilities (Dowker, Bennett and Smith, 2012).

Value has also been linked to students' engagement with mathematics (Meece et al, 2016) and provides a strong determinant for progression to study mathematics beyond the compulsory schooling age (Noyes, 2007; Hillman, 2014). This has to be considered an important factor when discussing the demand for STEM graduates in the UK (Wilson, 2009) and the economic risks of failing to meet that demand (UK Commission for Employment and Skills, 2013; 2015). Given the evidence from the current study that those who indicate mathematics as their favourite subject to have more positive attitudes, efforts to increase value can help improve attitudes in order to help fulfil the UK demand for a STEM workforce.

Ethnicity

Both *t*-Tests for Ethnicity and BAM and EAM did not find significant difference in attitudes to mathematics between white and BME pupils. The consistency in both findings highlight in the current study that focusing on ethnicity as a factor of attitudes to mathematics does not provide a difference to a pupil's attitudes to mathematics. Other factors may potentially influence this, such as gender and school attended. Additionally, the complexity in measuring ethnicity (Cline et al, 2002) and the sampling issues that often lead to categorising minor ethnicities as BME could be a reason why no difference is found. The Department for Education (2003) identified differences in performance amongst different ethnic minorities, which could not be identified in the current study given the sampling issue, with the univariate analysis of ethnicity indicating only 31% of the sample being of ethnic minorities and within a total sample size of 508. With complexities such as social class also being an issue, assessing whether ethnicity is individually associated with attitudes to mathematics may not be appropriate. Instead, it would arguably be more beneficial to assess whether ethnicity is an influential factor of mathematics when considering the teacher (Becker, 1963), parental value (Eccles, 1993; Department for Education, 2016), gender and the additional effect of the school attended. Previous research, however, has identified that BME pupils do have more positive attitudes towards mathematics than White pupils (Mirza 1992; Basit 1997; Leslie and Drinkwater 1999 in Payne 2003) for reasons related to social mobility and increasing the chances of employment, with a recent study identifying such an association in Years 7 and 8 (National Audit Office, 2018). Whilst this is a different age group to the current study, the multiple regression with behavioural attitudes to mathematics from the current study did find that BME pupils had more positive attitudes towards mathematics than White pupils did. This poses the need for additional research to identify a clear association before attempting to understand how ethnicity relates to attitudes to mathematics.

Self-Confidence

Both Mann-Whitney tests for pupils' self-confidence, and BAM and EAM found highly significant differences. More specifically, those who indicated they were good at mathematics had significantly more positive views toward mathematics than those who did not. This highlights the relationship between confidence and overall attitudes to mathematics (NCTM, 1989; Tapia and Marsh, 2004; Nunes et al, 2009; Kalder and Lesik, 2011; Chinn, 2012a) as this provides self-efficacy (Bandura, 1977), which helps establish positive mathematical dispositions (Pinxten et al, 2013). This is further evidence of the importance of confidence and its role in establishing positive attitudes to mathematics in pupils.

The other significant factor to address here is the age of the sample. If differences can already be identified at this early stage in the educational life course (Bloom, 2003; Beasley et al, 2001; Beilock et al, 2010), there is then a suggestion to be made that concerns how this difference increases through later stages of education (Noyes, 2007; Hillman, 2014; Marshall et al, 2016) and beyond (Mcdonald, 2014, Curtain-Phillips, 2016; National Numeracy, 2016). The need to establish positive mathematical dispositions is evident in those who fail to attain such dispositions and hinder their future encounters with numeracy (Beyers, 2008). That lack of confidence often leads to poor marks in education (Carey et al, 2019) and reinforces more negative mathematical dispositions that become habitual (Katz, 1993), eventually leading to mathematics anxiety (Chinn, 2012; Marhsall et al, 2016). The reinforcement of negative dispositions leads to a sense of identity (Wenger, 1998), which shapes attitudes in order to work that identity (Abrams et al., 1990; McGarty, Haslam, Hutchison, & Turner, 1994; Wilder, 1990; Smith and Hogg, 2008). This is captured in Macdonald's (2014) notion of non-STEM identities where the identity is established from a lack of confidence and positive experience in numeracy. Poor experiences lead to negative identities and poor attitudes, which reduces options for further education and employment (Noyes, 2007; Scarpello, 2007) and further impacts in later life (Chinn, 2012; National Numeracy, 2016a; Curtain-Phillips, 2016).

Motivation

The *t*-Test for doing mathematics at home and BAM; and the Mann-Whitney test for EAM both identified significant differences between those who agreed they do mathematics at home and those who do not. Those who agreed in both tests had significantly more positive attitudes to mathematics than those who did not. This provides evidence to highlight the importance of parental support in terms of providing pupils with the opportunities to do mathematics at home in order to increase their positive attitudes. This, undoubtedly, helps with confidence and value, and therefore can help explain how this variable has come to be associated with the two dependent variables. Doing mathematics at home would also suggest elements of motivation (Spaulding, 1992; Gallard & Cartmell 2014). Motivation has been found to relate to self-efficacy (Skaalvik, 2015) and affects pupils' attitudes through how they perceive a task, which is often dependent on teaching (Jackson, 2005; Sun and Pyzdworksi, 2009). Motivation is a factor that may contribute to attitudes through additional factors such as parental expectations (Eccles, 1993), which can be further mediated through gender and ethnicity, transmitting aspects of expectancy value (Butler, 2016).

Doing mathematics at home also implies homework, which has been found to relate to aspects of identity (Macdonald, 2014) where pupils would have the motivation to complete homework because of how they value that homework. An example would be completing homework relevant to a desired career (Ryan and Decci, 2000). Motivation has been found to be an issue with adults (Butler, 2016) because of their own experiences (Chinnb, 2012; National Numeracy, 2016a). Therefore, a child who does mathematics at home may require additional support, which discusses aspects of autonomous motivation on behalf of parents (Mahamood et al, 2012; Skaalvik, 2015) as this has evidently improved confidence (Coltman and Whitebread, 2008) and self-efficacy (Bandura, 1977; Fan and Williams, 2010). Autonomous motivation also requires support from teachers (Reeve & Jang 2006; McLachlan & Hagger 2005, in Hagger et al, 2015), which provides further reasoning to discuss how doing mathematics at home could be a factor of pupil attitudes that must be assessed whilst concerning the influence of other factors.

Parental Help

The *t*-Tests for pupil's perception of parental help with mathematics homework provided conflicting evidence regarding the influence on attitudes to mathematics. The *t*-Test for behavioural attitudes to mathematics identified no significant difference between those who did and those who did not believe they received help with homework. The *t*-Test for emotional attitudes to mathematics however, did find a significant difference. More specifically, those who did not believe they received parental help had more positive attitudes than those who did believe they received parental help, providing evidence to suggest that parental involvement negatively affects pupils' attitudes.

The difference in results for the two measures may indicate the complexity in parental involvement. Behavioural attitudes to mathematics concerns pupils' attitudes in particular scenarios both inside and outside the classroom. However, emotional attitudes to mathematics concern confidence, enjoyment and value, which are aspects of attitudes that have been previously identified as influenced by parental support (Mahamood et al, 2012). Tapia and Marsh (2004) highlight the different components of attitudes: Enjoyment Confidence, Value and Motivation, which provides an argument that different aspects of attitudes can be affected differently. The complexity of parental involvement has been previously identified where significant relationships were found between parental interest and pupil self-efficacy (Fan and Williams, 2010) helping with confidence (Bandura, 1977; Pinxten et al, 2013) and motivation (Skaalvik, 2015). Additionally parental support has also been found to positively affect pupil attitudes (Coltman and Whitebread, 2008) and this becomes more complex when children start school (Jay et al, 2018). An example of this complexity can be highlighted in how the formal schooling process that can emphasise textbooks over teaching processes can provide disadvantages to females and ethnic minorities (Ma, 2003; Scarpello, 2007; Turner et al, 2002). However, attempts to improve educational attainment through parental involvement has not appeared successful (Patall et al, 2008; Gorard and Huat See, 2013). A reason identified is the difference in parental attitudes and abilities, which affects how such programmes can work for all pupils (Menheere and Hooge, 2010). Parental value affects pupil value, and pupils work towards a subject based on the expectations of parents (Eccles, 1993). Therefore, negative parental value would be expected to lead to negative pupil attitudes.

The evidence indicating relationships, relates to emotional aspects of pupil attitudes, such as the need to feel supported (Coltman and Whitebread, 2008) to help provide elements of confidence and enhance learning (Desforges and Abouchaar, 2003; Fan and Williams, 2010). This may be particularly important when considering the attempts to improve the level of parental support have been difficult due to parents' attitudes towards mathematics, which ultimately differs based on their own experiences and achievement (Peters et al, 2008). This further impacts children's identities (Wenger, 1998; Eccles, 1993) based on the learner identity established in parents experiences (Wenger, 1998). Therefore, it can be argued that if a parent or parents share a sense of non-STEM identity (Macdonald, 2014) then that may further affect the identity of the pupil through the lack of parental support, or confident parental support. Given the emotional attitudes to mathematics measure consists of statements relating to confidence, value and enjoyment, parental involvement may hinder these aspects of attitudes if the parents suffer with negative attitudes themselves. The deprivation levels of the sample were identified to be significantly higher than the national average. Therefore, parents from more deprived backgrounds may have more negative experiences of mathematics (Eccles, 1993; Goodman and Gregg, 2010), providing a possible explanation behind the negative impacts from parents in the current study.

In more recent studies, parental involvement was found to successfully impact pupils' attitudes, with 79% of teachers believing they had witnessed a significant increase in their pupils concentration as a result of parental engagement and 88% of pupils' believing themselves that they had improved their mathematical abilities (National Numeracy, 2016b). It is argued that family background has a powerful influence on pupil attitudes (Maltimore, 1991) and negative attitudes to mathematics have been found to begin in early life, sometimes before entering education (Arnold et al, 2002). The family is also of particular importance when in the early years of education in developing positive self-image in school (Coltman and Whitebread, 2008) and establishing positive learner identities (Wenger, 1998; Macdonald, 2014). The significant relationship with parental involvement and emotional attitudes to mathematics proves evidence to further suggest that parents provide a positive impact to aspects of pupils' attitudes. The evidence of no association between parental involvement and behavioural attitudes to mathematics, however, provides evidence to suggest there is no impact on pupils' attitudes when discussing particular scenarios involving mathematics or numeracy, and more so aspects of motivation. A reason could be, as discussed previously, the complexity that lies within parents' own experiences of mathematics and how they provide individual influences to their children (Peters et al, 2008). Meaning that whilst parental support may not affect how a child feels they can perform mathematically in a classroom or specific numeracy related situations, it may still affect how confident a child feels and how much they enjoy and value mathematics generally. This still provides an important factor to consider, given the importance of value and enjoyment on mathematics (Kalder and Lesik, 2011) in order to increase the chances of deciding to study mathematics beyond the age of 16 (Hillman, 2014; Marshall, 2016), with evidence already identifying the impact of family background on such choices (Payne, 2003).

Perception of Someone Good at Mathematics

Both *t*-Tests for perception of someone who is good at mathematics and the two dependent variables identified significant differences in attitudes to mathematics between those who believed males were good at mathematics and those who believed females were good at mathematics ($p<.05$; $p<.05$). A consistency in the differences was also found, with those who indicated males to be better at mathematics to have significantly more positive attitudes to mathematics than those who believed females were good at mathematics. To further explore this, a Chi-Square test of association was ran to assess whether males or females were more likely to state if a male was good at mathematics, assessing whether similar evidence could be captured, as Beilock et al, (2010) found that female pupils with female teachers were more likely to experience mathematics anxiety. This test identified that males were significantly more likely than females to say males were good at mathematics. Furthermore, the percentage of males indicating their own gender was good at mathematics was 85.8% in comparison to females stating their own gender at 69%. This evidence helps suggest there may be stereotypical gender ability beliefs amongst the sample, which is particularly important when considering the underrepresentation of females in STEM careers and females sharing non-STEM identities (Macdonald, 2014) with pupils from as young as 8 years old in the current study sharing a particular attitude.

This relationship was further explored with an ANOVA for each dependent variable and the computed variable, Gender and Belief in someone good at mathematics. It was identified that those with the most positive attitudes to mathematics, in both tests, were males who believed that males were good at mathematics ($p<.001$; $p<.001$). Furthermore, it was identified in the post hoc comparison that males who believed males were good at mathematics had significantly more positive behavioural attitudes to mathematics than males who believed females were good at mathematics, and females who indicated either males or females. Figure 20 provides a visual aid to highlight how the highest median (circled) behavioural attitude to mathematics was males who believed males were good at mathematics. Whilst there was no significant association between attitudes and believing females were good at mathematics, or overall gender ability beliefs, there must still be discussion regarding the findings surrounding belief in someone who is good at mathematics.

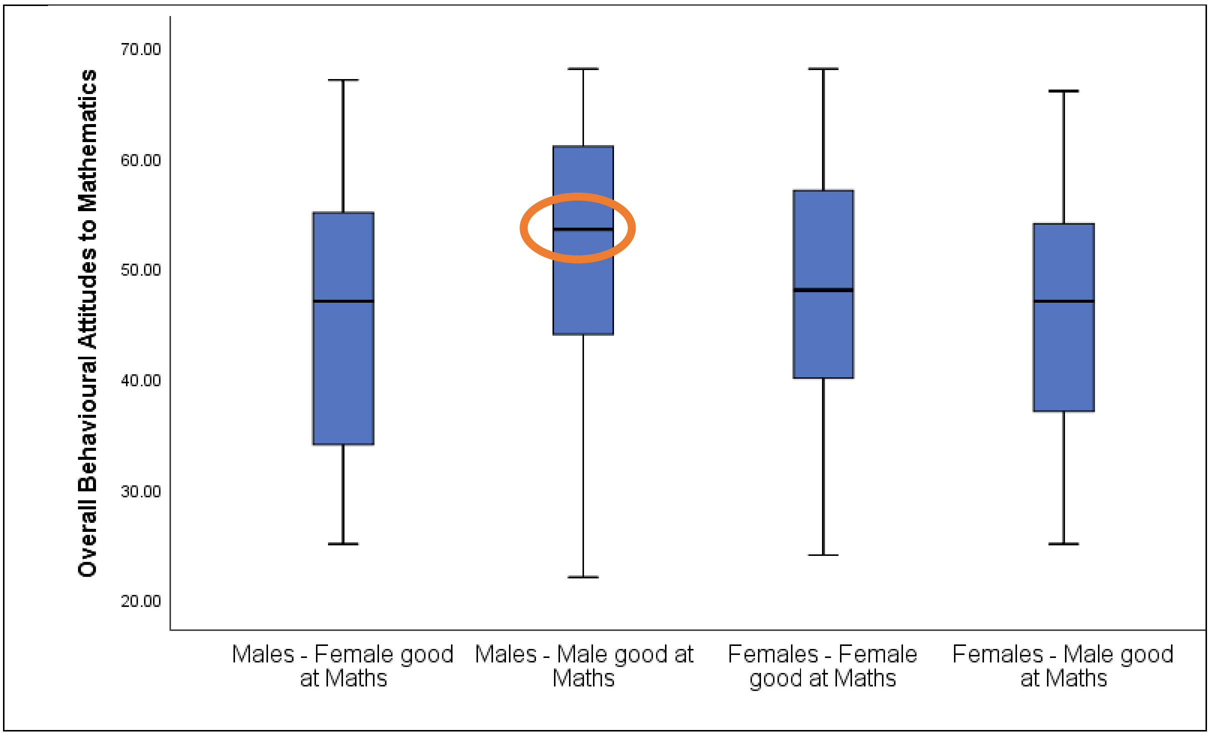


Figure 20: Box Plot for Gender and Belief in Someone Good at Mathematics and BAM

The findings of the current study echo previous evidence where perceptions have considered males to be higher skilled in mathematics (Beasley et al, 2001; Boaler, 2004; Mendick, 2005; Department of Education and Skills, 2007; Beilock et al, 2010). Additional evidence discusses females' advantages in other subjects such as reading as an explanation for the underrepresentation of females in STEM fields (Macdonald, 2014; Mcmaster, 2017) and gender pay gap respectively (Breda and Napp, 2019). Females' perception of their abilities have been studied further with a decrease in confidence found between years 3 and 5 which their male counterparts do not experience (Dowker, Bennett and Smith, 2012). This finding is of particular importance because of the discussed issues relating to gender pay and under representation of females in STEM fields, but also of equal importance when considering the negative impacts of females with negative attitudes to mathematics as it limits career options (Noyes, 2007; Hillman, 2014; Chinn, 2012a). Gender and gender ability beliefs therefore have to be considered as factors that contribute towards attitudes to mathematics and must be considered when strategising how attitudes to mathematics overall can be changed.

The final variables at the pupil level for the bivariate analysis that were not significantly related to either dependent variable were belief in someone who is good at reading and overall gender ability beliefs. Whilst there was a significant association with those who believed in someone who was good at mathematics, and this was further influenced by gender, the same opinion did not apply to reading, which led to there being no association with overall gender ability beliefs. Whilst Beilock et al (2010) did find that those with more stereotypical gender ability beliefs mediated the negative affect of female teachers with mathematics anxiety on their female students; this study did not find gender ability beliefs to have the same effect on attitudes. However, when focusing on the subject of someone who is good at mathematics, there is a clear tendency towards males being viewed as mathematically skilled. Whilst this does provide some evidence of gender ability beliefs and its effect on attitudes, there has to be further exploration to assess whether those beliefs are further affected not just by gender, but also by additional factors such as teachers and parental support (Beilock et al, 2010). Teacher beliefs, attitudes and confidence have been found to significantly affect pupil attitudes and therefore must be explored as factors of pupils' attitudes. The next section will therefore discuss the bivariate analysis between teacher characteristics and pupils' attitudes to mathematics.

Assessing Teacher Characteristics

Tables and provide a summary for the tests carried out to analyse the influence of teacher characteristics on pupils' attitudes. All the tests were significant with positive teacher attitudes associated with positive pupil attitudes.

Table 33: Tests for BAM Teacher Clustering Variables

IV	N	Mean (Mean Rank)	df	Sig.
I am good at maths (A)	407		403	**.000**
Strongly Agree	80	52.71		
Agree	179	47.85		
Not Sure	120	44.32		
Disagree	28	46.57		
I do maths at home (A)	407		404	**.000**
Strongly Agree	80	52.71		
Agree	231	47.3		
Disagree	96	44.4		
I believe I am good at teaching maths (A)	407		404	**.000**
Strongly Agree	80	52.71		
Agree	279	46.67		
Not Sure	48	45.15		
Correlations (Spearman's Rho)		**Correlation Coefficient**		**Sig.**
Teacher Maths Anxiety	407	-.217		**.000**
Teacher EATM	407	.162		**.001**

(A) = ANOVA

Table 34: Tests for EAM Teacher Clustering Variables				
IV	**N**	**Mean (Mean Rank)**	**df**	**Sig.**
I am good at maths (A)	411		407	**.000**
Strongly Agree	80	20.13		
Agree	188	18.6		
Not Sure	115	17.59		
Disagree	28	17.75		
I do maths at home (A)	411		407	**.000**
Strongly Agree	80	20.13		
Agree	235	18.4		
Disagree	96	17.64		
I believe I am good at teaching maths (A)	411		407	**.000**
Strongly Agree	80	20.13		
Agree	282	18.38		
Not Sure	49	17.02		
Correlations (Spearman's Rho)		**Correlation Coefficient**		**Sig.**
Teacher Maths Anxiety	411	.-.145		**.003**
Teacher EATM	411	.153	.	**.002**
(A) = ANOVA				

Teachers' Self-Confidence, Motivation, and Teaching Confidence

The ANOVA test found a significant difference between teachers answers regarding mathematics ability (p=.000). Those with teachers who 'strongly agreed' had a significantly higher average EAM score than those with teachers who 'agreed' (p=.019) and those with teachers who were 'not sure' (p=.000). Additionally, the ANOVA test found a significant difference between teachers' answers regarding mathematics ability (p=.000). Those teachers who 'strongly agreed' had significantly higher average EAM score than those teachers who were 'not sure' (p=.001). This provides evidence to suggest that teachers' belief in mathematics ability influences pupils' attitudes to mathematics.

The ANOVA test found a significant difference between teachers' motivation (p=.000). Those teachers who 'strongly agreed' that they do maths at home, had significantly higher average BAM scores than those who 'agreed' (*p*=.001) and those who 'disagreed' (*p*=.000). Additionally pupils with teachers who 'strongly agreed' that they do maths at home, had significantly higher average EAM score than those who 'agreed' (*p*=.005) and those who 'disagreed' (*p*=.000).

The ANOVA test found a significant difference between teachers' teaching confidence and pupils' attitudes (*p*=.000). Those with teachers who 'Strongly Agreed' they are good at teaching maths, had significantly higher average BAM scores than those who 'agreed' (*p*=.000) and those who were 'not sure' (*p*=.002). The ANOVA test found a significant difference between teachers' answers regarding their beliefs in teaching maths (*p*=.000). Those with teachers who 'strongly agreed' they are good at teaching maths, had significantly higher average EAM scores than those who 'agreed' (*p*=.004) and those who were 'not sure' (*p*=.000).

Null Hypothesis 3d is therefore rejected.

Teachers' Mathematics Anxiety Score and EAM

The Spearman's Rho test identified a significant, negative correlation between teachers' maths anxiety score and pupils' BAM scores (r = -.217; p = .000). The Spearman's Rho test identified a significant, negative correlation between teachers' maths anxiety score and pupils' EAM scores (r = -.145; p = .003).

The Spearman's Rho test identified a significant, positive correlation between teachers' EAM score and pupils' BAM score (r = -.162; p = .001). The Spearman's Rho test identified a significant, positive correlation between teachers EAM score and pupils' EAM score (r = -.145; p = .003).

Null Hypotheses 3b and 3c are therefore rejected.

All Null hypotheses for Research Question 3 were rejected. This provides evidence to suggest that teacher characteristics influence pupils' attitudes to mathematics.

Discussing Teacher Characteristics

Previous studies have identified the lack of primary school teachers with mathematical backgrounds (Vorderman, 2011; Hillman, 2014) and the importance of teacher-pupil relationships (Birch and Ladd, 1997; Attard, 2013; Coe et al, 2014), along with teachers confidence in teaching mathematics (Beilock et al, 2010). The effect that teachers have on their pupils has already been evidenced with suggestions that a focus on teaching methods that encourage students to get the right answer (Geist, 2000) leads to methods focusing on repetition and testing, which undermines the pupils' natural thinking processes and places the pupil in a more passive role (Sun and Pyzdwroski, 2009; Tall, 2014). The focus on memorisation leads to a lack of engagement and risks students' learning being hindered due to their learner needs not being met (Oberline, 1982 in Jackson, 2008), which can lead to negative attitudes to mathematics (Popham, 2008) as well as mathematics anxiety (Scarpello, 2007; Jackson, 2008; Chinn, 2012; Marsall et al, 2016). The repetitive nature of this process builds negative mathematical dispositions (Damon, 2007; National Numeracy, 2016a), reinforcing negative attitudes towards mathematics: this is experienced by many children in the early years of their education (Scarpello, 2007). Teacher attitudes and confidence are therefore important factors to consider when discussing influences of pupil attitudes. Whilst this study originally discussed teaching methods in the literature review, it also highlighted the importance of teacher confidence (Beasley et al, 2001; Beilock et al, 2010) given the evidence to suggest that teachers confidence in the methods they teach is more important than the methods themselves (Boylan, 2019).

Teachers' Self-Confidence in Mathematical Ability

Both ANOVA tests for teachers' self-confidence in mathematics and pupils' attitudes to mathematics identified significant differences. On both occasions, pupils with teachers who strongly agreed they were good at mathematics had significantly more positive attitudes than any other group. Teachers' confidence has already been found to positively relate to pupil attitudes (Sun and Pyzdwrowski, 2009; Attard, 2013) and achievement (Birch and Ladd, 1997; Beasley et al, 2001). A lack of confidence in teachers has been found to cause negative impact. Negative female teachers have been found to transfer negative emotions to female pupils (Beilock et al, 2010), which becomes more problematic when relying on teacher-centred methods to encourage pupils to retain information (Cates and Rhymer, 2003; Jackson, 2005; Coltman and Whitebread, 2008). These traditional methods have already been found to favour males who are more likely to adapt better (Boaler, 2002) through a preferred learning style and pace of working that is presumed to be shared identically amongst all learners (Boaler, 1997 in Geist, 2010). This has further contributed to the discussion of females developing mathematics anxiety (Beilock, 2008) due to poor learning and assessment experiences, with timed tests that depend on the retaining of information (Boaler, 2002).

Teachers' Perception of Doing Mathematics at Home

The ANOVA test for teacher's perception of doing mathematics at home identified a significant difference. Specifically, pupils with teachers who 'strongly agreed' they did mathematics at home had significantly more positive attitudes to mathematics than pupils with teachers who 'agreed' or were 'not sure'. Whether pupils interpret doing maths at home as meaning homework or something different, the premise of motivation and value is still present (Ryan and Decci, 2000) given the numerical tasks associated outside of teaching, such as balancing finances (Chinn,, 2012a; Curtain-Phillips, 2016; National Numeracy, 2019b). Therefore, an increase in agreeing they do mathematics at home could suggest an increase in motivation for teachers. Furthermore, an increase in motivation in teachers would expect an increase in motivation for their pupils, which is the case in the current research.

Teachers' Self-Confidence in Teaching Mathematics

The ANOVA test for teachers' self-confidence in teaching mathematics identified a significant difference. Pupils with teachers who 'strongly agreed' they are good at teaching mathematics had significantly more positive attitudes to mathematics than those whose teachers 'agreed' or were 'not sure'. Less than 5% of primary teachers come from mathematics backgrounds and have poor levels of knowledge (Vorderman, 2011).

Teachers' confidence could, therefore, be an important factor when considering the influence that teachers can have on pupils (Beasley et al, 2001). Countries, such as Singapore and China, (Tall, 2014) have been compared to the UK given their primary school teachers' specialist skills in mathematics. This would imply a strong level of confidence amongst the specialists and therefore expect a positive influence on pupils within these countries. The evidence from the current study additionally implies an improvement in teachers' confidence is associated with an improvement in pupil attitudes, which should expect an increase in attainment (National Numeracy, 2016a). Teaching methods have been argued to focus on pupils' retaining information and accepting teachers' statements (Jackson, 2005; Coltman and Whitebread, 2008; Sun and Pyzdowski, 2009; Cristillo, 2010), which often leads to pupils missing key information due to lack of engagement (Mpho, 2018). However, OFSTED (2018) claim that pupils prefer these traditional processes to other teaching methods. An argument can therefore be made that the confidence of the teacher is an important factor of pupil attitude, along with the teaching methods themselves. Regardless of whether pupils favour particular teaching methods, an argument can still be made that teachers with more confidence have pupils with more positive attitudes, as is the case that teachers with higher levels of anxiety have pupils with more negative attitudes (Beilock et al, 2010).

Teachers' Attitudes to Mathematics

The correlation for teachers' mathematics anxiety and pupils' attitudes to mathematics identified a significant negative relationship, indicating that as teachers' mathematics anxiety increases, pupils' attitudes to mathematics become more negative. This echoes similar evidence to Beilock et al (2010) who also identified teachers' mathematics anxiety was found to negatively affect students by also influencing them to become more mathematically anxious, and this relationship was stronger with female teachers and pupils. Further evidence indicates that negative emotions can be transmitted from teachers to pupils (Smith, 2004; Took and Leanord, 1998).

There has been discussion surrounding how teaching methods affect pupil attitudes and experiences and more so with mathematically anxious teachers (Beilock et al, 2010) and when using teacher centred techniques (Jackson, 2005; Coltman and Whitebread, 2008). Teachers' mathematics anxiety could affect pupils if teacher-centred techniques are relied on as these methods emphasise the authoritative role of the teacher who is expected to manage the classroom and pupil behaviour whilst also delivering learning content (Mpho, 2018). The reliance on memory provides a lack of explanation on behalf of the teacher (Jackson, 2008) and if that teacher is mathematically anxious, then this risk is even greater. Therefore, if the teacher is the focus of the learning experience and is anxious, then that anxiety could be absorbed by pupils (Jackson, 2008; Beilock et al, 2010).

The correlation for teachers' emotional attitudes to mathematics and pupils' attitudes to mathematics identified a significant negative relationship, indicating that as teachers' mathematics anxiety increases, pupils' attitudes to mathematics become more positive. Teacher behaviours have been found to be more influential than in how teachers and pupils relate to one another as people (Coe et al, 2014). Considering how emotions can be transmitted from teachers to pupils (Smith 2004) also provides ground to discuss how identities can also be established. Pupils relate to the gender of their teacher (Beilock et al, 2010) as this presents a shared group membership defined by a particularly identity (Smith and Hogg, 2008). Pupils work towards their sense of identity (Gray, 2014) by emulating behaviours of that perceived shared membership (Perry and Bussey, 1979; Bussey and Bandura, 1984). This further highlights the powerful influence that teachers can have on their pupils (Beasley et al, 2001; Kristapovich, 2014) and how it resembles an external factor of pupils' attitude to mathematics (Sun and Pyzdowrski, 2009).

Transmitting emotions from teachers to pupils can be particularly problematic in the context of establishing non-STEM identities (Macdonald, 2014), where pupils may learn to establish such identitites through relating to their teachers. Teachers are found to be strong influencers and contributors to pupils' mathematical dispositions (NCTM, 1989) and the UK has a long-standing shortage of primary school teachers from mathematical backgrounds (Vorderman, 2011). Furthermore, teaching methods also add to this affect with approaches that emphasise the importance of retaining information (Coltman and Whitebread, 2008; Sun and Pyzdrowski, 2009), which has additionally been found to favour male learners (Boaler, 2002). This provides additional impacts because of negative attitudes established, including restrictions on subject choice in high school and university (Archer et al, 2013; Marshall et al, 2016) and then employment trajectories (Noyes, 2007; Hillman, 2014; Macdonald, 2014; Mcmaster, 2017; Wilson, 2009; UK Commission for Employment and Skills, 2013; 2015).

Assessing School Characteristics

Tables 34 and 35 provide a summary of the tests carried out between teacher characteristics and pupils' attitudes to mathematics. All tests found associations indicating that less deprivation and higher maths progression would result in pupils with more positive attitudes.

Table 35: Tests for Difference for BAM School Clustering Variables

IV	N	Mean	df	Sig.
Percentage of Free School Meals (A)	439	47.89	430	**.002**
3.1	54	53.83		
4.6	44	49.91		
7.5	53	48.06		
12.7	51	44.67		
20	49	47.51		
20.9	45	47.04		
27.4	22	45.27		
28.5	48	44.5		
57.2	73	48.22		
School Index of Multiple Deprivation Decile (A)	439		434	**.000**
Most Deprived (1)	149	47.34		
3	121	44.72		
5	53	48.06		
6	62	50.13		
7	54	53.83		
Maths Progression Score 2 (A)	439		435	**.000**
Below Average	22	45.27		
Average	215	47.73		
Above Average	148	46.36		
Well Above Average	54	53.83		
Average Score in Mathematics (A)	439		434	**.000**
101	22	45.27		
104	204	46.82		
105	111	48.97		
106	48	44.5		
109	54	53.83		
Correlations				**Sig.**
Maths Progression Score				**.009**

Table 36: Tests for Difference for EAM School Clustering Variables			
IV	**N**	**Mean (Mean Rank)**	**Sig.**
Percentage of Free School Meals (A)	450		**.000**
3.1	53	20.68	
4.6	45	17.96	
7.5	50	18.32	
12.7	51	17.67	
20	54	19.02	
20.9	44	17.48	
27.4	25	19.16	
28.5	45	16.6	
57.2	83	19.88	
School Index of Multiple Deprivation Decile (A)	450		**.000**
Most Deprived (1)			
3			
5	159	19.08	
6	121	17.58	
7	50	18.32	
	67	18.21	
	53	20.68	
Maths Progression Score 2 (A)	450		**.002**
Below Average	25	19.16	
Average	222	18.31	
Above Average	150	18.36	
Well Above Average	53	20.68	
Average Score in Mathematics (A)	450		**.000**
101	25	19.16	
104	206	18.56	
105	105	18.57	
106	106	16.6	
109	109	20.68	
Correlations			**Sig.**
Maths Progression Score			**.220**

Interpreting the tables

Measures of Deprivation

The ANOVA identified a significant difference between the average BAM score of schools when grouped according their percentage of pupils eligible for free school meals (*p*=.002) The highest average (53.83), was the school with the lowest percentage of pupils eligible for FSM. This school had a significantly higher average BAM score (53.83) than the school with 12.7% of pupils eligible for FSM (44.67; *p*=.037) and the school with 28.5% of pupils eligible for FSM (44.5; *p*=.035).

Additionally, the ANOVA identified a significant difference between the average EAM score of schools when grouped according the percentage of pupils eligible for free school meals (*p*=.000) The highest average, was the school with the lowest percentage of pupils eligible for FSM. This school has a significantly higher average EAM score (20.68) than the school with 28.5% of pupils eligible for FSM (16.6) (*p*=.002).

Null hypothesis 4b is therefore rejected.

The ANOVA identified a significant difference between the average BAM score of schools when grouped according to their IMD Decile (*p*=.000). The highest average BAM score belonged to the school from the least deprived area (IMD = 7) (53.83). This school had a significantly higher average BAM score than schools from IMD 1 (47.34; *p*=.013) and IMD 3 (44.72; p=.000).

The ANOVA identified a significant difference between the average EAM score of schools when grouped according to their IMD Decile (*p*=.000). The highest average EAM core belonged to the school from the least deprived area (IMD = 7). This school had a significantly higher average EAM score than schools from IMD 6 (18.21; *p*=.030) and IMD 3 (17.58; *p*=.000).

Null hypothesis 4c is therefore rejected.

School Performance Measures

The ANOVA identified a significant difference between the average BAM score of schools when grouped according to their average score in maths (*p*=.000). The highest average BAM score belonged to the school with the highest average score in maths (53.83). This school had a significantly higher average than schools with an ASM of 106 (44.5; *p*=.003) and 104 (46.82; *p*=.003).

The ANOVA identified a significant difference between the average EAM score of schools when grouped according to their average score in maths (p=.000). The highest average EAM score belonged to the school with the highest average score in maths. This school had a significantly higher average than schools with an ASM of 106 (16.6; *p*=.000), 105 (18.57; *p*=.045) and 104 (18.56; *p*=.025).

Null Hypothesis 4d is therefore rejected.

The ANOVA identified a significant difference between the average BAM score of schools when grouped according to their maths progression score categories (*p*=.000). The highest average BAM core belonged to the school whose maths progression score qualified as well above average (53.83). This school had a significantly higher average BAM score than above average (46.36; *p*=.001), average (47.73; *p*=.007) and below average (45.27; *p*=.036).

The ANOVA identified a significant difference between the average EAM score of schools when grouped according to their maths progression score categories (*p*=.002). The highest average EAM core belonged to the school whose maths progression score qualified as well above average (20.68). This school had a significantly higher average EAM score than above average (18.36; *p*=.003) and average (18.31; *p*=.007).

The Spearman's Rho test identified a significant, positive correlation between maths progress score and pupils' BAM score (*r*=.124; *p*=.009). Contrastingly, the Spearman's Rho test did not identify a significant correlation between maths progression score and EAM.

Null Hypothesis 4e is therefore rejected.

Aside from Null Hypothesis 4a, which will be discussed in the Multivariate Analysis section, all null hypotheses for Research Question 4 were rejected, providing evidence to suggest that the school attended influences pupils' attitudes to mathematics. Pupils' attitudes are said to be shaped by the pedagogic practices they encounter, which differ according to the school (Bogdan and Biklen, 2007; Kena et al, 2014) and this evidence also indicates that argument. In terms of how that difference is influenced, the evidence produced from the current study indicates that schools in more affluent areas, or with higher performance measures, have pupils with more positive attitudes to mathematics. Hussain (2016) identified schools with higher performance measures provided positive impact to the economic values of houses within the catchment areas of those schools. There could therefore be a relationship between the performance of the school and the positive impact on the affluence of the area, highlighting the economic capital that can provide advantages to pupils (Tan, 2015). This explains how the additional provision of resources depending on economic capital, can be used to increase mathematical ability, as has been found (Chie and Xishua, 2008).

Testing Teacher Attitudes with School Characteristics

A series of bivariate correlations were ran for exploratory purposes to assess whether the characteristics of a school were associated with the pupils' teacher anxiety scores. Given there were only 19 teachers and 10 schools, these tests cannot be used as evidence to infer or generalise, but they can provide insight into any potential relationship between schools and the attitudes of their teachers.

Spearman's Rho Correlation Tests	**Teacher Maths Anxiety**	**Teacher EAM**
% Free School Meals	.560***	-.397***
Index of Multiple Deprivation	-.356***	-.007
Maths Progression Score	-.314***	-.046
Average Score in Maths	-.580***	.188***
***** = *p*<.001**		

Table 37: Exploratory Tests for Relationship between Teacher Attitudes and School Characteristics

Of the eight Spearman's Rho correlation tests, six were significant. Maths progression score did not significantly relate to teachers' emotional attitudes to maths.

Percentage of free school meals was found to positively relate to teachers' maths anxiety. Therefore, schools with higher percentages of pupils eligible for free school meals had teachers with higher levels of maths anxiety (p<.001). A negative relationship was identified with emotional attitudes to mathematics. Therefore, schools with more pupils eligible for free school meals had teachers with more negative attitudes to mathematics (p<.001).

The Index of Multiple Deprivation had a negative relationship with teachers' maths anxiety. Therefore, schools with more deprivation, closer to 1, had teachers with higher levels of maths anxiety (p<.001). A positive relationship was identified with emotional attitudes to mathematics. Therefore, schools with lower levels of deprivation, further from 1, had teachers with more positive attitudes to mathematics (p<.001).

Maths progression score was negatively related to teachers' maths anxiety. Therefore, as schools progression scores, increased, teachers' maths anxiety decreased (p .001). Maths progression score did not relate to teachers' emotional attitudes.

Average score in maths had a strong, negative, relationship with teachers' maths anxiety. Therefore, schools with higher average scores in mathematics had teachers with lower levels of maths anxiety (p>.001). A positive relationship as identified with emotional attitudes. Therefore, schools with higher average scores in mathematics had teachers with more positive attitudes to mathematics (p<.001).

Whilst these correlations cannot be regarded as inferential evidence given the lack of variation between 10 schools and 19 teachers, they can be used to indicate the potential relationship between schools with higher levels of attainment and deprivation. The correlations provide grounds to argue that schools with more deprivation have less confident teachers with more negative attitudes. An argument can also be made that schools with higher maths attainment have more confident and more positive teachers. This also provides an interesting discussion on what comes first, between teachers' attitudes and the performance of a school. Additionally, the same can be said for the affluence of a school, which can lead to more pupils with additional resources (Chie and Xishua, 2008) and Economic capital to succeed (Tan, 2015). Pampaka et al (2012) discuss how the commitment to improve STEM education concerns achieving high grades in examinations rather than improving educational experiences within the classroom. This is echoed in the

Department for Education's (2013) vision that expects all year 4 pupils to have memorised particular times tables by the end of the academic year. There is a particular focus on content being finished, when it comes to what is viewed as pupils achieving the learning of something, that does not really concern whether they understand something (Jackson, 2005; Pampaka and Williams, 2016) and this is found in the teaching experiences, which is pupils simply 'accepting statements' from teachers (Tall, 2014). Additionally, OFSTED (2018) argue that pupils prefer the teaching of traditional algorithms, which is what Jackson (2005) argues constitutes the teaching of mathematics to lack creativity and suit the procedures of examination. This helps provide a sense of narrative to why schools with higher affluence and performance scores have teachers with more positive attitudes. However, in order to accurately identify whether the school they attend influences a pupil's attitudes, and whether this is mediated by the attitudes of their teacher, multivariate analysis is required. This will be discussed in more detail in the multivariate analysis chapter.

Discussing School Characteristics

The pedagogic practices of schools differ according to the school attended (Bogdan and Biklen, 2007). An example of how this may be is highlighted in the introduction of school league tables has impacted pedagogic practices (Siraj and Taggart, 2014). This again highlights how the pressures of achievement outcomes such as grades force practitioners to teach in a way that emphasises memorisation rather than understanding (Jackson, 2005; Pampaka et al, 2012) and places the pupil in a passive position (Sun and Pyzdrowski, 2009). This also highlights how a pupil's experiences of mathematics would expectedly differ based on the school they attended. The bivariate analysis section for School Characteristics identified many significant associations that overall highlight the less deprived a school is, or the more maths progress of a school, the more positive pupils' attitudes to mathematics are.

Measures of Deprivation

The ANOVA test for percentage of free school meals and pupils' attitudes to mathematics was significant. The pupils with the most positive attitudes to mathematics were those studying at the school with the lowest percentage of pupils (3.1%) eligible for free school meals. This was the case for both dependent variables. It must also be noted however, that the second highest EAM score for pupils was with those studying at the school with the highest proportion of pupils eligible for free school meals (57.2%). The findings here are particularly important when considering the argument regarding the culture of the family home and its powerful influence (Moltimore, 1991) and the argument regarding family background of a more middle class culture. Hussain (2016) notes how houses near schools with lower proportions of free school meals benefit from an increase in economic value. This further adds evidence to suggest that middle class families may be more likely to benefit from higher attainment in mathematics, given their greater access to catchment areas of higher house price value. Variations in students achievement has been linked with economic capital (Tan, 2015; Chiu and Xishua, 2008), and this research also suggests that pupils of families with more economic capital have more positive attitudes, which can additionally relate to attainments as seen in previous research, and in this research when looking at schools' average scores in mathematics.

The ANOVA test for Index of Multiple Deprivation and pupils' attitudes to mathematics identified significant differences. Schools from the least deprived areas had the highest attitudinal scores for both dependent variables, with the lowest reported attitudinal scores reported from the third most deprived areas. This provides consistent findings with the percentage of free school meals and indicates that those in less deprived areas or from wealthier backgrounds have more positive attitudes to mathematics. Children from low socio-economic backgrounds often have parents with more negative attitudes because of their own experiences. This effects pupils (Eccles, 1993) and establishes negative learner identity (Wenger, 1998).

School Performance Measures

The grouped mathematics progression score measure identified significant differences between schools' attitudes to mathematics according their score grouping. More specifically, pupils in schools with the highest grouped score, 'well above average', had the most positive attitudinal scores for both dependent variables. This provides evidence to suggest that attitudes to mathematics positively relate to attainment. Therefore, those who have attitudes that are more positive are expected to have higher attainment scores.

Additionally, the correlations for ‘raw’ MPS and BAM identified a significant, positive correlation. The correlation with EAM however, was not significant and this could be due to measurement issues with the scales for ‘raw’ MPS and EAM being small. The competitive nature of the English school system drives the demand for schools to improve their grades and scores (Reay, 2017) whilst pedagogies and collaborative efforts to improve experiences have evidently produced better outcomes for pupils and schools (Jones, 2019). The evidence from the current study implies that positive attitudes associate with positive mathematics progression scores, meaning that the teaching implemented in these schools is providing pupils with more positive attitudes. To further add to this evidence, teachers’ attitudes and confidence in their teaching was also positively related to pupil attitudes.

The Department for Education (2017) stated that there are clear expectations for pupils to memorise up to 12 times tables by the end of the school year whilst also claiming that teachers and schools have the freedom to introduce content at times they see appropriate (DfE, 2013). These clear expectations are said to encourage more teacher centred approaches (Jackson, 2005; Sun and Pyzdrowski 2009; Coltman and Whitebread, 2008) where pupils simply accept statements from teachers (Tall, 2014) in order to ensure the content of the curriculum is delivered on time. The criticisms of this approach are that the passive nature does not allow students to engage as strongly with other, more creative methods (Bruner, in Wood, 1998; Sun and Pyzdrowski, 2009) whilst OFSTED have argued that pupils do prefer traditional methods. This provides the need to develop a further understanding behind what style of teaching encourages more positive attitudes towards mathematics and whether this does relate to mathematics progression scores.

The ANOVA test for average score in mathematics and pupils’ attitudes to mathematics identified significant differences. More specifically, those with higher average sores in mathematics had higher average attitudinal scores for both dependent variables. This provides additional evidence regarding the positive impacts that attitudes can have on attainment, as should be expected (National Numeracy, 2016a). The Department for Education (2017) also identified that schools in more affluent areas had pupils with higher attainment scores. The evidence from bivariate analysis provides grounds to suggest that attitudes and attainment are linked to levels of deprivation. This could additionally provide insight into how family background can influence pupil attitudes when focusing on how those parents from more deprived backgrounds may be more likely to have had poor experiences of mathematics and pass those attitudes onto their children. This provides a similar discussion to mathematics progression scores, where pupil attitudes associate with higher attainment scores and therefore the school attended does provide an influence to pupils' attitudes. However, there must also be recognition of how positive attitudes contribute to higher attainment scores (Gray, 2013; National Numeracy, 2016a) and the impact of teaching, given that teacher attitudes and confidence were found to relate to positive attitudes. Furthermore, parental involvement was found to negatively relate to pupils' attitudes with previous evidence showing that parental previous attainment, positive or negative, impacts children's attainment (McMaster, 2017), meaning that the importance of teacher interaction is clear. The consistency in mathematics attainment measures positively relating to pupils' attitudes provides the need to further study how the school attended can effect pupil attitudes and attainment in order to understand how to help lower performing schools improve through improving pupil and teacher attitudes.

Summary of Bivariate Analysis Chapter

The Bivariate analysis identified a number of significant associations between behavioural attitudes to mathematics and pupil, teacher and school characteristics. Of the pupil characteristics, Ethnicity, opinion on someone who is good at reading and total gender ability beliefs were not significantly associated with behavioural attitudes to mathematics.

Of pupil characteristics, gender, favourite subject, self-confidence, belief in doing maths at home and opinion on someone being good at maths were significantly associated. All teacher and school characteristics were significantly associated. This provides evidence to suggest that attitudes to mathematics are influenced by external factors. Whilst it is important to identify the factors associated with attitudes, the aims of this research are to identify factors associated whilst acknowledging the influence of other factors. The next chapter, multivariate analysis, provides a series of models that identify influential factors of attitudes to mathematics whilst additionally acknowledging the other influential factors.

Chapter 6: Multivariate Analysis

Introduction to Chapter

This section consists of multiple multivariate models assessing the influence of pupil, teacher and school characteristics on pupils' attitudes to mathematics. The first section will assess the influence of pupil characteristics on pupils' attitudes, with a multiple regression being used for each distinct measure of attitudes to mathematics, with the same pupil characteristics.

Like the previous analysis chapters, there will be two dependent variables used to test these hypotheses and therefore there will be separate multivariate models testing the same independent variable against two different dependent variables, measuring separate aspects of attitudes to mathematics. Multivariate analysis consists of multiple regression when testing influence of multiple independent variables concerning the pupils and their parental support. Multilevel Modelling was to build a model consisting of independent variables representing teachers' views and school characteristics to take into account the hierarchal clustering within the data.

List of Multivariate Models

Model 1. Multiple Regression: Assessing the Influence of Pupil Characteristics without Teachers and Schools

Model 2. Multilevel Model: Assessing the Influence of Pupil and Teacher Characteristics

Model 3. Multilevel Model: Assessing the Influence of Pupil and School Characteristics

Model 4. Multilevel Model: Assessing the Influence of Pupil, Teacher and School Characteristics

Model 1. Multiple Regression

Behavioural Attitudes to Mathematics

Characteristics	*B*	S.E	Sig.	Beta
Constant	30.71	2.54	.000	
Gender	-1.43	1.24	.249	-.062
Favourite Subject	.943	1.27	.457	.041
Ethnicity	-1.16	1.3	.374	-.047
I am good at maths	15.75	2.33	**.000**	.364
I do maths at home	10.19	1.6	**.000**	.382
Parental Help	-2.05	1.23	.097	-.088
Gender Ability Beliefs	.274	.878	.755	.016
***p* = .000 Adjusted R squared = .348**				

Table 38: Model 1.1 with level 1 variables

The statistically significant model provides evidence to suggest that the model containing gender, favourite subject, ethnicity, self-confidence, motivation and parental help is significantly different (better) than the one without (p<.001). The adjusted R squared value (.330) indicates that the seven predictors account for 35% of the total variance of pupils' behavioural attitudes to mathematics (BAM) (n=318). Null Hypothesis 5a is therefore rejected.

The unstandardized regression coefficient for gender (B=.-1.43; p = .249) indicates that gender does not influence pupils' BAM score when controlling favourite subject, gender ability beliefs, ethnicity and belief in maths ability.

The unstandardized regression coefficient for favourite subject (B= .943; p = .457) indicates that favourite subject does not influence pupils' BAM score when controlling the influence of gender, ethnicity, self-confidence, motivation, and parental help.

The unstandardized regression coefficient for ethnicity (B= -1.16; p = .374) indicates that ethnicity does not influence pupils' BAM score when controlling the influence of gender, favourite subject, self-confidence, motivation and parental help

The unstandardized regression coefficient for self-confidence (B= 15.75; p = .000) indicates that those who believe they are good at maths are predicted to attain a BAM score of approximately 15.8 points more than pupils who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation and parental help. This provides evidence to suggest that pupils whose favourite subject is maths have significantly more positive views toward mathematics than pupils whose favourite subject is not maths. Findings are to be treated with caution however, due to evidence of multicollinearity when including this factor. An additional model without this factor will therefore be analysed to assess any potential changes in association between other independent variables and pupils' BAM.

The unstandardized regression coefficient for perception of doing maths at home (motivation) (B= 10.19; p =.000) indicates that those who believe they do maths at home are predicted to attain a BAM score of approximately 10.2 points more than pupils who do not when controlling the influence of gender, favourite subject, ethnicity, self-confidence and parental help.

The unstandardized regression coefficient for parental help (B= -2.05; p =.097) indicates that parental help does not influence pupils' BAM score when controlling the influence of gender, favourite subject, ethnicity, self-confidence and motivation.

The unstandardized regression coefficient for gender ability beliefs (B= .27; p =.755) indicates that gender ability beliefs do not influence pupils' BAM score when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

Of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help. This provides evidence to suggest that pupils' behavioural attitudes are affected by confidence and motivation. Moreover, this also provides evidence to suggest that gender, favourite subject, ethnicity and parental help(all of which were significantly associated with behavioural attitudes in bivariate analysis), do not influence behavioural attitudes when considering the influence of multiple factors simultaneously. This is particularly important in the context of identifying influential factors when capturing the complexity of pupil characteristics.

Emotional Attitudes to Mathematics

Characteristics	**B**	**S.E**	**Sig.**	**Beta**
Constant	10.83	1.02	**.000**	
Gender	.09	.41	.835	.01
Favourite Subject	1.61	.41	**.000**	.21
Ethnicity	.39	.43	.372	.05
I am good at maths	7.63	.91	**.000**	.43
I do maths at home	1.77	.49	**.000**	.19
Parental Help	-1.15	.42	**.006**	-.15
Gender Ability Beliefs	.06	.3	.845	-.01
***p* = .000 Adjusted R squared = .345**				

Table 39: Model 1.2 with level 1 variables

The statistically significant model provides evidence to suggest that the model containing the level 1 variables is significantly different (better) from the model that the model without (p<.001). The adjusted R squared value indicates that the seven predictors account for 35% of the total variance for pupils' emotional attitudes to mathematics (EAM). Null Hypothesis 5b is therefore rejected.

The unstandardized regression coefficient for gender (*B*= .09; *p* =.835) indicates that gender does not influence pupils' EAM score when controlling the influence of favourite subject, Ethnicity, self-confidence, motivation and parental help.

The unstandardized regression coefficient for favourite subject (*B*= 1.61; *p* = .000) indicates that pupils who state maths to be their favourite subject are predicted to attain an EAM score of approximately 1.6 points higher than those who do not state maths to be their favourite subject, when controlling the influence of gender, ethnicity, self-confidence, motivation and parental help. This provides evidence to suggest that pupils who value maths as their favourite subject have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths.

The unstandardized regression coefficient for ethnicity (*B*= .39; *p* = .372) indicates that ethnicity does not influence pupils' EAM score when controlling the influence of gender, favourite subject, confidence, motivation and parental help. This provides evidence to suggest that when accounting other factors, ethnicity does not influence how pupils feel about mathematics.

The unstandardized regression coefficient for self-confidence (B = 7.63; p = .000) indicates that the pupils who have greater self-confidence have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation and parental help. Specifically, those who indicate they are confident in their mathematics ability are predicted to attain an EAM score of approximately 7.6 points higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics. Findings are to be treated with caution however, due to evidence of multicollinearity when including this factor, as identified in the first model with BAM. An additional model without this factor will therefore be analysed to assess any potential changes in association between other independent variables and pupils' EAM.

The unstandardized regression coefficient for motivation (B = 1.77; p = .000) indicates that that who elicit motivation have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence and parental help. Specifically, those who indicate motivation are predicted to attain an EAM score of approximately 1.7 points higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for parental help (B = -1.15; p = .006) indicates that those who state their parents help them with homework have more negative EAM scores than those who do not. Specifically, those who indicate their parents help them are predicted to attain an EAM score of approximately 1.2 lower than those who do not state that they receive parental help. This provides evidence to suggest that parental help negatively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for gender ability beliefs (B= .06; p =.845) indicates that gender ability beliefs do not influence pupils' EAM score when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

Of the seven predictors associated with pupil characteristics, four were found to significantly influence pupils' emotional attitudes to mathematics. Whilst gender and ethnicity were found to have no influence when acknowledging other factors simultaneously, value of mathematics (Favourite subject) self-confidence, and motivation all positively influenced pupils' emotional attitudes. Parental help provided a negative influence. This must therefore be considered when discussing factors of attitudes and recognising that the sample consists of higher levels of deprivation at the school level in comparison to the national average, along with higher overall mathematics abilities at the school level.

Addressing issues of Multicollinearity

When assessing whether the assumptions of the linear regression models were met, issues of multicollinearity were met for both dependent variables. When assessing collinearity diagnostics, self-confidence was identified as the issue, with a significant proportion of the variance (78% For BAM, 84% for EAM) being explained by the pupil factor. It was therefore decided that the same models would again be assessed without self-confidence. All evidence of assumptions being met aside from the multicollinearity due to pupils self-confidence (for both dependent variables) can be found in Appendix I.

Behavioural Attitudes to Mathematics

Characteristics	**B**	**S.E**	**Sig.**	**Beta**
Constant	42.761	1.87	**.000**	
Gender	-2.94	1.29	**.023**	-.13
Favourite Subject	3.66	1.29	**.005**	.153
Ethnicity	-.36	1.32	.786	-.014
I do maths at home	10.48	1.44	**.000**	.39
Parental Help	-2.1	1.3	.108	-.09
Gender Ability Beliefs	.433	.9	.632	.025
***p* = .000 Adjusted R squared = .192**				

Table 38.2: Model 1.1 with level 1 variables (without self-confidence)

Model 1.1.1 for behavioural attitudes to mathematics provided similar results with the exception of gender and favourite subject, originally not influencing BAM, to in fact be significant. In addition, the adjusted R Squared value of .192 indicates the variance in pupils' BAM score is reduced from 35% to 19% when removing pupil self-confidence. The model is still significance, and we therefore still reject null hypothesis 5a.

The unstandardized regression coefficient for gender (*B = -2.94; p = .023)* indicates that gender females are predicted to attain a behavioural attitudes to mathematics score of approximately 2.9 lower than male pupils, when controlling the influence of favourite subject, ethnicity motivation, parental help and gender ability beliefs.

The unstandardized regression coefficient for favourite subject (*B = 3.66; p = .005)* indicates that pupils who indicate mathematics to be therefore favourite subject are predicted to attain a behavioural attitudes to mathematics score of approximately 3.7 lower than male pupils, when controlling the influence of gender, ethnicity motivation, parental help and gender ability beliefs.

As identified in Model 1.1, the other independent variables were found to not significantly influence BAM when controlling for the influence of other factors.

Emotional Attitudes to Mathematics

Characteristics	**B**	**S.E**	**Sig.**	**Beta**
Constant	17.08	.715	**.000**	
Gender	-.47	.47	.322	-.05
Favourite Subject	2.98	.47	**.000**	.34
Ethnicity	6.18	.486	.204	.07
I do maths at home	1.68	.54	**.002**	.16
Parental Help	-1.49	.49	**.002**	-.16
Gender Ability Beliefs	.18	.34	.585	.03
***p* = .000 Adjusted R squared = .193**				

Table 39.2: Model 1.2 with level 1 variables (without self-confidence)

Model 1.2.1 for emotional attitudes to mathematics provided similar results with the exception of gender and favourite subject, originally not influencing BAM, to in fact be significant. In addition, the adjusted R Squared value of .193 indicates the variance in pupils' EAM score is reduced from 35% to 19% when removing pupil self-confidence. The model is still significance, and we therefore still reject null hypothesis 5b.

When assessing the coefficients for the model, no changes were identified in how any of the independent variables influence pupils' emotional attitudes to mathematics.

Multilevel Models: Attempting to address the hierarchal clustering within the data.

The following model consists of variables added to the model that provide a clustering effect. Model 2 consisted of adding teacher characteristics, whilst model 3 consisted of adding school characteristics. Models 2 and 3 assessed the influence of either teacher or school factors separately, whilst Model 4 consisted of both teacher and school characteristics simultaneously.

Model 2.1.1: Teacher Groupings: Behavioural Attitudes to Mathematics

An attempt was made to assess whether the variance in pupils' behavioural attitudes to mathematics was explained by the teachers they learned from.

This was done by attempting to build an unconditional model that simply assessed how much variance in pupils' behavioural attitudes to mathematics occurs within the data at the teacher level.

	Model 2.1.1 Unconditional Model	Model 2.1.2 Conditional Model	Model 2.1.3 Conditional Model 2
Residual variance	129.9***	83.56***	84.17***
Intercept variance (Teacher Level)	7.59	2.65	.39
Intra-class correlation	.06	.03	.005
Log Likelihood	3395.98	1791.9	1666.18
****p<.001*			

Table 40: Overview of Multilevel Model 2.1

The ‘unconditional’ model yielded a statistically significant residual variance. The intercept variance however, was not significant. The ICC was calculated to be .06, indicating that 6% of the total variance in pupils’ attitudes to mathematics is accounted for by the teacher, however this is not significant. Null Hypothesis 6a is therefore not rejected. This therefore not provide evidence to suggest that pupils’ attitudes to mathematics are influenced by the attitudes of their teacher.

A post hoc power analysis was carried out to estimate the design effect of teacher to pupils’ attitudes. By calculating the design effect, we can use it to multiply by the sample size in order to estimate an appropriate sample size where a Multilevel Model can accurately estimate how much affect the school attended has on pupils’ attitudes. In other words, a calculation for the requirements of a simple random sample (Lohr, 1999). This was done with the following equation (Donner, Birkett and Buck, 1981):

$$\boldsymbol{DE = 1 + (n - 1)\rho}$$

Where: n = average clustering size (508/19 = <u>26.74</u>) and; p = ICC (0.06)

- DE = 1 + (26.74 – 1)*.06
- DE = 1 + 25.74 *.06
- DE = 1 + 1.54
- DE = 2..54

The next minimum simple random sample size is therefore calculated to be 1290, which is the original sample size, 508, multiplied by the Design Effect, 2.54. The number of teachers, 19, also multiplied by the design effect calculates the required number of teachers to be 48. This means that a sample size of at least 1290 pupils from 48 different teachers, providing an average clustering of 26.74 like the original sample, would be appropriate to estimate the variance in pupils’ attitudes to mathematics at the teacher level.

Model 2.1.2: Teacher Groupings: Behavioural Attitudes to Mathematics with Pupil level variables

The ‘conditional’ model yielded a statistically residual variance. The intercept variance however, was not significant. The ICC was calculated to be .03, indicating that 3% of the total variance in pupils' attitudes to mathematics is explained by the teacher they learned from when considering the influence of the pupil level variables.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	52.71	1.6	134.45	32.91	.000	49.55	55.88
Gender (Male)	1.41	1.23	237.33	1.14	.254	-1.02	3.83
Favourite Subject (Other)	-1.17	1.27	241	-.924	.357	-3.7	1.33
Ethnicity (BME)	1.25	1.37	100.74	.91	.365	-1.48	3.98
Self-Confidence (No)	-15.96	2.32	240.98	-6.87	.000	-20.53	-11.38
Perception of doing maths at home (No)	-9.67	1.48	230.34	-6.55	.000	-12.57	-6.76
Parental Help (No)	2.14	1.22	236.81	1.76	.080	-.26	4.54
Gender Ability Beliefs							
(-1)	-1.25	1.85	239.6	-.68	.500	-4.88	2.39
0	.74	1.31	237.75	.56	.573	-1.84	3.31

Table 41: Estimates of Fixed Effects for Model 2.1.2

The estimate for gender (*B*= .1.41; *p* = .254) indicates that gender does not influence pupils' BAM score when controlling the influence of ethnicity, self-confidence, motivation, parental help and gender ability beliefs.

The estimate for favourite subject (*B*= -1.17; *p* = .357) indicates that favourite subject does not influence pupils' BAM score when controlling the influence of gender, ethnicity, self-confidence, motivation, parental help and gender ability beliefs.

The estimate for ethnicity (*B*= -1.25; *p* = .365) indicates that ethnicity does not influence pupils' BAM score when controlling the influence of gender, favourite subject, self-confidence, motivation parental help and gender ability beliefs.

The estimate for self-confidence (*B*= -15.96; *p* = .000) indicates that those who believe they are good at maths are predicted to attain a BAM score of approximately sixteen more than pupils who do not when controlling the influence of gender, favourite subject, ethnicity, motivation, parental help and gender ability beliefs. This provides evidence to suggest that pupils whose favourite subject is maths have significantly more positive views toward mathematics than pupils whose favourite subject is not maths.

The estimate for perception of doing maths at home (motivation) (*B*= -9.67; *p* =.000) indicates that those who believe they do maths at home are predicted to attain a more positive BAM score when controlling the influence of gender, favourite subject, ethnicity, parental help and gender ability beliefs. Specifically, it is estimated that they attain a score of approximately 9.7 points more than pupils who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence parental help and gender ability beliefs.

The estimate for parental help (*B*= 2.14; *p* =.080) indicates that parental help does not influence pupils' BAM score when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and gender ability beliefs.

The estimate for gender ability beliefs (*B*= -.125; *p* =.500) (*B* = .74; *p* = .573) indicates that gender ability beliefs do not influence pupils' BAM score when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

As identified in the multiple regression, two of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help.

MLM Model 2.1.3: Behavioural Attitudes with Teacher Groupings and Teacher Attitudes Added to Fixed Effects

The second 'conditional' model yielded a statistically residual variance. The intercept variance however, was not significant. The ICC was calculated to be .005, indicating that when considering the influence of the pupil level variables and teacher characteristics, less than1% of the total variance in pupils' attitudes to mathematics is explained by the classroom context.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	67.45	10.05	9.95	6.71	.000	45.05	89.85
Gender (Male)	1.3	1.29	218.44	1.01	.313	-1.24	3.84
Favourite Subject (Other)	-1.44	1.35	214.51	-1.07	.288	-4.1	1.22
Ethnicity (BME)	1.75	1.43	55.85	1.22	.227	-1.12	4.62
Self-Confidence (No)	-16.23	2.38	219.32	-6.81	.000	-20.93	-11.54
Perception of doing maths at home (No)	-9.55	1.63	219.35	-5.84	.000	-12.78	-6.33
Parental Help (No)	2.08	1.26	219.91	1.65	.101	-.41	4.56
Gender Ability Beliefs							
(-1)	-1.46	1.88	209.78	-.77	.440	-5.17	2.26
0	.06	1.35	205.69	.044	.965	-2.62	2.74
Teacher Overall EATM	.23	.3	8.76	.76	.466	-.45	.9
Teach Overall Maths Anxiety	-.34	.15	9.75	-2.20	.053	-.68	.01
Teacher Good at maths							
(Strongly Agree)	-9.86	6.35	8.92	-1.55	.155	-24.24	4.53
(Agree)	-5.68	2.89	5.78	-1.97	.098	-12.81	1.44
(Not sure)	-3.14	3.16	7.74	-.995	.350	-10.46	4.18
Teacher Motivation	1.92	1.8	11.07	1.07	.309	-2.04	5.87
Teacher Confidence in teaching	-4.35	3.13	12.71	-1.39	.188	-11.13	2.43

Table 42: Estimates of Fixed Effects for Model 2.1.3

The estimate for gender (B= 1.3; p =.313) indicates that gender does not influence pupils' BAM score when controlling the influence of favourite subject, Ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics.

The estimate for favourite subject (B= -1.44; p = .288) indicates that favourite subject does not influence pupils' BAM score when controlling the influence of gender, ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics.

The estimate for ethnicity (B= 1.75; p = .227) indicates that ethnicity does not influence pupils' BAM score when controlling the influence of gender, favourite subject, confidence, motivation, parental help and gender ability beliefs. This provides evidence to suggest that when accounting other factors, ethnicity does not influence how pupils feel about mathematics.

The estimate for self-confidence (*B* = -16.23; *p* = .000) indicates that the pupils who have self-confidence have more positive BAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation, parental help, gender ability beliefs and teacher characteristics. Specifically, those who indicate they are confident in their mathematics ability are predicted to attain a BAM score of approximately 16.2 higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics.

The estimate for motivation (B = -9.55; *p* = .000) indicates that that who have motivation have more positive BAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence and parental help. Specifically, those who indicate motivation are predicted to attain a BAM score of approximately 9.6 higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The estimate for parental help (*B* = 2.08; *p* = .101) indicates that parental help with homework does not influence pupils' BAM score, when controlling the influence of gender, ethnicity, favourite subject, self-confidence, motivation, gender ability beliefs and teacher characteristics.

The unstandardized regression coefficient for gender ability beliefs (*B*= -.1.46; *p* =.440) (*B* = .06; *p* = .965) indicates that gender ability beliefs do not influence pupils' BAM score, when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

All teacher characteristics were found to not significantly relate to pupils' BAM scores. Based on the post hoc power analysis calculations, it is estimated that with a sample size of approximately 1300 pupils from 48 different teachers, pupils' attitudes could be varied by the teacher they have.

As identified in the multiple regression and the first conditional model before including teacher characteristics, two of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help.

Model 2.2.1: Teacher Groupings: Emotional Attitudes to Mathematics

	Model 2.2.1 Unconditional Model	**Model 2.2.2 Conditional Model**	**Model 2.2.3 Conditional Model 2**
Residual variance	16.16***	8.96***	9.22***
Intercept variance (Teacher Level)	1.45*	.79	.65
Intra-class correlation	.08	.08	.07
Log Likelihood	2550.06	1291.15	1210.12
			****p<.001*

Table 43: Overview View of Multilevel Model 2.2

The ‘unconditional’ model yielded a statistically significant intercept and residual variance. The ICC was calculated to be .08, indicating that 8% of the total variance in pupils’ emotional attitudes to mathematics is associated with teacher groupings. Null hypothesis 6b is therefore rejected. This provides evidence to suggest that pupils’ attitudes to mathematics are influenced by the attitudes of their teacher.

When teacher attitudes were added to the Multilevel Model, in Model 2.2.2, the intercept variance was no longer significant. A post hoc power analysis was therefore carried out to identify a suitable sample size where a difference could be detected with teacher attitudes added to the model.

Where n = average clustering size (508/19 = 26.74) and; p = ICC (0.08)

- DE = 1 + (26.74 – 1)*.08
- DE = 1 + 25.74 *.08
- DE = 1 + 2.06
- DE = 3.06

The next simple random sample size is therefore calculated to be 1554, which is the original sample size, 508, multiplied by the Design Effect, 3.13. The number of teachers, 19, also multiplied by the design effect calculates the required number of teachers to be 58. This means that a sample size of at least 1554 pupils from 58 different teachers, providing an average clustering of 26.74 like the original sample, would be appropriate to estimate the variance in pupils' emotional attitudes to mathematics at the teacher level.

MLM Model 2.2.2: Teacher Groupings: Emotional Attitudes to Mathematics with Pupil level variables

The 'conditional' model yielded a statistically residual variance. The intercept variance however, was not significant. The ICC was calculated to be .08, indicating that 8% of the total variance in pupils' attitudes to mathematics is explained by the teacher they learned from when considering the influence of the pupil level variables, however this is not significant.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	20.94	.55	123.38	37.99	.000	19.85	22.03
Gender (Male)	-.07	.40	242.18	-.17	.868	-.86	.73
Favourite Subject (Other)	-1.83	.41	246.93	-4.47	.000	-2.64	-1.02
Ethnicity (BME)	-.07	.47	149.8	-.15	.884	-1.01	.87
Self-Confidence (No)	-7.56	.9	245.74	-8.43	.000	-9.33	-5.8
Perception of doing maths at home (No)	-1.57	.49	246.5	-3.22	.001	-2.53	-.61
Parental Help (No)	1.2	.41	241.78	2.94	.004	.4	2.00
Gender Ability Beliefs (-1)	-.11	.62	245.74	-.19	.852	-1.33	1.1
0	.21	.43	246.93	.48	.632	-.64	1.06

Table 44: Estimates of Fixed Effects for Model 2.2.2

The unstandardized regression coefficient for gender (*B*= -.07; *p* =.868) indicates that gender does not influence pupils' EAM score, when controlling the influence of favourite subject, Ethnicity, self-confidence, motivation, parental help and gender ability beliefs.

The unstandardized regression coefficient for favourite subject (*B*= -1.83; *p* = .000) indicates that pupils who state maths as their favourite subject are predicted to attain an EAM score of approximately 1.8 points higher than those who do not state maths to be their favourite subject, when controlling the influence of gender, ethnicity, self-confidence, motivation, parental help and gender ability beliefs. This provides evidence to suggest that pupils who value maths as their favourite subject have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths.

The unstandardized regression coefficient for ethnicity (*B*= -.07; *p* = .884) indicates that ethnicity does not influence pupils' EAM score, when controlling the influence of gender, favourite subject, confidence motivation, parental help and gender ability beliefs. This provides evidence to suggest that when accounting for other factors, gender does not influence how pupils feel about mathematics.

The unstandardized regression coefficient for self-confidence (*B* = -7.56; *p* = .000) indicates that the pupils who have self-confidence in mathematics have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation, parental help and gender ability beliefs. Specifically, those who indicate they are confident in their mathematics ability are predicted to attain an EAM score of approximately 7.6 points higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for motivation (*B* = -1.57; *p* = .001) indicates that that who elicit motivation have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence, parental help and gender ability beliefs. Specifically, those who indicate motivation are predicted to attain an EAM score of approximately 1.6 higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for parental help (*B* = 1.2; *p* = .004) indicates that those who state their parents help them with homework have more negative EAM scores than those who do not, when controlling the influence of gender, ethnicity, favourite subject, self-confidence, motivation and gender ability beliefs. Specifically, those who indicate their parents help them are predicted to attain an EAM score of approximately 1.2 point lower than those who do not state they receive parental help. This provides evidence to suggest that parental help negatively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for gender ability beliefs (*B*= -.11; *p* =.852) (B = .21; *p* = .632) indicates that gender ability beliefs do not influence pupils' EAM score, when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

As identified in the multiple regression, two of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help.

MLM Model 2.2.3: Emotional Attitudes with Teacher Groupings and Teacher Attitudes Added to Fixed Effects

The second 'conditional' model yielded a statistically significant intercept and residual variance. The ICC was calculated to be .07, indicating that 7% of the total variance in pupils' emotional attitudes to mathematics is associated with teacher groupings.

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	20.36	4.37	10.4	4.66	.001	10.68	30.05
Gender (Male)	-.16	.43	220.71	-.367	.714	-1.00	.688
Favourite Subject (Other)	-2.09	.44	219.6	-4.73	.000	-2.96	-1.22
Ethnicity (BME)	.04	.52	98.32	.09	.931	.98	1.07
Self-Confidence (No)	-7.30	.92	224.75	-7.9	.000	-9.12	-5.48

Perception of doing maths at home (No)	-1.58	.533	222.35	-2.06	.003	-2.63	-.53
Parental Help (No)	1.08	.43	223.43	2.52	.012	.23	1.92
Gender Ability Beliefs (-1) 0	-.1 .17	.64 .46	225.00 224.98	-.155 .363	.88 .72	-1.36 -.64	1.16 1.07
Teacher Overall EATM	-.16	.13	10.11	-1.22	.249	-.45	.13
Teach Overall Maths Anxiety	.01	.07	9.72	.216	.833	-.13	.16
Teacher Good at maths (Strongly Agree) (Agree) (Not Sure)	4.85 1.04 .75	2.77 1.34 1.41	9.06 7.1 8.18	1.75 .780 .534	.114 .460 .608	-1.42 -2.11 -2.48	11.12 4.19 3.99
Teacher Motivation (Agree)	1.81	.77	9.86	1.54	.154	-.53	2.89
Teacher Confidence in teaching (Agree)	.82	1.32	11.18	.614	.551	-2.10	3.73

Table 45: Estimates of Fixed Effects for Model 2.2.3

The unstandardized regression coefficient for gender (*B*= -.16; *p* =.714) indicates that gender does not influence pupils' EAM score, when controlling the influence of favourite subject, Ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics.

The unstandardized regression coefficient for favourite subject (*B*= -2.09; *p* = .000) indicates that pupils who value mathematics as their favourite subject have more positive EAM scores than those who do not when controlling the influence of gender, ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics. Specifically, pupils who identify mathematics as their favourite subject are predicted to attain an EAM score of approximately 2.1 points higher than those who do not. This provides evidence to suggest that pupils who value maths as their favourite subject have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths.

The unstandardized regression coefficient for ethnicity (*B*= .04; *p* = .931) indicates that ethnicity does not influence pupils' EAM score, when controlling the influence of gender, favourite subject, confidence, motivation, parental help and gender ability beliefs. This provides evidence to suggest that when accounting for other factors, gender does not influence how pupils feel about mathematics.

The unstandardized regression coefficient for self-confidence (*B* = -7.30; *p* = .000) indicates that the pupils who have self-confidence have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation, gender ability beliefs and teacher characteristics. Specifically, those who indicate they are confident in their maths ability are predicted to attain an EAM score of approximately 7.3 points higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for motivation (*B* = -1.58; *p* = .003) indicates that that who elicit motivation have more positive EAM scores than those who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence, parental help, gender ability beliefs and teacher characteristics. Specifically, those who indicate motivation are predicted to attain an EAM score of approximately 1.5 points higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for parental help (*B* = 1.08; *p* = .012) indicates that those who state their parents help them with homework have more EAM scores than those who do not. Specifically, those who indicate their parents help them are predicted to attain an EAM score of approximately 1.1 point lower than those who do not state they receive parental help. This provides evidence to suggest that parental help negatively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for gender ability beliefs (*B*= -.1; *p* =.880) (B = .21; *p* = .720) indicates that gender ability beliefs do not influence pupils' EAM score, when controlling the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

As identified in the multiple regression, two of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help.

Model 3.1: School Groupings for Behavioural Attitudes to Mathematics

An attempt was made to assess whether the variance in behavioural attitudes to maths was explained by the school the pupils attended.

This was done by attempting to build a base model that simply assesses how much variance in pupils' attitudes to mathematics occurs within the data at the school level.

	Model 3.1 Unconditional Model
Residual variance	131.86***
Intercept variance (School Level)	5.72
Intra-class correlation	.04
Log Likelihood	3396.63
	****p<.001*

Table 46: Overview of Multilevel Model 3.1

The 'unconditional' model yielded a statistically residual variance. The intercept variance however, was not significant. The ICC was calculated to be .04, indicating that 4% of the total variance in pupils' attitudes to mathematics is explained by the school attended, however this was not significant. Null hypothesis 4a is thereforenot rejected. This therefore does not provide evidence to suggest pupils' attitudes to mathematics are explained by the school attended.

A post hoc power analysis was carried out to estimate the design effect of schools to pupils' behavioural attitudes.

Where: n = average clustering size (508/10 = <u>50.8</u>) and; p = ICC (0.04)

- DE = 1 + (50.8 – 1)*.04
- DE = 1 + 49.8 *.04
- DE = 1 + 1.99
- DE = 2.99

The next simple random sample size is therefore calculated to be 1519, which is the original sample size, 508, multiplied by the Design Effect, 2.99. The number of schools, 10, also multiplied by the design effect calculates the required number of schools to be 30. This means that a sample size of 1519 pupils in 30 different schools, providing an average clustering of 50 pupils per school, like the original sample, would be appropriate to estimate the variance in pupils' attitudes to mathematics at the school level. For the current study, multiple regression will therefore be used to estimate the current effects of schools on pupils' attitudes to mathematics.

Model 3.2: School Groupings for Emotional Attitudes to Mathematics

An attempt was made to assess whether the variance in pupils' emotional attitudes to maths was explained by the schools the pupils attended.

This was done by attempting to build a base model that simply assessed how much variance in pupils' attitudes to mathematics occurs within the data at the school level.

	Model 3.2 Unconditional Model
Residual variance	16.18***
Intercept variance (School Level)	1.32
Intra-class correlation	.07
Log Likelihood	2543.76
	****p<.001*

Table 47. Overview of Multilevel Model 3.2

The 'unconditional' model yielded a statistically residual variance. The intercept variance however, was not significant. The ICC was calculated to be .07, indicating that 7% of the total variance in pupils' attitudes to mathematics is explained by the school attended, however this is not significant. A post hoc power analysis was carried out to estimate the design effect of schools to pupils' attitudes. Like Unconditional Model 3.1, this does not provide evidence to suggest pupils' attitudes to mathematics are explained by the school attended. Null hypothesis 4a is therefore not rejected.

A post hoc power analysis was carried out to estimate the design effect of schools to pupils' behavioural attitudes.

Where: n = average clustering size (508/10 = 50.8) and; p = ICC (0.07)

- DE = 1 + (50.8 – 1)*.07
- DE = 1 + 49.8 *.07
- DE = 1 + 3.49
- DE = 4.49

The next simple random sample size is therefore calculated to be 2281, which is the original sample size, 508, multiplied by the Design Effect, 4.49. The number of schools, 10, also multiplied by the design effect calculates the required number of schools to be 45. This means that a sample size of 2281 pupils in 45 different schools, providing an average clustering of 50 pupils per school like the original sample, would be appropriate to estimate the variance in pupils' attitudes to mathematics at the school level. For the current study, multiple regression will therefore be used to estimate the current effects of schools on pupils' attitudes to mathematics.

As this provides a much larger predicted simple random sample size than the other post power analyses, this will be the minimum required sample size for future studies.

Model 4.1.1: Teacher and School Groupings: Behavioural Attitudes to Mathematics

	Model 4.1.1 Unconditional Model	**Model 4.1.2 Conditional Model**
Residual variance	129.96***	84.28***
Intercept variance (School Level) Intercept Variance (Teachers and School)	2.93 3.85	.59 .96
Intra-class correlation Teacher Level School Level	.95 .03 .02	.98 .01 .01
Log Likelihood	3396.92	1679.96
		***$p<.001$

Table 48: Overview of Multilevel Models 4.1

The unconditional model identified a significant residual variance of 129.96, with a calculated ICC of .95, indicating that 95% of the sample's behavioural attitudes to mathematics differs at the pupil level. The intercept variance for Schools was not significant at 2.93 and the ICC was calculated to be .03, indicating that 3% of the variation in behavioural attitudes to mathematics is explained by the school attended. The intercept variance for Teachers was not significant at 3.85 and the ICC was calculated to be .02, indicating that 2% of the variation in behavioural attitudes to mathematics is explained by the pupils' teacher. Null Hypothesis 7a is therefore not rejected. This therefore does not provide evidence to suggest that pupils' attitudes to mathematics are influenced by teacher characteristics and the school attended.

MLM Model 4.1.2: Behavioural Attitudes with Pupil, Teacher and School Characteristics

The 'conditional' model identified a significant residual variance of 84.28, with a calculated ICC of .98, indicating that 98% of the sample's emotional attitudes to mathematics differs at the pupil level. The intercept variance for Teachers and Schools was not significant at .3 and the ICC was calculated to be .01 at the school level, indicating that 1% of the variation in behavioural attitudes to mathematics is explained by the school attended. For teachers, the ICC was also calculated to be .01, indicating that 1% of the variation in behavioural attitudes to mathematics is explained by the pupils' teacher and school.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	57.83	8.14	5.66	7.1	.001	37.62	78.04
Gender (Male)	1.36	1.29	218.11	1.05	.295	-1.19	3.90
Favourite Subject (Other)	-1.43	1.35	214.4	-1.06	.292	-4.09	1.23
Ethnicity (BME)	1.51	1.46	42.98	1.03	.308	-1.44	4.46
Self-Confidence (No)	-15.77	2.36	219.23	-6.66	.000	-20.42	-11.10
Perception of doing maths at home (No)	-10.06	1.59	213.66	-6.32	.000	-13.20	-6.92
Parental Help (No)	2.07	1.27	219.2	1.63	.104	-.43	4.56
Gender Ability Beliefs							
(-1)	-1.32	1.91	218.53	-.69	.492	-5.08	2.45
0	.16	1.39	219.67	.12	.907	-2.57	2.9
Teacher Overall EATM	.33	.30	7.61	1.08	.312	-.38	1.04
Teach Overall Maths Anxiety	-2.	.15	8.88	-1.32	.221	-.55	.15
Teacher Good at maths							
(Strongly Agree)	-4.88	4.83	6.33	-1.01	.350	-16.55	6.8
(Agree)	-4.68	3.31	6.05	-1.41	.207	-12.77	3.4
Not Sure	-1.15	3.22	6.24	-.356	.734	8.96	6.66
% of Free School Meals	-.02	.06	3.88	-.313	.770	-.18	.14

Table 49: Estimates of Fixed Effects for Model 4.1.2

The unstandardized regression coefficient for gender (*B*= 1.36; *p* =.295) indicates that gender does not influence behavioural attitudes to mathematics, when controlling the influence of favourite subject, ethnicity, self-confidence, motivation and parental help.

The unstandardized regression coefficient for favourite subject (*B*= -1.43; *p* = .292) indicates that pupils' BAM scores are not influenced by those who do not state maths to be their favourite subject, when controlling the influence of gender, ethnicity, self-confidence, motivation and parental help. This provides evidence to suggest that pupils who value maths as their favourite subject have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths.

The unstandardized regression coefficient for ethnicity (*B*= 1.51; *p* = .308) indicates that ethnicity does not influence pupils' BAM score, when controlling for the influence of gender, favourite subject, confidence, motivation, parental help and gender ability beliefs.

This provides evidence to suggest that when accounting other factors, gender does not influence how pupils feel about mathematics.

The unstandardized regression coefficient for self-confidence (B = -15.77; p = .000) indicates that the pupils who elicit self-confidence have more positive BAM scores those who do not, when controlling the influence of gender, favourite subject, ethnicity, motivation and parental help. Specifically, those who indicate they are confident in their math ability are predicted to attain an BAM score of approximately 15.8 points higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for motivation (B = -10.06; p = .000) indicates that that who elicit motivation have more l positive attitudes to mathematics than those who do not, when controlling the influence of gender, favourite subject, ethnicity, self-confidence and parental help. Specifically, those who indicate motivation are predicted to attain a BAM score of approximately ten points higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for parental help (B = 2.07; p = .104) indicates that parents help with homework does not influence pupils' BAM score when controlling the influence of gender, favourite subject, ethnicity, confidence, motivation and gender ability beliefs.

The unstandardized regression coefficient for gender ability beliefs (B= -1.32; p =.492) (B = .16; p = .907) indicates that gender ability beliefs do not influence pupils' BAM score, when controlling for the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

As identified in the multiple regression, two of the seven predictors associated with pupil characteristics, two were found to significantly influence pupils' behavioural attitudes to mathematics. Self-confidence and motivation were found to positively influence attitudes whilst considering the influence of pupils' individual gender, ethnicity, favourite subject and parental help.

Model 4.2.1: Emotional Attitudes to Mathematics with Teacher and School Groupings

	Model 4.2.1 Unconditional Model	**Model 4.2.2 Conditional Model**
Residual variance	16.16***	9.21***
Intercept variance (School Level)	1.15	.30
Intercept Variance (Teachers and School)	.03	.40
Intra-class correlation	.93	.93
Teacher Level	.002	.03
School Level	.07	.04
Log Likelihood	2543.78	1220.38
		****p<.001*

Table 50: Overview of Multilevel Models 4.2

The unconditional model identified a significant residual variance of 16.16, with a calculated ICC of .93, indicating that 93% of the sample's emotional attitudes to mathematics differs at the pupil level. The intercept variance for Teachers and Schools was not significant at .03 and the ICC was calculated to be .07, indicating that 7% of the variation in behavioural attitudes to mathematics is explained by the school attended. For teachers, the ICC was calculated at .002, indicating that less than 1% of the variation in behavioural attitudes to mathematics is explained by the pupils' teacher. Null Hypothesis 7b is therefore not rejected. This therefore does not provide evidence to suggest that pupils' attitudes to mathematics are influenced by teacher characteristics and the school attended.

MLM Model 4.2.2: Emotional Attitudes with Pupil, Teacher and School Characteristics

The conditional model identified a significant residual variance of 9.21, with a calculated ICC of .93, indicating that 93% of the sample's emotional attitudes to mathematics differs at the pupil level. The intercept variance for Teachers and Schools was not significant at .3 and the ICC was calculated to be .03 at the school level, indicating that 3% of the variation in behavioural attitudes to mathematics is explained by the school attended. For teachers, the ICC was calculated to be .04, indicating that 4% of the variation in behavioural attitudes to mathematics is explained by the pupils' teacher and school.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	23.75	3.44	8.09	6.9	.000	15.82	31.67
Gender (Male)	-.14	.43	222.07	-.326	.745	-.98	.7
Favourite Subject (Other)	-2.1	.44	219.92	-4.76	.000	-2.97	-1.23
Ethnicity (BME)	-.11	.51	88.27	-.22	.824	-1.14	.91
Self-Confidence (No)	-7.39	.91	225.82	-8.09	.000	-9.19	-5.59
Perception of doing maths at home (No)	-1.67	.52	225.54	-3.19	.002	-2.7	-.64
Parental Help (No)	1.04	.43	223.51	2.43	.016	.2	1.88
Gender Ability Beliefs							
(-1)	-.06	.64	225.26	-.09	.931	-1.32	1.21
0	.24	.46	223.45	.52	.603	-.67	1.15
Teacher Overall EATM	-.14	.12	9.85	-1.13	.284	-.42	.14
Teach Overall Maths Anxiety	-.03	.06	9.75	-.56	.592	-.17	.1
Teacher Good at maths							
(Strongly Agree)	1.76	2.02	8.67	.87	.406	-2.84	6.37
(Agree)	.06	1.4	7.98	.05	.965	-3.16	3.28
(Not Sure)	-.46	1.34	8	-.34	.741	-3.59	2.66
% of Free School Meals	.03	.02	5.17	1.22	.277	-.03	.09

Table 51: Estimates of Fixed Effects for Model 4.2.2

The unstandardized regression coefficient for gender (B= -.14; p =.745) indicates that gender does not influence pupils' EAM score, when controlling for the influence of favourite subject, Ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics.

The unstandardized regression coefficient for favourite subject (B= -2.1; p = .000) indicates that pupils who value mathematics as their favourite subject have more positive EAM scores than those who do not, when controlling for the influence of gender, ethnicity, self-confidence, motivation, parental help, gender ability beliefs and teacher characteristics. Specifically, pupils who identify their favourite subject as mathematics are predicted to attain an EAM score of approximately 2.1 points higher than those who do not. This provides evidence to suggest that pupils who value maths as their favourite subject have significantly more positive attitudes to mathematics than pupils whose favourite subject is not maths.

The unstandardized regression coefficient for ethnicity (B= -.11; p = .824) indicates that ethnicity does not influence pupils' EAM score, when controlling for the influence of gender, favourite subject, confidence, motivation, parental help and gender ability beliefs. This provides evidence to suggest that when accounting other factors, gender does not influence how pupils feel about mathematics.

The unstandardized regression coefficient for self-confidence (B = -7.39; p = .000) indicates that the pupils who have self-confidence have more positive EAM scores than those who do not, when controlling for the influence of gender, favourite subject, ethnicity, motivation, gender ability beliefs and teacher characteristics. Specifically, those who indicate they are confident in their maths ability are predicted to attain an EAM score of approximately 7.4 points higher than those who do not. This provides evidence to suggest that self-confidence positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for motivation (B = -1.67; p = .002) indicates that that who elicit motivation have more positive EAM scores than those who do not, when controlling for the influence of gender, favourite subject, ethnicity, self-confidence, parental help, gender ability beliefs and teacher characteristics. Specifically, those who indicate motivation are predicted to attain an EAM score of approximately 1.87 points higher than those who do not. This provides evidence to suggest that motivation positively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for parental help (B = 1.04; p = .016) indicates that those who state their parents help them with homework have higher EAM scores than those who do not. Specifically, those who indicate their parents' help them are predicted to attain an EAM score of approximately one point lower than those who do not state they receive parental help. This provides evidence to suggest that parental help negatively affects pupils' emotional attitudes to mathematics.

The unstandardized regression coefficient for gender ability beliefs (*B*= -.06; *p* =.931) (B = .24; *p* = .603) indicates that gender ability beliefs do not influence pupils' EAM score, when controlling for the influence of gender, favourite subject, ethnicity, self-confidence, motivation and parental help.

The rest of the predictors were found to not significantly relate to pupils' emotional attitudes to mathematics.

Exploratory Models for School Influence

Whilst evidence was identified that a larger sample was needed to asses the influence of schools on pupil attitudes, a multiple linear regression was ran for each dependent variable including pupil factors and school ID. This was to assess whether attending any of the schools influenced pupil attitudes. School 1, the largest group, was used as the reference group.

Behavioural Attitudes to Mathematics

Characteristics	**B**	**S.E**	**Sig.**	**Beta**
Constant	43.63	2.83	**.000**	
Gender	-3.08	1.29	**.017**	-.131
Favourite Subject	4.13	1.29	**.001**	.172
Ethnicity	-2.09	1.81	.251	-.08
I do maths at home	9.53	1.5	**.000**	.35
Parental Help	-2.17	1.3	.096	-.09
Gender Ability Beliefs	.2	.92	.832	.011
School ID *(Dummy Coded)*				
2	2.23	2.46	.364	.06
3	8.22	4.1	**.046**	.11
4	.81	2.65	.758	.02
5	-.19	2.6	.942	-.01
6	-2.79	3.44	.418	-.05
7	5.6	2.4	**.020**	.17
9	.24	2.57	.926	.01
10	-1.6	2.92	.585	-.04
11	-1.75	2.95	.554	-.05
***p* = .000 Adjusted R squared = .217**				

Table 52: Single Level Model with School ID for BAM

When adding school attended to the model with pupil level variables, the adjusted R Square value increased to .217, indicating that 22% of the variance in pupils' BAM score can be explained by the pupil factors and the school attended. The influence of the pupil factors has not changed from the model without school attended, model 1.1.1 on page 187.

The unstandardized regression coefficient for School 3 (B = 8.22; p = .046) and School 7 (B = 5.6; p = .020) indicates that pupils attending school 3 are predicted to attain a BAM score of approximately 8.2 higher, whilst School 7 are predicted to attain a BAM score of approximately 5.6 higher than the reference group, School 1. This provides evidence to suggest that when controlling the influence of pupil gender, favourite subject, ethnicity, motivation, parental help and gender ability beliefs, the school attended can influence a pupils' behavioural attitudes to mathematics.

Emotional Attitudes to Mathematics

Characteristics	**B**	**S.E**	**Sig.**	**Beta**
Constant	19.14	1.04	**.000**	
Gender	-.46	.46	**.315**	-.05
Favourite Subject	3.06	.45	**.000**	.347
Ethnicity	-.28	.65	.673	-.03
I do maths at home	1.41	.55	**.011**	.35
Parental Help	-1.55	.42	.001	-.17
Gender Ability Beliefs	.03	.33	.088	.01
School ID *(Dummy Coded)*				
2	-1.28	.88	.148	-.1
3	.94	1.42	.507	.04
4	-2.05	.94	**.029**	-.14
5	-1.66	.92	.073	-.12
6	-.59	1.23	.632	-.03
7	1.02	.86	.236	.08
9	-2.15	.91	**.018**	-.16
10	-3.09	1.07	**.004**	-2.1
11	-2.56	1.04	**.014**	-.18
***p* = .000 Adjusted R squared = .257**				

Table 53: Single Level Model with School ID for EAM

When adding school attended to the model with pupil level variables, the adjusted R Square value increased to .257, indicating that 26% of the variance in pupils' EAM score can be explained by the pupil factors and the school attended. The influence of the pupil factors has not changed from the model without school attended, model 1.2.1 on page 188.

The unstandardized regression coefficient for School 4 ($B = -2.05; p = .029$), School 9 ($B = -2.15; p = .018$), School 10 ($B = .-3.09; p = .004$) and School 11 ($B = -2.56; p = .014$) indicates that pupils attending School 3 are predicted to attain a EAM score of approximately 2.1 less, School 9, 2.2 less, School 10, 3.1 less and School 11, 2.6 less than the reference group, School 1. This provides evidence to suggest that when controlling the influence of pupil gender, favourite subject, ethnicity, motivation, parental help and gender ability beliefs, the school attended can influence a pupils' emotional attitudes to mathematics. The exploratory single level models displayed in tables 52 and 53 found some evidence of schools influence attitudes. Schools 3 and 7 were identified to have more positive BAM scores whilst schools 4, 9, 10 and 11 were all found to have more negative EAM scores. Whilst this does provide some evidence, the lack in consistency between the schools' influence on both attitudinal dependent variables do not provide enough evidence to infer that pupils' attitudes are influenced by the school attended when controlling other factors and more research is therefore still needed. Other details of the models can be found in Appendix I.

Summary of Multilevel Models

All multilevel models consistently found a lack of evidence to suggest that pupils' attitudes to mathematics are influenced by their teacher or school, whilst the exploratory single levels models provided some mixed evidence to suggest so. Null Hypotheses: 3a, 4a 6a, 6b, 7a and 7b are therefore not rejected. Based on the post hoc power analysis calculations to estimate the Design Effect (Rutterford et al, 2015), it can be estimated that with approximately 2500 pupils, from fifty different schools, the variations in pupils' attitudes could be explained by teacher or school groupings. This will be discussed in greater detail in the following section, which works towards the conclusion that further study should take place with a sufficiently larger sample size to accurately answer Research Questions: 6, (*Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes* *to Mathematics*?), and Research Question 7 ***(****Do demographic factors, confidence, value and motivation and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics and factors associated with the school studied?)* from this study.

Discussion of the Multivariate Models

Focusing on the Pupils: Discussing Findings from the Multiple Regression

In order to assess the influence of pupil characteristics on their attitudes to mathematics simultaneously, a multiple regression was carried out to focus on the influence of factors associated with the pupils. This included seven predictors; gender, value, ethnicity, self-confidence, motivation, parental help and gender ability beliefs. Two multiple regressions were carried out in total, one for each dependent variable. The multiple regression for behavioural attitudes to mathematics identified two significant predictors associated with pupil characteristics and this accounted for approximately 33% of the variance in pupils' attitudes to mathematics. The two significant predictors were self-confidence and motivation. In the second multiple regression model, with Emotional Attitudes to Mathematics as the outcome variable, four of the seven predictors were found to significantly influence pupils' attitudes. The significant predictors were value, self-confidence, motivation and parental support. This accounted for approximately 34% of the variance in pupils' emotional attitudes.

A number of findings highlighted the reliability in the attitudinal measures. Firstly, the similar variation in pupil attitudes explained by pupil characteristics at 33% and 34% showed the same variation for each of the measures. Secondly, the consistency in no significant association between ethnicity and gender, and pupil attitudes, showed the same findings for both attitudinal measures. Finally, the consistency in association between self-confidence and motivation, and pupil attitudes also provided similar findings for both measures. Self-confidence was found to positively influence behavioural attitudes, as identified in previous research (NCTM, 1989; Nunes et al, 2009; Kalder and Lesik, 2011; Pinxten et al, 2013). Additionally, motivation was found to positively influence behavioural attitudes. This was also identified previously (Hagger et al, 2015). The consistency in finding the association between attitudes, self-confidence and motivation, provides more evidence to argue that these factors should be recognised as important aspects of building positive attitudes that can go on to influence later pupil subject-choice (Noyes, 2007), post-school study and career prospects (Scarpello, 2007; Hillman, 2014; UK Commission for Employment and Skills, 2013; 2015; Marshall et al, 2016).

The consistency in variation of pupil attitudes explained by the seven predictors, along with the evidence in the Cronbach's (1951) alpha test to measure the internal consistency of the samples understanding of the attitudinal measures, provides further evidence regarding the reliability of the attitudinal measures. With the two models having different attitudinal measures regarding mathematics, with the same seven predictors and similar levels of variation explained by those predictors, we can expect the same variation to be explained in both models.

The consistency in both gender and ethnicity provides evidence to suggest that when considering the influence of multiple factors simultaneously, these aspects of pupil identity may not influence pupils' overall attitudes to mathematics. This is particularly important when discussing gender and males are typically expected to have more positive attitudes than females (Fennema and Peterson, 1985; Wigfield and Eccles, 1992; Bidin et al 2003; Woodard 2004; Sahin, 2008 in Karimi and Venkatesan, 2009; Dowker, Bennet and Smith, 2012), as was found in the bivariate analysis of the current study for both attitudinal measures. Ethnicity was identified as not a significant influence on attitudes when excluding the influence of other variables. The complexity in measuring ethnicity has been argued to be the reason behind the lack of evidence, suggesting that ethnicity affects attitudes or attainment but may be hard to measure (Cline et al, 2002). However, the consistency in this lack of evidence is of equal importance, and must be discussed. Ethnicity also concerns culture and aspects of identity (Payne, 2003) that may depend on parental influence, family background and social class (Eccles, 1993; Signer et al, 1995). Therefore, using ethnicity as a factor to assess influence may not capture the complexity in pupil identity based on their socio-cultural background. The consistency in this lack of evidence allows an argument to be made that pupils' attitudes to mathematics do not differ based on ethnicity and this is also the case when including multiple factors such as gender, value and parental support. Both gender and ethnicity will be discussed in further detail when acknowledging the influence of other multiple external factors, including teacher attitudes and school characteristics, in a series of Multilevel models.

The consistency in association between the attitudinal measures and both self-confidence and motivation, highlight the importance of the two factors and their positive influence on pupils' attitudes. A wealth of research has discussed the impact of self-confidence (Kalder and Lesik, 2011; Chinn, 2012a) and how self-efficacy is required to attain confidence. There is therefore a requirement to identify how teachers shape the learning experience and contribute to pupils' self-efficacy attainment (Bandura, 1977; Pretzlik, 2003). The influence of motivation on attitudes was also identified and this again relies, on not just aspects of attitudes such as confidence and value, but also depends on positive learning experiences (Gallard and Cartmell, 2014), which could be profoundly affected by the teacher (Reeve and Jang, 2006; Sun and Pyzdrowski, 2009; Hagger et al, 2015). Therefore, whilst these two factors have been found to positively influence attitudes in their bivariate tests and in the multiple regression models, it would be equally important to identify whether these factors are further affected by teacher attitudes. These factors will therefore be further discussed in the Multilevel Model subsection.

Value and parental support were not found to significantly influence pupils' behavioural attitudes; however, they did influence emotional attitudes. This provides an interesting discussion given the consistency with the other four predictors, as these predictors may provide a different association. Behavioural attitudes consisted of different scenarios, and measured how well pupils would enjoy these scenarios, whilst emotional attitudes consisted of general attitudes and liking towards mathematics. Therefore, value and parental support did not influence pupils' level of enjoyment in various mathematical scenarios, but they did affect how much pupils enjoy, like or value the importance of mathematics. Value positively influenced emotional attitudes whilst parental support negatively influenced. Value has been identified as an important aspect of attitudes to mathematics (Tapia and Marsh 2004; Meece et al, 2006; Noyes, 2007), particularly when concerning how to engage with positive experiences and build positive mathematical dispositions (Meece et al, 2006; Fredricks and Eccles, 2005). The negative influence of parental support could be due to the cultural influences or previous experiences of parents (Adler and Kaczala, 1982: Fredricks and Eccles, 2005). It was identified that the sample had higher levels of deprivation, at the school level, than the national average, and evidence has found parental backgrounds from more deprived areas may contribute to more negative attitudes in pupils because of their parents negative experiences and transferring of negative emotions (Partridge et al, 2008). This could therefore provide an explanation behind why parental support impacts how much a pupil enjoys, values and likes mathematics. The factors will be discussed in further detail in the Multilevel Model subsection.

Adding Teachers and Schools to the Multivariate Models

To assess the influence of the external factors on pupils' attitudes to mathematics simultaneously, whilst acknowledging the influence of clustering variables such as teacher attitudes and school characteristics, a Multilevel Model was carried out for each of the dependent variable. The characteristics of one teacher are likely to influence the pupils' attitudes and we would therefore expect the attitudes of pupils in the same class to be alike and different to pupils from other classes (Steele, 2008). The same argument could also be said for schools, given the difference in progression scores and average scores in mathematics and therefore we should expect pupils' attitudes to differ according to the school they attend. Prior to this, a series of unconditional models were built to assess whether pupils' behavioural and emotional attitudes to mathematics differed according to the grouping of teachers and schools. Six unconditional models were built to assess the individual effects of teachers and schools on both dependent variables, along with the effect of both teachers and schools on the dependent variables. These models did not find significance due to the lack of clustering groups and therefore required a larger sample. The sample consisted of 508 pupils clustered by 19 teachers and 10 schools. This therefore did not provide a sufficient sample for Multilevel Modelling. It was therefore decided that a post hoc power analysis would be used to estimate the minimum sufficient sample size needed to determine a significant effect on pupils' attitudes according to their clustering. These calculations were then used to infer a needed sample size to identify the effect this model originally intended.

Following the unconditional models, a series of conditional models were ran to test the clustering effect of schools and teachers simultaneously on the two separate attitudinal measures whilst additionally assessing the influence of the pupil characteristics. This was in attempt to provide robust findings that echo the significant findings from the multiple regression model, whilst acknowledging the complexity of the multiple factors that contribute to pupils' identities and mathematical experiences, as well as the clustering effect of certain factors. Whilst multiple regression models also determine the effect of more than one independent variable on a dependent variable (Guarav, 2010), a Multilevel Model was conducted. This was an attempt to generalise findings to a wider population and, by assuming the random effects on groups are coming from a common distribution (i.e Year 4 pupils), the predictions can be deemed more precise (Buxton, 2008; Meyers et al, 2012).

The unconditional Multilevel models with teachers and schools failed to provide evidence that pupils' attitudes to mathematics differed according to teachers of the pupils or the school taught for both dependent variables. This is particularly due to the methodological issues surrounding the sampling and the sample size. Post hoc power analysis, however, concluded that with a sufficient sample size, a difference could be identified. Furthermore, bivariate analysis produced varied evidence to suggest that pupils' attitudes differ when grouped according to their school deprivation levels and mathematics progression scores.

The Consistency in Association between Pupil Learner Identity and Attitudes

The fixed effect analysis of the Multilevel models including teacher and school characteristics identified two significant factors, self-confidence and motivation associated with pupils' behavioural attitudes and four significant factors, self-confidence, value, motivation and parental help, associated with pupils' emotional attitudes. These models echo the same findings as the multiple regression models, and the bivariate analysis tests prior to those models. The consistency in these factors being associated highlights the importance in recognising them as factors contributing to the establishment of pupil attitudes.

Self-Confidence in the Multivariate Models

Self-confidence was identified as a significant influence on pupils' emotional attitudes to mathematics when controlling the influence of other factors. This provides additional evidence regarding the impact of pupil confidence and attitudes. Tapia and Marsh (2004) highlight how confidence is a crucial aspect of positive attitudes to mathematics and self-confidence has further been argued to provide a positive impact on pupils' attitudes. This is particularly important when considering the relationship between attitude and attainment, which was found in the bivariate analysis, where schools with higher mathematics progression scores and average scores in mathematics had more positive attitudinal scores. Whilst identified as a significant influence, self-confidence was also found to provide issues of multicollinearity when presented in the multiple regression models. It is therefore suggested that future research consider how confidence be measured in the attitudinal variables to avoid multicollinearity and influence other potential relationships between factors and attitudes.

Value, Motivation and Parental Help in the Multivariate Models

Pupils indicating mathematics to be their favourite subject yielded a significant more positive attitudinal score than those who did not indicate mathematics to be their favourite subject, when controlling the influence of other factors. This provides additional evidence surrounding value of mathematics and its impact on attitudes (Tapia and Marsh 2004; Meece et al, 2006).

The perception of doing mathematics at home was also identified as a significant factor. Those who indicated they did mathematics at home had significantly more positive emotional attitudes than those who did not.

Those who indicated they did not receive parental help with homework had significantly more positive emotional attitudes than those who do. This finding additionally echoes the results of the earlier *t*-Test, when specifically looking at parental help and emotional attitudes to mathematics without considering the influence of additional factors. The consistency in finding parental help negatively impacting on attitudes, provides conflicting arguments regarding the need for parental support in order to build positive attitudes to mathematics. However, another argument can be made that parents who have poor experiences of mathematics can pass on their anxieties to children, along with the same learner identity (Eccles, 1993; Macdonald, 2014).

Ethnicity in the Multivariate Models

Ethnicity was found to not significantly relate to emotional attitudes when controlling the influence of other factors, despite BME pupils having significantly more positive attitudes than white pupils in the bivariate analysis. A particular issue when finding differences in attainment was measuring ethnicity due to the high number of different ethnic minorities in the sample; as identified in previous research (Cline et al 2002). It can therefore be assumed that there are no differences when comparing white pupils to BME, when considering the influence of other factors such as gender, confidence, teacher attitudes and school characteristics. This provides positive findings in terms of discussing whether particular ethnicities have more positive attitudes than others. Previous research has found that ethnic minorities typically have more positive attitudes than white pupils (Mirza 1992; Basit 1997; Leslie and Drinkwater 1999 in Payne 2003)), which was not found in the current study. However, it is equally important to acknowledge the complexity involved in assessing the influence of multiple factors simultaneously in order to provide more reliable evidence to support this debate (Wuensch, 2016). Additionally, multivariate models addressing the hierarchal nature of clustering data should also be acknowledged (Goldstein, 2003; Meyer, 2009). In the case of the current research, it can be argued that when analysing a comparable sample of Year 4 pupils, there is no difference when comparing white and BME pupils, in terms of their attitudes to mathematics.

Gender in the Multivariate Models

Despite identifying a consistent difference in attitudes to mathematics between males and females, with males being more positive, there was no relationship between gender and emotional attitudes to mathematics when considering the influence of additional factors. This provides another important argument when considering the complexity of multiple factors and their influence on pupils' attitudes. Despite a wealth of research identifying gender differences in attitudes (Fennema and Peterson, 1985; Wigfield and Eccles, 1992; Bidin et al 2003; Woodard 2004; Sahin, 2008 in Karimi and Venkatesan, 2009; Dowker, Bennet and Smith, 2012) and attainment (Boaler, 2004; Mendick 2005; Department for Education and Skills, 2007; Department for Education, 2016), evidence of no difference must also be considered (Marsh 2004; Stevens 2013 in Mutodi and Ngirande 2014).

There must be an acknowledgement of how the relationship between gender and attitudes is mediated by additional factors (Beilock et al, 2010). Family background for example, is said to be a more powerful influence over culture and class (Maltimore, 1991). However, there must additionally be consideration of the findings from the bivariate analysis where males had more positive attitudes then females, even when considering their own gender to be good at mathematics. The discussion surrounding gender and mathematics is not new (Macdonald, 2014; WISE, 2015; McMaster, 2017): there is additional evidence indicating that females tend to be more mathematically anxious (Beasley et al, 2001; Beilock et al, 2010; Mutodi and Ngirande, 2014) due to poorer experiences of mathematics at school (Eccles, 1994; Macdonald, 2014; Marshall et al, 2016). As a result, females tend to be more likely to share negative attitudes through the same learner identities (Perry and Bussey, 1979; Bussey and Bandura, 1984; Smith and Hogg, 2008; Gray, 2014; Macdonald, 2014; Carey et al, 2019). This evidence also includes the influence of teachers, with female teachers negatively influencing female students and pupils (Beilock et al, 2010). Therefore, whilst the study aims to infer from a comparable sample that gender has no influence on attitudes to mathematics when considering additional factors, it also acknowledges the evidence that would suggest otherwise. It would be appropriate to carry out more research that considers the influence of gender, and additional factors to attain reliable evidence that captures pupil attitudes as well as the complex system of factors that contribute to building those attitudes.

Gender Ability Beliefs in the Multivariate Models

Gender ability beliefs also did not significantly relate to pupils' emotional attitudes when considering other factors. This, like gender, provides an opportunity to further discuss the importance of acknowledging multiple factors and their influence on attitudes. Whilst the discussion surrounding the influence of gender attitudes towards gender as a variable in this research, there must additionally be an attempt to capture a realistic sample that represents the complexity of the pupil population, which consists of different ethnicities, teachers, parental support and schools. There must also be recognition of the influence that gender ability beliefs can have on attitudes. Prior to multivariate analysis, those that perceived males as being good at mathematics had more positive attitudes to mathematics. This was also the case when focussing on males who viewed males as good at mathematics, in comparison to females viewing males as good at mathematics.

Teacher Attitudes in the Multivariate Models

Neither of the teacher attitudinal measures related to pupils' attitudes, when considering the influence of pupil identity, parental support, and school characteristics. This provides evidence to suggest, however, that pupils' attitudes are not influenced by the attitudes or anxiety of their teachers, which previous research has identified as significant. It is important to acknowledge that the current study is using a multivariate model to assess the influence of teacher attitudes whilst identifying significant relationships between teacher attitudes and pupil attitudes in bivariate analysis. This must therefore not be regarded as a truly reliable finding considering the sampling issues regarding the clustering of teachers. Of the 508 pupils within the sample, the number of teachers to which groups of pupils are clustered is 19. This therefore does not provide a sufficient sample to determine the effect of teachers' attitudes on pupils through the chosen method that is a Multilevel model. Instead, for the purposes of this study, it would be more appropriate to assess the evidence from bivariate analysis that did find significant relationships, whilst suggesting how a sufficient sample would also find significance in the multivariate model, as evidenced in the post hoc power analysis.

Teachers' self-confidence was also identified as a factor that did not significantly relate to pupils' attitudes to mathematics. This however poses similar concerns regarding sampling, with only 19 teachers accounting for the clustering of 508 pupils. The post hoc power analysis identified that with a minimum sufficient sample size of 1554 pupils clustered by 58 teachers, that significant differences in pupil attitudes based on teachers could be identified. It must therefore be acknowledged that whilst this study does not produce evidence to suggest teachers' self-confidence with a multivariate model, a larger sample size is required for such models and there was in fact a significant difference found in pupils based on teachers' self-confidence. Like teacher attitudes, pupils with teachers who expressed self-confidence had more positive attitudes to mathematics. This must be considered in the light of the consistent evidence surrounding teacher attitudes and their effect on pupils and students (Beasley et al, 2001; Jackson 2005; Sun and Pyzdrowski, 2009; Beilock et al, 2010), which additionally provides more argument to conduct a multivariate model on a sufficient sample size.

School Characteristics in the Multivariate Models

The percentage of pupils eligible for free school meals in a school was found to not significantly relate to pupils' attitudes to mathematics in the multivariate models. This again, could relate to sampling issues within the model as the sample was clustered via 19 teachers and 10 schools. This therefore does not provide a sufficient sample size to determine the effect of school characteristics on pupil attitudes. Instead, the post hoc power analysis identified that with an estimated sample size of 2316 pupils in 45 different schools that variation in attitudes could be explained by the school attended. This along with evidence from the bivariate analysis suggesting that pupils' attitudes can differ based on the percentage of pupils eligible for free school meals requires discussion, particularly when considering the evidence that schools in less deprived areas have pupils with better grades and possibly greater economic capital being a considerable factor (Tan, 2015; Department for Education, 2017). As demonstrated in this study, pupils in schools with less deprivation have more positive attitudes, and pupils with more positive attitudes cluster within schools that have higher mathematics progression scores and higher average scores in mathematics. The relationship between attitudes and attainment has been identified in a range of previous studies (Beasley et al, 2001; Beilock et al, 2010; Marshall et al, 2016; Mayes, Chase and Walker, 2008).

The effect of a school on a pupil has been somewhat evidenced in the current study when analysing the relationship between pupil attitudes and the school characteristics. However, it would be more beneficial to conduct a multivariate model of a sufficient sample size that captures the complexity of pupil populations, including a diversity of ethnicities, parental support and teacher attitudes, to truly capture how a school may effect a pupil's attitude. The current study does however, provide evidence that school characteristics are associated with pupil attitudes, and that, as expected, schools with less deprivation and higher mathematics progression or average mathematics scores, have pupils with more positive attitudes.

When discussing issues of deprivation, in particular, it can be argued that it is of great importance that we attempt to identify and understand how schools can influence pupils' mathematical attitudes and abilities when considering the lack of STEM graduates. In order to work towards growing the population of STEM graduates, and improve numerically as a nation, attitudes have to change (National Numeracy, 2016a). For example, evidence has shown that traditional methods of learning such as memorisation, are found to disadvantage females and ethnic minorities, and this becomes more complex when including social class (Geist, 2000). Whilst this research has aimed to make similar identifications, the issue of sampling required for such multivariate models meant that such relationships could not be identified in the current study. However, the study could estimate a minimum sample size to identify significance, based on the average clustering of the current study. There must therefore be an attempt to understand how attitudes can be changed through recognising how the school attended affects a pupil's attitude in order to propose ideas that can help schools work with their pupils to try to build more positive attitudes. More importantly, there must be an attempt to collect a sufficient sample size, and this study estimates that a minimum of approximately 2300 pupils within 45 different schools would establish a sample appropriate for a multivariate model to identify a significant difference in attitudinal scores based on the clustering of schools.

Moving On

Issues surround the multivariate analysis concerning the sampling for this study: 10 schools took part in the research, with 19 teachers consenting to take part in an attitudinal questionnaire and 508 pupils respectively. Whilst this provided a comparable sample in terms of deprivation at the school level, gender and ethnicity at the pupil, it did not provide a sample sufficient for robust multivariate analysis that addresses the clustering effect of teachers and pupils. What this study has provided, however, is a range of evidence to suggest that pupils' attitudes to mathematics are influenced by multiple external factors, including the perceived level of support they received from parents, teachers' attitudes towards mathematics and self-confidence in teaching, as well as school characteristics, including deprivation measures and progress scores. The literature review of introduced the topic by focusing on the issues regarding mathematics and numeracy in the UK. In the UK, it is culturally acceptable to express a disliking towards mathematics (National Numeracy, 2016a; Royal Society, 2019) to an extent where it can be perceived as a badge of honour (Sharp, 2017).

The discussion of identity has also been of particular importance, given the range of educational research that emphasises the importance of learner identity (Wenger, 1998; Eccles, 1993; Beilock et al, 2010; Macdonald, 2014; McMaster, 2017). Along with identity, are issues surrounding self-efficacy and confidence. These traits have been found to be particularly important in the context of establishing positive mathematical dispositions, which shape our mathematical experiences and establish our attitudes to mathematics. The current study identifies that pupils with self-confidence, who value mathematics and are motivated to engage in mathematics at home, are more likely to have positive attitudes, whilst pupils who indicate they received parental support for homework had attitudes that are more negative. These findings were additionally echoed in multivariate models that acknowledge the influence of a multitude of factors. Aspects of pupils' learner identity and parental support are therefore essential to discussions of the establishment of pupils' attitudes to mathematics.

There has also been a discussion concerning the measurement of attitudes to mathematics. Whilst some research has focused on mathematics anxiety (Richardson and Suinn, 1972; Suinn et al, 1988; Hunt et al, 2011), other research has considered an objective measurement of attitudes towards mathematics that expresses positive or negative emotions (Tapia and Marsh, 2004). This research has managed to adapt those attitudinal measures to become applicable to the lives of Year 4 pupils, where they engage in particular mathematical activities in classrooms or in numerically related scenarios, that do not involve school. The measures in the current research were carefully designed to reliably measure the attitudes of respondents between the ages of eight and nine years old. Additionally, alternative techniques were used to carry out questionnaire-based research that measures attitudes along with beliefs concerning gender ability. This research has managed to establish a reliable methodology that, with a sufficient sample size, can identify significant influences on young pupils' attitudes to mathematics, that include aspects of the pupil's identity along with views of teachers and characteristics of schools simultaneously.

Working towards this method will not only help identify the core influences of children's' attitudes to mathematics, but will additionally do so with a reliable sample and method that captures the complexity of pupil identity, including their gender and ethnicity. This method will also capture additional factors further beyond their control, such as their teachers' self-confidence and the deprivation levels of the school they attend. This method captures the complexity of a school population and therefore any identifications can be deemed reliable identifications. It is of great importance that reliable identifications are made in order to further build an understand of why certain factors may influence young pupils' attitudes. By building that understanding, can we then begin to propose methods that work with influential factors to build positive attitudes to mathematics and help groups of pupils who suffer from negative attitudes. Building more positive attitudes should encourage more pupils to engage in mathematics and study the subject beyond the compulsory schooling age (Macdonald, 2014; Marshall et al, 2016; McMaster; 2017). This is therefore essential if the UK wishes to upskill future generations and meet the economic demand of the growing STEM sector. By improving attitudes, we can improve numerical abilities, and reduce the economic risks of poor levels of numeracy, such as debt (Chinn, 2012c; Curtain-Phillips, 2016), but also improve our prospects mathematically as country to keep up with the economic demands of the digital age (National Numeracy, 2019c).

Chapter 7: Conclusions

Introduction to Chapter

There are four key findings from this research:

- Key Finding 1. Methodological Contribution: Modelling a Measure of Attitudes to Mathematics and External Factors. The Multilevel Model uses a highly reliable measurement of pupils' attitudes to mathematics and identifies a complex system of multiple external influences from different levels, including teacher perception and school characteristics.
- Key Finding 2. Theoretical Contribution: The Components of Attitudes and the Impact of Parental Support. The provision of evidence to suggest that aspects of pupils' learner identity, self-confidence, value, motivation and parental support, are all key influences of children's attitudes to mathematics.
- Key Finding 3. The Issue of Gender: Why Boys v Girls is a Problematic Approach. This study suggests that gender does not influence attitudes when taking into account other aspects of identity, such as ethnicity, parental support, and value of mathematics. This finding is of particular importance when discussing the relationship between gender and mathematical abilities. Whilst previous research has consistently found male pupils to have more positive attitudes than females (as did this study in the bivariate analysis), there has been a lack of recognition of the overlapping factors that also contribute to a pupils' identity.
- Key Finding 4. The Impact of Teachers and Schools: Why More Evidence is Needed. This study indicates that pupils' attitudes to mathematics are externally influenced by the attitudes of teachers and the deprivation or overall maths progress of the school they attend. Whilst this was not found in the multivariate model that also acknowledges pupils' identity and parental support, it did identify evidence that when focusing on the relationship between schools or teachers and attitudes, significant relationships were identified. Furthermore, evidence from post hoc power analysis identified that with a suitable size sample, approximately 2300 pupils within 45 schools, a significant variation in pupils' attitudes would be identified.

In addition to the key findings, table 54 below provides an overview of the hypotheses of this research and whether they were supported or rejected, separated via the original research question that was set.

Research Question Null Hypothesis	Supported/Rejected
RQ 1: Reliability in Measuring Pupils' Attitudes to Mathematics NH1a; b	 Rejected
RQ 2: Pupil Characteristics influence on Attitudes to Mathematics NH2a; c; d; e; f; NH2b; g	 Rejected Supported
RQ 3: Teachers Characteristics' influence on Attitudes to Mathematics (p59) NH3a; b; c;	 Supported
RQ 4: School Characteristics ' influence on Attitudes to Mathematics (p57) NH4a; NH4b; c; d; e	 Supported Rejected
RQ 5: Pupil Level Multivariate Analysis NH5a; b	 Rejected
RQ 6: Pupil and Teacher Level Multivariate Analysis NH6a; b;	 Supported
RQ 7: Pupil, Teacher and School Level Multivariate Analysis NH7a; b	 Supported

Table 54: Summary of Hypotheses Tests

To summarise the series of hypotheses tested in this research, evidence to suggest that pupils' attitudes to mathematics was identified by two distinct measures yielding high reliability. Additionally, with questionable validity being found in the BAM measure unless some sub-scales are removed, this research suggests condensing the BAM scale for future research in order to expect high reliability and validity for both distinct measures. All pupil characteristics, except ethnicity and gender ability beliefs, significantly influenced attitudes. A discussion on the limitation of how ethnicity was measured can be found on page 231, suggesting other methods to measure ethnicity in future studies should be considered. All teacher and school characteristics were found to significantly influence pupils' attitudes to mathematics in bivariate analysis. In multivariate analysis, evidence was identified to suggest pupils' attitudes are influenced by multiple pupil factors. Multivariate analysis with teacher and school characteristics however, did not identify the same evidence whilst providing evidence to suggest that with a sufficiently larger simple random sample, variation in pupils' attitudes can be explained by teachers and the school attended.

Reflecting on the Limitations of the Project: Improving Future Study

This research set out to measure and assess children's attitudes to mathematics along with a series of associated factors. Whilst evidence of high reliability of these measures was identified along with some evidence of validity, there were additional limitations that need to be addressed in order to meet another key focus of the research, repeatability. Specifically, the project consisted of a series of limitations associated with measurement concerning: dimensionality, reliability and validity.

Dimensionality

Whilst the BAM measure provided evidence of high reliability overall, dimensionality was still identified when carrying out confirmatory factor analysis on both the overall scale and sub scales. Details of the dimensionality can be found in Appendix C. This, along with the evidence of questionable validity using the Forner-Licker Criterion (1981) to calculate the average variance extracted, provides an argument that the BAM scale could be further revised to attempt to rectify such issues. Given the evidence of high reliability, validity, and confirmation of one dimension during the CFA of the six item scale, an argument can be made that both the measure itself and the techniques used could be replicated in a condensed BAM measure to improve its psychometric properties. Furthermore, a discussion concerning the methods that could be used to merge the two measures, and have one dependent variable measuring children's attitudes, should also take place. An example of such attempts can be found in Tapia and Marsh (2004).

Reliability

Whilst the EAM measure did provide evidence of high reliability and validity, and low dimensionality, a discussion around improving the measure can still take place, along with further identifying whether the psychometric properties of the measure are reliable. This measure, whilst consisting of new means to elicit responses, still had more outdated and questionable practices that should be critically discussed. Specifically, the use of completely opposite items that consist of the same conceptual meaning, whilst providing an opportunity to express understanding, have also been evidenced to do the opposite. Research has identified cases where adding opposing items, and therefore increasing the number of items to answer, increases the chances of inattention and confusion (Swain et al, 2008; Sonderan et al, 2013), therefore increasing the number of mistakes and compromising reliability. This issue is not new and the issue of confusion from such items does provide reason to argue against the need for this technique (Sonderan, 2013; Robinson, 2017). Therefore, whilst condensing the BAM measure has been suggested for other reasons, this measure could also be condensed to a four-item scale, which may prove useful if merged with the BAM scale.

Methods of testing psychometric properties

Discussing how dimensionality, reliability and validity can be improved leads to the discussion on the methods carried out to assess such concepts. Alternative methods are recommend for repeated studies. For example, the Exploratory Factor Analysis used to test dimensionality of the measures assumes the scales being used are continuous. In the case of the current research, the items used were ordinal Likert scales, therefore failing to meet this assumption. Alternative and more robust measures, such as item response theory, could provide a more holistic analysis of the properties of the measure, given the focus is on the items and their overall contribution to the latent measure. The confirmatory factor analyses of the measures, used to calculate the average variance extracted through the Forner-Liker Criterion (1981) can be found in appendix C. Results from the Principal Components Analyses provided evidence to suggest the subscales are valid measures of their intended latent constructs and therefore item response theory could help further validate such evidence or help propose revisions.

The range of methods available to test psychometric properties should not be overlooked, and more evidence can be gathered to identify whether the measures used in this research are indeed reliable and valid. The methodological strengths in this study are still important to acknowledge, whilst considering how other methods can be added to increase the overall strengths of survey research and more so with children respondents. Such efforts would therefore increase the reasons to suggest that children respondents can be deemed reliable, and future study should therefore take place to assess children’s attitudes.

Measuring Ethnicity

Another measure that can be questioned is the dichotomous grouping of ethnicities to either White or BAME. Whilst this served methodological purposes of aiming to gather sufficient sizes within groups for testing, along with trying to gain a comparable sample, an argument can also be made concerning the validity of the measure. Letherby, Scott and Williams' (2013) discussion on the quantifiable measurement of ethnicity as a social object highlights the challenges through how we think of ethnicity subjectively before trying to measure it is an object. This can be said in the case of this research, noting the discussion of ethnicity in the literature review concerned more than how ethnic minorities may be different to White pupils. Cline et al (2002) faced similar issues in their study when also assessing attitudes to mathematics. Although, some discussion was provided on more specific ethnicities, the lack of research in this area, particularly in the field of younger pupils, provides barriers to how we measure and test ethnicity in quantitative studies and when studying this particular topic.

With a suitable sample size however, it is recommended that future study look at more thorough measurements of ethnicity in quantitative studies. Given the complexity in ethnic background alone, this would not only provide more clarity on the relationship between ethnicity and attitudes, but would also aid a further understanding of the complexity in identity and its relationship with attitudes to mathematics. This is also important when considering parental influence and the home culture of pupils influencing children's expectancy value (Eccles, 1993), potential dispositions (Katz, 1993) and overall attitudes as a result. The A2M model of this study therefore recognises that ethnicity must be further explored as a factor of attitudes to mathematics.

Key Finding 1. Methodological Contribution: Modelling a Measure of Attitudes to Mathematics and External Factors

The Resulting Model: How We Got Here

This research set out to observe and identify a significant educational and economic issue for the UK. The study focused on the issue of pupil attitudes to mathematics, and used a deductive approach to observe the factors that influence those particular attitudes. Whilst recognising that the majority of academic focus, and common media discourse, has concerned attitudes in adults (Chinn, 2012a; Curtain-Phillips, 2016 National Numeracy, 2016a; Royal Society 2019) and adolescents (Richardson and Suinn, 1972; Hunt et al, 2011; Hillman, 2014); this research recognised a need to explore the issue with a younger ae.

Whilst considering the wealth of research that emphasises the importance of positive educational experiences in mathematics (Tapia and Marsh, 2004; Fan and Williams, 2010; Zaskis, 2011; Feldhaus, 2014; Hillman, 2014; Marshall et al, 2016; Curtain-Phillips, 2016), this research also considered how aspects of pupil identity could mediate the impact that teacher relationships have on pupils' experiences. Furthermore, when considering this mediation of impact, there has to be further recognition that the school in which the relationships and learning experiences take place could further affect how attitudes come to be established. The study committed to a quantitative approach that understood that whilst a reality exists, it may not be perfectly captured (Cohen, 2007). This is because of the concerns that come with studying younger participants (Kellett, 2011; Mabelis, 2019) and the reliability of their responses (Kellet and Ding, 2004; DeLeeuw, 2011), and the subjectivity of the researcher (Cohen, 2007; Williams, 2009). This concern, along with reviewing the limitations of more experimental methods, such as randomised control trials (Pampaka, Williams and Homer, 2016; Gorard, See and Siddiqui, 2017; Connolly, 2017), led to the decision to conduct an observational study that focused on pupils' attitudes.

This methodology allowed the researcher to rely on statistical method to support data collection and analysis (Riley, 2007), whilst recognising the role of the researcher is still a subjective one (Cohen, 2007), reducing the risk of bias or vested interest from that subjective position as much as possible (Willig, 2013). This additionally provided an opportunity to carry out a methodology where respondents can be more aware of what is being researched through fully informed consent (McLeod, 2009).

In order to provide evidence of reliability within the attitudinal measure, a statistical method was employed to examine the internal consistency of responses within the sample, known as Cronbach's Alpha (Cronbach, 1951). This test produced evidence of high reliability in both measures, upholding a key methodological aim that is producing reliable evidence in regards to the issue of pupils' attitudes to mathematics. Validity was measured through using the Forner-Larcker Criterion (1981) in order to provide evidence of respondents' awareness of what is actually being measured (McLeod, 2009). This resulted in one of the two measures having high reliability (Cronbach, 1951) and sufficient validity (Forner and Larcker, 1981) that can be used for future research. That measure was 'Emotional Attitudes to Mathematics', and was a six-item scale that required respondents to draw a specific Emoji in the correct column to accurately elicit a response, whilst providing the opposite answer to opposing statements. This measure included a range of techniques such as a 'Draw a Person' task (Beilock et al, 2010; Short et al, 2011; Syyeda, 2016) and visible acts of meaning (Bavelis and Chovil, 2011) in the form of using Emojis to develop response techniques in academic research (Alismail and Zhang, 2018). Directly involving the young participants in the research, as recommended, (Kellett, 2011) led to consistently maintaining respondents' engagement in the task (Mabelis, 2019) and this was evidenced in the results of reliability and validity.

By committing to a self-completion questionnaire based approach, that additionally measured school factors, this study built a model that considered the complexity of young children's attitudes and how they can be the result of multiple factors beyond the pupil's control. The decision to choose the age range of the sample came from evidence that attitudes are already established at such an age (Suinn et al, 1988; Bloom, 2008), differ at such an age (Macdonald, 2014) and produce reliable responses at such an age (Kellet and Ding, 2004; DeLeeuw, 2011; Mabelis, 2019). Using evidence based practice to inform the data collection tools, this study produced highly reliable measurements of children's attitudes that can be used to add to the evidence collected in this study.

Discussing Reliability and Validity of BAM and EAM: The Rewards and Consequences of Committing to a Quantitative Approach

Whilst this research carried out certain statistical techniques in attempt to uphold relibalility in measurement and opportunities for repeatability, it additionally recognised the possible lack of validity (Aliyu et al, 2014) and ideological bias (Borudieu, 1993). For example, the discussion on whether social objects could be objectively measured based on our subjective understanding of what those objects are in the first place (Letherby, Scott and Williams, 2013) already limit the validity to how well those objects are measured. This provides the need to test for reliability and validity. Whilst the study did produce evidence of high reliability in the two measures of attitudes to mathematics (Cronbach, 1951) which was seen as a reward of the methodology, BAM still had questionable validity (Fornell and Larcker, 1981).

When visualising both measures it became apparent that there was a skew towards more positive attitudes, with possible explanations being the progression scores of the schools were significantly higher than the national average. However, there is still the issue that must be addressed that whilst BAM reliably measured aspects of pupils' attitudes, its questionable validity and negative skew provides reason to suggest that the measure elicits more positive responses and should therefore be scrutinised. Reflecting on how the measure was designed and discussed with year 4 practitioners, the decision to change the terms used such as 'Anxiety' to a scale from 'Enjoy a Lot' to 'Very Worried', could be a reason behind the questionable validity, along with the high number of items. Furthermore, this measure did not possess opposing statements, like EAM did, which had sufficient validity (Fornell and Larcker, 1981), and can be useful in ensuring respondents understand the questions that are being asked. That being said, EAM also had a negative skew due to more positive answers and whilst this could reflect the performance of the schools, it could also reflect another potential consequence of survey research which are Socially Desirable responses (Steenkamp de Jong and Baumgartner, 2009). Whilst the questionnaires were anonymised and self-administered, without the help of practitioners to try and reduce this risk (McLeod, 2009), the questionable validity provides reasoning to review the BAM measure prior to further use.

It is equally important however, to discuss the reliability of the measures as much as the validity. The high internal consistency of both measure provided evidence to suggest that these measures were highly reliable (Cronbach, 1951). Furthermore, the EAM measure required pupils to draw the Emojis themselves in the correct column in order to elicit their response, which allowed them to directly participate in the research (Kellett, 2011). This provides additional evidence to support the use of Emojis in academic research (Alismail and Zhang 2018). Given technology and media are a part of children's everyday lives (Fane, 2017) Emojis can provide a sense of familiarity as their means of communication (McCullock, 2019) and therefore the sufficient validity can possibly be explained by the increased familiarity in behaviour when responding (Grieg et al, 2013).

This also provides an opportunity to discuss not only the strengths of directly involving the young participants in the research (Kellett, 2011), whilst maintaining good practice with younger ages. Examples include the use of clear concise statements (DeLeeuw, 2011; Mabelis, 2019), that are meaningful to respondents (Kellet and Ding, 2004) and providing a method of response that keeps them engaged (Wadsworth, 2003). Therefore, going forward, it is recommended that these methods be carried out in future research with young respondents. These methods provide the opportunity to design reliable, repeatable measures (Aliyu et al, 2014). Furthermore, the high reliability of these measures and with previous research studying attitudes from as young as five years old (Suinn et al, 1988), provides additional grounds to argue that reliable quantitative research looking at attitudes to mathematics could possibly be carried out with even younger respondents.

Discussing the results of the Multilevel Model

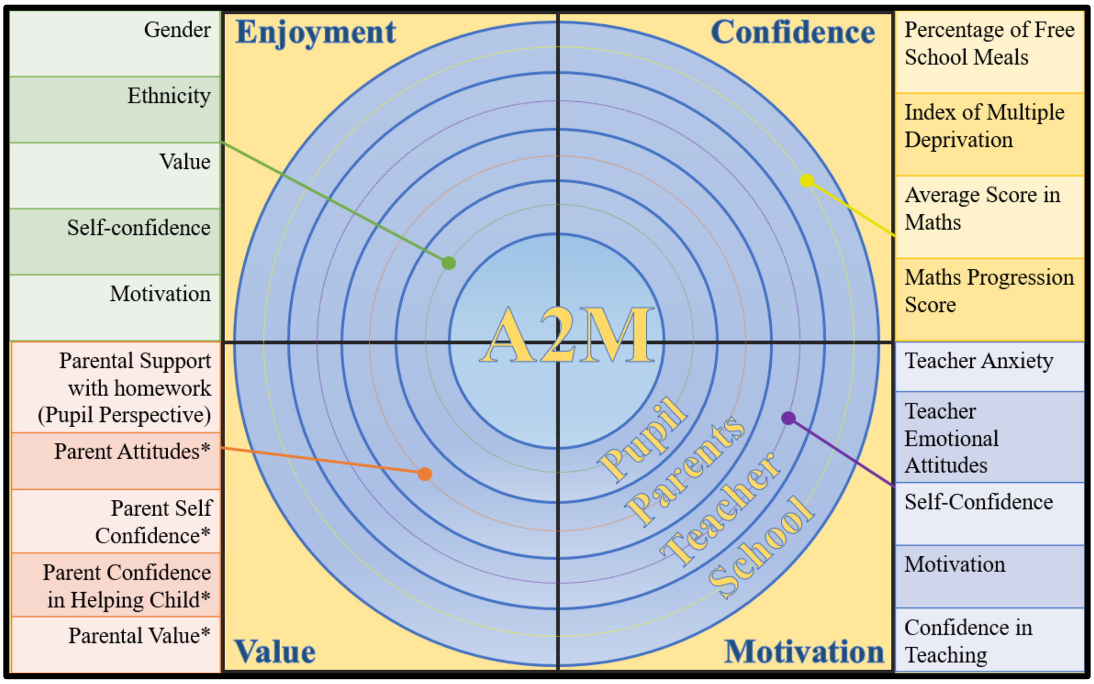
Whilst the Multilevel Model itself did not identify direct evidence to suggest that the variation in pupils' attitudes can be explained by the teacher they have or the school they attend, it did provide the data to predict that direct evidence could be attained with a larger sample. The Multilevel Model itself did not have the appropriate sample, with the required amounts of clustering factors to accurately assess the influence of those clustering factors. The model did provide the variance to then calculate an Intraclass Correlation Coefficient that could then be used to multiply by the average clustering and calculate a Design Effect Value, using an equation from Rutterford et al (2015). That Design Effect value then provided the figure to multiply the sample to then predict the required sample to identify the significant variation according to the clustering. This, therefore, provides the evidence to suggest that attitudes can be affected by teachers and schools and provides reasoning to conduct further research with a sample size sufficient to estimate those effects.

Suggestions for the Next Step

This study can be used to influence the next stage of research that can help build an understanding how pupils' attitudes can be influenced and changed. This can be achieved through using the cluster sampling approach of the current study and using schools, their teachers and pupils as the data and using the techniques discussed to produce reliable and valid measures. Whilst cluster sampling can accumulate data, it is important to use a strategic approach when recruiting schools in order to allow the researcher to attain a sample comparable to the population of study. Ways to ensure this would be methods such as this research: considering deprivation levels, maths progress and attainment at the school level, percentage of male to female teachers and percentage of school pupil characteristics, such as gender and ethnicity. The ethical nature of this research can also influence the conduct of the study, with head teachers providing informed consent, parents having the opportunity to withdraw their child, and pupils themselves having the opportunity to withdraw. The anonymous identity of the schools, teachers and pupils helps avoid Social Desirable Responses (Steenkamp, de Jong and Baumgartner, 2009) from both pupils and teachers, whilst allowing schools to learn about the progress of their pupils and teachers without risk of such sensitive information being publicly accessed. In order to have a reliable sample for the methodological framework that uses a form of Multilevel Modelling, the post hoc power analysis identified that a minimum of 45 schools would be required, with an average number of 50 pupils per school, in order to accurately identify a difference in pupils' attitudes according to the school they go to.

The attitudinal measures can be further used in order for future research to produce reliable data whilst contributing to the evidence attained that young pupils can be deemed reliable responses, and how using visual acts of meaning (Bavelas and Chovil, 2000), such as Emojis (Alismail and Zhang, 2018), can help elicit those reliable responses. The process of the self-completion questionnaires, and the tasks required for pupils to provide responses, meant that the children had to be directly involved in the research, which is recommended from evidence-based practice (Kellett, 2011). The methods used in the research therefore provided the necessary information to carry out the appropriate study that, with a sufficient sample, should provide the identification desired to then set out how we can build an understanding of children's attitudes and their influences.

This research, therefore, provides the opportunity to take the next step in working towards building more positive attitudes in children, in order to sustain more positive attitudes in young people and adults. This can help as a means to building a more numerate and numerically confident nation (National Numeracy, 2016a).Other possible positive impacts can be achieved with adults less likely to find themselves in with limited career options (Scarpello, 2007; Hillman, 2014; McMaster, 2017), anxiety (Marshall et al, 2016), and financial issues (Curtain-Phillips, 2016).



* = Suggested for Further Study

Figure 21: A2M Model with Independent Variables and Suggested Future Independent Variables

Figure 21 provides a visual aspect for the conceptual model, like figure 2, whilst additionally including the independent variables. For the parents section, there is also a list of suggested variables to be added to the model for future study. Due to accessibility issues, parents could not take part in the current study. However, with evidence suggesting that parental support, from the pupil perspective, negatively impacts attitudes, it is recommended that parental attitudes also be measured and added as factors to pupils attitudes. This will be further discussed in the following section.

In addition to capturing parental attitudes, this study also concludes that peer group influence should also be considered a possible factor in attitudes to mathematics in future studies. The literature review chapter discusses aspects of peer group influence, noting the work of Becker's labelling theory (1963), along with Willis's (1993) work on white working class males in education. Additionally, MacDonald's (2014) work on non-STEM identities and McMaster's (2017) discussion on gender and STEM also highlight issues relating to gender, peer group and accepting views of female gender ability. When considering that this study has acknowledged the importance of identity in education (Wenger, 1988) and how identities can be worked towards through assimilating the behaviours of those we share and identity with (Smith and Hogg, 2008) this research reflects on the methodology and acknowledges that peer groups could be a factor in establishing attitudes towards mathematics.

Considering the influence of parents (Eccles, 1993) and Teachers (Beilock et al, 2010) when discussing gender alone, we should also concern ourselves with how peers at a young age can also influence our attitudes. Whilst gender is a common example, it is a valid example. With common stereotypical beliefs sharing the view that females are less numerically proficient than males, we should acknowledge that an aspect of identity, such as gender, can be identified in young individuals and could therefore be a strong influential factor of attitudes. The polarisation of mathematical ability (Snow, 1959) discusses how individuals can distinctively see themselves as mathematically skilled or not (Williams et al, 2008; Macdonald, 2014). Peer groups could therefore reinforce such attitudes through assimilating their attitudes towards mathematics as a form of sharing an identity with one another. Much like parental attitudes, this study did not manage to capture peer group influence. It is therefore recommended that consideration of how we capture and assess peer group influence should take place in future studies of this subject.

Key Finding 2. Theoretical Contribution: The components of Attitudes to Mathematics and the Impact of Parents

This section answers research question 2 (*Do pupil Characteristics influence pupils' Attitudes to Mathematics?)* and rejects a number of null hypotheses. Firstly, null hypotheses 2b, which concerned ethnicity, and null hypotheses 7, concerning gender ability beliefs, were not rejected given the findings from both the bivariate and multivariate analysis. There was a consistent lack of association between these factors and attitudes. However, the components of attitudes to mathematics, confidence, value and motivation, which helped design the measures for attitudes, were also measured individually to assess their influence on attitudes overall. Enjoyment of mathematics was measured in the BAM scale, asking pupils whether they enjoyed a number of different mathematical scenarios. Confidence, value and motivation were identified in bivariate and multivariate analysis to positively influence attitudes to mathematics and will be discussed in detail throughout this section. Surprisingly, parental support was a negative influence onpupils' attitudes and will also be discussed. These findings provide the theoretical justifications to the argument of key finding 1, which concludes that parental attitudes should be included into the multitude of factors that influence pupils' attitudes.

With two separate Multilevel models to assess pupils' attitudes to mathematics, that concerned how much they enjoy mathematics in different scenarios and their emotional reactions in general to mathematics, a number of factors continuously appeared to significantly influence pupils' attitudes. Self-Confidence and Motivation were found to consistently associate with attitudes. This was found in bivariate and multivariate tests, with both dependent variables measuring attitudes. Additionally, whether pupils value maths as their favourite subject and whether they receive parental help was also found to influence their attitudes, with both dependent variables in bivariate analysis and EAM in the multivariate analysis. Those who valued maths as their favourite subject were found to have more positive views whilst those who received more help from parents had more negative views.

Confidence

The issues concerning the UK's negative attitudes to mathematics (Nuffield Foundation, 2010; National Numeracy 2016a, 2016b, 2016c; Sharp, 2017; Royal Society, 2019) typically stems from poor experiences, which often result in lack of confidence in maths ability. Those who lack in confidence have been found to be more likely to experience maths anxiety (Chinn, 2012a; 2012b; Marshall et al, 2016; Curtain-Phillips, 2016) which affects multiple aspects of their adult lives. Tapia and Marsh (2004) identify confidence to be one of the four key components of positive attitudes to mathematics. In the current study, pupils who indicated self-confidence had more positive attitudes to mathematics. This was not affected by gender or ethnicity, both factors identified by others studies as being influential (Bidin et al 2003; Woodard 2004; Sahin 2008 in Karimi and Venkatesan, 2009; Beilock et al, 2010; Mayes, Chase and Walker, 2012). Confidence contributes to self-efficacy, where pupils judge their abilities as appropriate for accomplishing the task(s) set out for them (Bandura, 1977). This is dependent however on positive mathematical experiences (Scarpello, 2007), which evidentially depend on additional factors.

First, positive mathematical experiences should occur before school, and therefore within the family home (Eccles, 1993). Parents' attitudes provide an influence on their children and therefore children depend on their parents to build their confidence through positive mathematical experiences that are in turn valued and rewarded by parents. This differs however when taking into account the variation in parental attitudes (Menheere and Hooge, 2010; Jay et al, 2018) and therefore leads to different mathematical experiences andlevels of confidence before pupils even enter the classroom. There is therefore a crucial stage that contributes to a pupil's confidence prior to entering the education system, and this stage requires more consideration when discussing how pupils' identities influences their educational experiences (Becker, 1963; Willis, 1978).

Confidence is argued to be essential in attaining positive mathematical dispositions (NCTM, 1989) which are in turn necessary for building positive attitudes to mathematics through the development of habits of the mind (Katz, 1993), forming positive mathematical experiencing through developing positive self-efficacy (Bandura, 1977) that helps establish positive mathematical experiences by possessing the belief that those mathematical experiences can be completed successfully. Confidence and achievement have been found to depend on one another (Nunes et al, 2009), which further highlights the importance of pupils' possessing confidence in order to build those positive mathematical dispositions that enable positive attitudes. Furthermore, this highlights the importance of positive attitudes to mathematics in the context of building more a mathematically proficient workforce (National Numeracy, 2016a; Macdonald, 2014).

Motivation

Motivation was measured by pupils indicating whether they do maths at home, as this elicits aspects of motivational thoughts (Ryan and Decci, 2000). Those who indicated motivation had more positive attitudes. Motivation was another component identified within positive attitudes to mathematics in previous studies (Tapia and Marsh, 2004; Kalder and Lesik, 2011). Motivation additionally is affected by parental values and expectations of whether their child 'should' succeed in mathematics (Eccles, 1993; Feather, 1988; Butler, 2016). Therefore, understanding the influence of motivation is essential to understanding how motivation can be elicited in young pupils in order to build more positive attitudes.

Motivation is also essential for building positive mathematical dispositions, as it helps establish mathematical attitudes and contribute to positive mathematical experiences; in addition each contributes to a sense of ability and identity (Wenger, 1998; Macdonald, 2014). Bandura (1976 in Skaalvik et al 2015) discusses how motivation can be affected by self-efficacy and therefore confidence. This not only highlights the importance of recognising how components of attitudes to mathematics work collaboratively, but how failing to do so can result in negative attitudes. We must therefore recognise that whilst this evidence indicates motivation provides a positive influence to pupils' attitudes to mathematics, it is additionally a key aspect of positive mathematical experiences. Understanding how different pupils are motivated is therefore important when considering how to motivate pupils to engage in lifelong mathematical learning and numerical application(Macdonald, 2014; McMaster, 2017)). Ming Chiu (2016) highlights the motivation within Chinese education where there is a belief that success in mathematics provides rewards of economic, social and political capital and this belief is shared in both school and home. This not only highlights the importance of motivation, but also how motivation would be further supported by parental beliefs and therefore also be interdependent on value.

Value

This study identified that those who value mathematics as their favourite subject are more likely to express positive attitudes to mathematics. Value is an important aspect of whether an individual will engage with a particular activity (Meece et al, 2006) and an important component of positive attitudes to mathematics (Tapia and Marsh, 2004). MacDonald's (2014) work on leaner identity discusses how those who do not value their mathematical abilities often hold their lack of skills as part of their non-STEM identity and this in some cases is used a badge of honour in those who may be successful without mathematical skills (Sharp, 2017). Individuals satisfy their sense of identity in their work (Brewer, 1991) and this includes working towards academic achievement (Gray, 2014). Therefore, by valuing maths as a favourite subject, it would be expected that positive attitudes result.

Much of the work on valuing mathematics has been discussed in relation to gender, as males tend to hold a higher value for mathematics than females; with female advantages in reading being a suggested reason for this value difference (Breda and Napp, 2019). This research identified that males were more likely than females to state that mathematics was their favourite subject. Previous research has identified the same association and discussed a common misconception of successful mathematicians as male (Boaler, 2004; Department for Education and Skills, 2007; Bilton, 2017) with parents' beliefs about maths additionally affecting their children's beliefs (Partridge et al, 2008), including females adopting the same values as their shared gendered parent (Parsons et al, 1982; 1984). This is said to be the reason behind girls' underachievement in mathematics (Hargreaves et al, 2008) and could explain why females are found to do better than males in all subjects, except mathematics, at primary school (Department for Education, 2016).

Therefore, value for mathematics can be recognised as part of a pupil's learner identity (Macdonald, 2014; McMaster, 2017). Understanding why value affects attitudes can be helped by recognising how pupils work towards their identity and how parents and teachers respond to (Eccles, 1993;Becker, 1963) thus establishing pupils' attitudes (Smith and Hogg, 2008). This can additionally affect their attainment (Gray, 2014; National Numeracy, 2016a) as evidenced in this research where pupil respondents who attended schools with higher maths scores had more positive attitudes towards mathematics. Whilst this research did not identify gender as an influence on attitudes with value in the multivariate models, it has produced evidence that value is associated with gender and attitudes. Value is highly important in the context of building mathematical attitudes and taking into account the influence of parents and teachers on a child's value of mathematics. There must therefore be more research to build an understanding on how mathematical values in relation to gender specifically and other attributes generally, can be improved and supported at earlier stages in education to avoid polarising learners into specific domains of education.

Parental Support

Previous research has identified that parental support can result in an increase in pupil engagement (Fan and Williams, 2010) due to the impact of parental values on subjects and how they expect their child to succeed (Eccles, 1993). The discussion on value and how it relates to parental relationships highlights the impact parents provide and the current study interestingly identified that pupils who indicated that their parents help with mathematics homework had negative attitudes in comparison to those who did not have parents who helped.

The negative impact of parental support would seem unexpected when considering the evidence that discussed the positive impact of parents on a child's learning (Fan and Williams, 2010; National Numeracy, 2016b; Jay et al, 2018) with improvements in academic and social development (Mahamood et al, 2012); and attainment (Gorard, See and Davies, 2012). These positive impacts are a supposed improved sense of ability facilitated through the feeling of support from parents (Coltman and Whitebread, 2008). This can become complicated when children enter school (Jay et al, 2018). But perceptions of ability and learner attitudes are affected differently by differences in their parents' attitudes, abilities (Menheere and Hooge, 2010) and expectations (Eccles, 1993). In terms of recent studies, National Numeracy's (2016b: 2) 'Family Maths Toolkit' has been identified to positively impact pupil attainment; with teachers reporting an improvement in pupil engagement and pupils reporting an improvement in their confidence. This further highlights the need to have the same values shared in home and school cultures and how this is just as important as a focus on curriculum development (Mathematical Association, 2011).

Work has also been discussed regarding the unsuccessful attempts to improve attainment through parental involvement (Patall et al, 2008; Gorard and Huat See, 2013). A core issue is the attitudes and achievement of parents themselves (Peters et al, 2008), often preventing them from participating in such schemes. This further adds greater importance on the influence of school and teacher(s); highlighting the complexity in working with these factors that deal with different pupils and parents (Jay et al, 2018). Ming Chiu (2016) highlights how there is a message of consistency in the Chinese curriculum, where success in mathematics provides reward and this is believed in both school and at home. Therefore, parental values need to resemble the values of schools, which highlights the need to consider how attitudes are established by multiple factors.

The Influence of the Four Significant Factors Together

Motivation can be affected by aspects of confidence, where an individual requires the self-efficacy to complete the tasks (Skaalvik et al, 2015), along with aspects of value based on what the individual perceives as a result of completing the task (Ryan and Decci, 2000). The current study identified that when considering the influence of multiple factors, pupils' attitudes, which included their enjoyment, are affected by confidence, motivation, value and parental help simultaneously. Those who have more confidence, value mathematics as their favourite subject, and possess the motivation to do maths at home indicated that they do not receive support from parents. Interestingly, the sample of schools consisted of higher levels of deprivation than the national average, which provides possible reasoning behind the negative impact of parental help, given that there are previous findings regarding pupils from higher income families being more likely to succeed (DfE, 2017) and higher levels of mathematical progress and attainment being linked with economic capital (Tan, 2015). Furthermore, within the sample of this study, schools from with less deprivation had pupils with more positive attitudes, meaning the negative impact of parental help could be more from schools in more deprived areas. Additionally, it was identified that the attitudes of the overall sample were skewed towards more positive attitudes, which may be explained by the schools having higher maths progression scores. This raises the issue of sampling within this study, and provides further reasoning to conclude that more evidence be obtained with a larger sample in order to accurately identify the relationship between social class and parents on pupils attitudes. This will be discussed in further detail in Key Finding 4.

It is therefore equally important to acknowledge how the factors work together to collaboratively influence pupils' attitudes. The complexity in pupils' attitudes is highlighted by the different parental and teachers expectations they are subjected to, which may further depend on their own identity. This model should therefore acknowledge that complexity and consider how the factors, together, influence a pupils' attitude.

Self-confidence was associated with positively influencing pupils' attitudes and confidence has been identified to be established with the help of motivation, value and parental attitudes in this study. A common reason for people lacking in confidence is poor experiences of mathematics in school (Scarpello, 2007; Marshall et al, 2016) which could create a reduction in motivation and value. Confidence can additionally be linked to parental support through the need of security, which provides a sense of value to pupils and as they come to value themselves; they value their efforts and the work that they do (Coltman and Whitebread, 2008). A link between confidence and value should therefore be expected and the need for security from parents provides a clear bridge between these two factors. Additionally, those expected by their parents to succeed in mathematics not only possess the confidence and value to work towards those expectations (Eccles, 1993; O'Mara et al, 2006; Pinxten et al, 2013), but additionally the motivation to carry out the task (Ryan and Decci, 2000). This motivation is also dependent, however, on social factors, such as parents (Butler, 2016), that influence the action (Gallard and Cartmell, 2014). Motivation is regarded crucial to mathematics achievement (Noyes, 2007; Hall, 2016). An example, such as completing homework (Ryan and Decci, 2000) highlights the motivation to carry out the task along with the value of the outcome of completing that task (Bandura, 1977; Kalder and Lesik, 2011). This motivation can be achieved through parental support (Coltman and Whitebread, 2008). Parental support is therefore another factor of pupils' attitudes to mathematics that should be included within the multitude of factors measured and analysed, in order to holistically understand how a pupil's attitudes to mathematics are influenced and established.

Conclusion of Key Finding 2: The Importance of Including Parental Support in Future Studies

Parental support contributes to all four components of a child's attitude through expectancy value (Eccles, 1993). Furthermore, differences not only in economic capital (Tan, 2015), but also cultural capital (Bourdieu, 1986) would also indicate that pupils' attitudes would be influenced differently depending on their parental support or family background (Bourdieu and Passeron, 1990; Mortimer, 1991). There must also be consideration how cultural capital can coincide with economic capital (Bourdieu, 1986), with the Department for Education identifying a link between house prices and quality of schools, with additional findings showing that pupils who achieved higher grades typically came from higher income families (Deparmtent for Education, 2017). This provides additional justification for including parental attitudes in a model in future studies. Aspects of socio-economic status are expected to influence attitudes differently, and this study captured that schools in less deprived areas consisted of pupils with more positive attitudes towards mathematics. The study additionally noted that the deprivation levels of the sample were higher than the national average, which whilst providing a possible reason for the negative influence of parental support, also indicates a type of disadvantage from a lack of cultural or economic capital, and again provides reasoning as to why parental attitudes should also be studied.

The negative influence identified from pupils who indicate their parents help with their homework provides an interesting discussion when considering the positive influence of confidence, motivation and value. Previous studies have identified a relationship between child and parental value (Parson et al, 1984; Fredericks and Eccles, 2005; Fan and Williams, 2010) and children have been found to establish a sense of identity based on the reactions of their parents to the child's success or failures (Eccles, 1993). It was identified in the study that the sample was of higher deprivation levels than the national average, by measuring the eligibility of free school meals at the school level, with additional evidence indicating that parents from more working class backgrounds have more negative attitudes towards mathematics because of poorer experiences (McMaster, 2017). Therefore, the pupils from more deprived areas may be subjected to more negative parental values of mathematics sharing non-STEM identities (Macdonald, 2014) and by assimilating their parents' attitudes and beliefs (Parson et al, 1982; 1984), they are establishing a similar identity themselves and therefore experiencing more negative attitudes to mathematics. If pupils have parents with low value and confidence in mathematics, we can expect to see more negative attitudes due to the powerful influence of parents (Maltimore, 1991) and the effect on pupil learner identity (Wenger, 1998; McMaster, 2017).

Macdonald (2014) discusses how negative learner identities in mathematics stem from the lack of particular aspects of attitudes such as confidence and motivation and emphasises the importance of parental support, echoing aspects of Eccles' Expectancy Value Theory (1993). This study provides similar evidence in the context of positive attitudes to mathematics, where those with confidence, value, motivation, and do not receive help from parents with homework, exhibit positive attitudes to mathematics. It could certainly be the case that those who do not receive help from parents feel they do not need it, given they are more likely to have confidence, value and motivation. Their possession of those factors, as a result of experiences in school and at home, can be achieved through working towards the satisfaction of their own identity, as explained by Optimal Distinctiveness theory (Brewer, 1991; Gray, 2014) and other frameworks (Wenger, 1998; Smith and Hogg, 2008).

Key Finding 3. The Issue of Gender: Why Boys v Girls is a Problematic Approach

When discussing attitudes to mathematics, gender is perhaps one of the most discussed factors in terms of the difference in attitudes between male and female pupils (Eccles, 1994; Bidin et al 2003; Marsh, 2004; Woodard 2004; Sahin 2008 in Karimi and Venkatesan, 2009; Beilock et al, 2010; Dowker, Bennet and Smith, 2012; Breda and Napp, 2019). Additionally, the under-representation of females in STEM carrers (McMaster, 2017) means we establish a sense of normality based on our expectations of females to succeed with literacy more than mathematics from both parents (Eccles, 1993) and teachers (Beilock et al, 2010); and therefore provides potential reasoning to female advantages in those subjects (Breda and Napp, 2019). It can also be argued however, that the literacy advantage identified in young females by Breda and Napp (2019) may already be the result of parental and teacher expectations. There must also be recognition of the research that has found no difference in gender attitudes towards mathematics (Marsh 2004; Stevens 2013 in Mutodi and Ngirande, 2014). An issue that can be applied to this discussion is the different findings between this study's bivariate and Multilevel models.

During the bivariate analysis of the current study, it was identified that males had more positive attitudes to mathematics than females, echoing previous research (Bidin et al 2003; Woodard 2004; Sahin 2008 in Karimi and Venkatesan, 2009). The difference in value for mathematics between male and female has been discussed at length concerning young people and students for over thirty years (Eccles et al, 1983; Parsons et al 1984; Fennema and Peterson,1985; Wigfield and Eccles, 1992; Eccles 1994; Beilock et al 2010; Macdonald, 2014; Mcmaster, 2017). The current study focused on eight and nine year old pupils and identified that males were more likely to value mathematics as their favourite subject, and that males had more positive attitudes to mathematics than females. Males who viewed their own gender as good at mathematics also had more positive attitudes than females who viewed their gender as good at mathematics. The evidence to suggest that gender affects attitudes is therefore present in the study; however so is the evidence to suggest that gender does not influence attitudes.

The multivariate models consistently identified no association between gender and attitudes when controlling for the influence of additional factors, including ethnicity, value, motivation, parental support and teacher characteristics. This has to be discussed when considering the wealth of evidence discussed suggesting a difference between male and females in their attitudes. This is particularly important given that the sample of this study is of a young age and therefore may suggest that if differences appear in multivariate models with older age groups, then a key question is at what point in the educational life course this differentiation begin to take place.

The UK has long held gender stereotypical views where males are viewed as more able in mathematics (Boaler, 2004; Mendick 2005; Department for Education and Skills, 2007) whilst females possess advantages in literacy (Breda and Napp, 2019). Our attitudes to subjects can be affected by the views of our parents (Eccles, 1993), and further developed through interactions with teachers (Becker, 1963; Willis, 1978), and evidence has indicated the mediation between teacher views and gender; and pupils' attitudes and anxiety (Noyes, 2007; Beilock et al 2010). Female pupils excel above males in all subjects except mathematics at SATs levels (Department for Education, 2016a) and report lower self-perceived abilities than males even as they improve (Dowker, Bennet and Smith, 2012).

The notion that our attitudes are therefore shaped externally is a notion that must be further explored given the impact that a pupil's gender can have on their experiences with mathematics. Our experiences with subjects, establish our learner identity (Wenger, 1998) and we therefore work towards that identity to reaffirm it (Abrams et al., 1990; Brewer, 1991; McGarty et al, 1994; Wilder, 1990).

Working towards an identity establishes attitudes that help reaffirm that sense of identity, and this becomes more so when we share the same attitudes amongst those who with whom we share an identity (Wenger, 1998; Smith and Hogg, 2008), with females adopting their parents beliefs as an example (Parsons et al, 1984; Fredricks and Eccles, 2005). This provides potential explanations for issues, such as maths anxious female teachers transmitting negative attitudes (Beasley et al, 2001; Beilock et al, 2010) and establishing negative learner identities (Macdonald, 2014) that go on to cause impacts such as the under representation of women in STEM workforces (McMaster, 2017). Not only does this promote and normalise the under achievement of females in mathematics (Hargreaves et al, 2008), but also contributes to the outcomes of females lacking in engagement in mathematics through disfavour (Burnes, 2014), underachievement (Hall and Hoff, 1988; Eccles, 1993 Beilock et al, 2010), and failure (Mayes, Chase and Walker, 2008). Such outcome can follow girls into their adult lives and limit career options (Noyes, 2007; Hillman, 2014; Marshall, et al 2016). This process highlights the importance of attaining confidence, enjoyment, value, and motivation (Tapia and Marsh, 2004).

Based on the evidence discussed, an argument can be made that the required four components, and how they are attained, could differ according to the gender of the pupil. Value can be affected by parental beliefs (Eccles, 1993; 1994; Sun and Pyzdwoski, 2009; Fan and Williams, 2010), enjoyment by shared identity (Wenger, 1998; Smith and Hogg, 2008), motivation by teachers (Becker, 1963; Beilock et al, 2010; Hagger et al, 2015) and confidence can be both the result of the other three factors and the reason (Tapia and Marsh, 2004). This complex process highlights how we come to establish mathematical dispositions (NCTM, 1989; Feldhaus, 2014). Forming habits of the mind (Katz, 1993), these dispositions go on to provide people with a sense of who they are (Damon, 2007) and therefore establish distinct learner identities (Wenger, 1998). This highlights the establishment of non-STEM identities (Macdonald, 2014) where individuals see themselves as persons who are not mathematical (Williams et al, 2008).

The same level of discussion, however, must also take place for gender not affecting pupils' attitudes. As discussed in the literature review, there is an emerging view that social aspects provide better explanations for performance differences than gender (Hargreaves et al, 2008). McCall (2005) highlights the limitations of focusing on gender, as a single category to analyse, as gender can intersect with class, ethnicity, religion, and ability (Wingrave, 2016). These intersections may overlap with one another and result in complex interactions and experiences, which in turn lead to different concepts of identity that gender still intersects with (Collins, 2000). This further highlights the complexity in attitudes that are both worked toward and the result of the identity held (Brewer, 1991). Aspects of identity are known to include gender with or without the work of teachers (MacNaughton, 1998 in Chapman, 2016), and children are found to associate interests to what they recognise associated with their gender (Our Watch, 2018). Learner identities can therefore be established (Wenger, 1998; Macdonald, 2014) and values can differ as shown in the current study. Therefore, whilst gender does not directly influence attitudes in this study, there must be recognition of the relationship between gender and value for mathematics; as well as and how value influences attitudes.

The complexity in attitudes, and how they are externally influenced, highlights the importance of using multivariate models to address the complex real world independent of the researcher's perception (Aliyu et al, 2014) in order to accurately capture the epistemological aims of the study. This is additionally important when considering the need for reliable evidence to help further an understanding of how attitudes can be changed for the better when thinking about the disadvantages suffered by females. Gender has been recognised as an important factor whilst also considering the limitations of analysing it individually when there is evident overlapping with other aspects of identity (McCall, 2005). Evidence of no association between gender and attitudes to mathematics has been previously identified (Marsh 2004; Stevens 2013 in Mutodi and Ngirande, 2014).

The evidence from this study highlights the importance of using social aspects rather than gender to explain performance difference (Hargreaves et al, 2008), as we could essentially argue that it is the external influences that establish different attitudes because of pupil gender (Eccles, 1993; 1994; McCall, 2005; Chapman, 2016). Therefore, whilst gender may not distinctly relate to pupils' attitudes in the study's multivariate model, aspects of pupils' learner identity and parental support do. Furthermore, given the association with gender and favourite subject, there is an argument to be made that gender may contribute to attitudes through how we value mathematics and how we receive parental support. If it is the case that female pupils adopt their parents beliefs (Parsons et al 1984) and parents provide negative impact to attitudes, as seen in this study, this could be due to negative expectancy value (Butler, 2016). This provides explanations for the findings of the current study where those who valued maths as their favourite subject were more likely to be male and also more likely to have positive attitudes in a multivariate model. The aspects of learner identity, in the case of this study, were therefore of more influence than the demographic aspects of pupils, including gender. It is therefore recommended that future studies adopt the same approach when assessing attitudes, and particularly in contexts where many additional factors can contribute to attitudes or behaviours. Much like the concerns that come with Randomised Control Trials where the complexity of the real world environment may not be captured (Connolly et al, 2018), simply looking at gender and its effect on attitudes does not capture the realist environment being studied. It is therefore more beneficial to measure social aspects (Hargreaves et al, 2008) and observe the influence of those social aspects when identifying factor associated with attitudes to mathematics.

Key Finding 4.

The Impact of Teachers and Schools: Why More Evidence is Needed

This section aims to answers research question 3 (*Do Teacher Characteristics influence pupils' Attitudes to Mathematics?)* and research question 4 (*Does the school attended influence pupils' Attitudes to Mathematics?)*.

When discussing the influence of teachers and schools, this study produced conflicting evidence based on the models used to analyse influences. Whilst studying how attitudes were influenced focusing on particular characteristics of teachers or schools individually, a series of evidence was identified that suggested pupils' attitudes are positively influenced by positive teacher attitudes, and when attending high performing schools or schools in lower levels of deprivation. However, when presenting these factors simultaneously in a

Multilevel Model, the evidence collated suggested that there is not significant variation in pupils' attitudes based on their teachers' attitudes or the school they attend. One potential reason for this could be concerning sampling and the lack of clustering groups, with only 10 schools and 19 teachers, as previously discussed. Also previously discussed, was the calculation of design effect and post hoc power analysis used to predict the sample size needed to stablish a sufficient sample that would be appropriately analysed by a Multilevel Model and identify significant variation (Lohr, 1999 in Rutterford et al, 2015). The bivariate analysis findings can therefore not be ignored, nor can the evidence from post hoc power analysis, and there must therefore be more research to clearly identify whether pupils attitudes are affected by these factors. Previous evidence has identified influence from teachers (Sun and Pyzdrowski, 2009; Beilock et al, 2010) and schools (Bogdan and Biklen, 2007; Kena et al, 2014), and the epistemological commitment of this study recognises that the objective truth may not necessarily be captured in this one piece of evidence. It is therefore recommended future research should be done using the methodological framework of this study, with a larger sample, in order to make a more clear identification of the influences of teachers and schools.

The current study identified various forms of evidence to suggest that positive teacher attitudes are related to positive pupil attitudes, as has been found in previous studies (Beasley, 2003; Beilock et al, 2010). The components of attitudes to mathematics, such as confidence and motivation, depend on the mathematical experience presented by the teacher (Bandura, 1977), emphasising the importance of the teacher-pupil relationship (Coe et al, 2014). Teachers' anxiety has been found to effect pupils' anxiety (Beilock et al, 2010) and the UK has been found to have a low number of teachers in primary schools with higher mathematics qualifications (Vorderman, 2011). Therefore, the value of mathematics on the teacher's behalf, as does confidence and motivation, must be positive in order to expect pupils to feel the same way. Additionally, the current study identified positive teacher attitudes in schools with less deprivation and with higher performance scores in mathematics. The positive scores reflects the confidence in teachers and therefore it could be argued that pupils with more confident teachers have more positive attitudes and attainment. The teacher, as a result of this and previous research, must be recognised as an important factor that could influence a pupil's attitude to mathematics. The learner identity of pupils not only depends on parents, but teachers (Wenger, 1998; Macdonald, 2014).

Pupils react to teachers' interpretations of their success as they do parents (Willis, 1978; Coe et al, 2014).

Negative emotions from teachers can transmit to students (Smith, 2004; Sun and Pyzdrowski, 2009) and teaching methods can additionally impact on student experiences (Muis, 2004; Jackson, 2005; Tall, 2014) through teaching methods, which link to motivation. Positive teacher-pupil interaction must therefore take place in order to encourage positive attitudes in pupils. Positive teaching requires positive attitudes in teachers and therefore an understanding of what facilitates teachers' confidence is essential to then understanding how teachers can be used as a factor to help produce more positive attitudes to mathematics in pupils.

Recognition of schools' influence is equally important when discussing external influences on attitudes to mathematics. The current study identified relationships between school characteristics and teacher attitudes. Pupils/ understanding of mathematics is not only shaped by the teacher providing the learning experiences but also the pedagogical practices of the school attended (Bogdan and Biklen, 2007; Kristapovich , 2014). Schools additionally have flexibility to decide when to introduce content in their curriculum, providing the required content is taught by the end of the Key Stage (Department for Education, 2013).

The current study identified more positive attitudes in pupils attending schools with less pupils who are eligible free school meals, and higher Index of Multiple Deprivation Scores indicating more affluence. A potential issue here is the advantages of economic capital (Tan, 2015) where pupils with more resources for learning are more likely to attain positive experiences (Chiu and Xishua, 2008). Schools with higher average scores in maths, therefore possess more value (Hussain, 2016) meaning families with more economic resources are more likely to have their children attending well performing schools. Additionally, the analysis in this study identified a skew with the majority of the sample having more positive attitudes. The maths performance measures at the school level were also identified to be higher than the national average, which may explain the positive skew amongst the data. Interestingly, the deprivation levels for the sample was also higher than the national average, providing evidence to suggest that deprivation and attainment may not relate. This poses a need for additional evidence to assess the influence of the school attended on pupils' attitudes. The post hoc power analysis from the Multilevel Model provided a prediction that with an estimate sample size of 2300 from 45 different schools would identify significant variation in pupils' attitudes based on the school attended. As stated in key finding 1, an issue of sampling is present in the study given the significantly higher levels of deprivation and contrastingly school performance measures, in comparison to the national average. Given the discussion on the positive relationship between affluence and attitudes, it would be expected that if the samples' school performance measures are higher than the national average, then the levels of deprivation would be lower. However, this is not the case and poses two issues to consider. The first issue is sampling. Given the evidence to suggest a larger sample is needed for the model to accurately assess the influence of the multiple factors concerned in this study, it is recommended that a larger sample be obtained whilst being comparable of the national average school performance measures and levels of deprivation.

The second issue, is the issue of school culture. The study discussed the impact of the school attended by referring to issues relating to the impact of OFSTED on catchment areas and value of homes (Hussain, 2016) as a form of economic capital that can provide advantages to education (Tan, 2015), it also discussed the different pedagogic practices that can be encountered by the school a child attends (NTCM, 1989). Furthermore, this study also discussed how a school culture can be affected by league tables (Siraj and Taggart, 2014) which can impact how a teacher implements there teaching based on the pressures they are under to achieve particular outcomes like grades, which can affect the understanding of pupils (Jackson, 2005; Pampaka et al, 2012). It is therefore possible, that certain areas that re more deprived can be subjected to other initiatives that help improve the attitudes of their students. It is also possible that the teachers in these deprived schools are stronger in their mathematical abilities and therefore have a positive impact on pupils attitudes, given the evidence to suggest teacher confidence is a factor arguably more important than methods (Beilock et al, 2010; Vorderman, 2011; Tall, 2014; Boylan, 2019?). It is also suggested that funding can be focused on helping improve disadvantaged children in poorer areas by recruiting the best teachers to teach in those schools (Sarij and Taggart, 2014) and it can therefore be argued that the teacher is a more influential factor than the actual school. This provides additional reasoning for more research and also suggests that teachers attitudes continue to be measured in order to assess this issue.

Linking the Key Findings: Identifying how Pupils Become Opposed to Mathematics

This section aims to answer research question 6 (*Do demographic factors, confidence, value, motivation, and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics?) and research question 7 (Do demographic factors, confidence, value and motivation and Gender Ability Beliefs of pupils, influence Attitudes To Mathematics when considering the influence of Teachers' Attitudes to Mathematics and factors associated with the school studied).* Whilst questions 3 and 4 concerned teachers and schools, research question 6 concerns teachers' attitudes within multivariate models, as does question 7 with schools and teachers respectively. Whilst bivariate analysis found a number of associations between teacher and school factors and pupils' attitudes, these associations were not present in the multivariate models. As previously discussed, it is important that we observe the school conditions in their most real state, meaning that we should use the appropriate methods to infer our findings. This research therefore does not wish to generalise a number of findings based on bivariate analysis where a number of Null Hypotheses have been rejected. Instead, this research wishes argue the case for more observational studies in educational settings, along with Multilevel Modelling techniques to analyse the factors within those settings. In addition to arguing the case for more complex modelling to analyse the complex conditions of educational research, this study has produced evidence to suggest a sufficient sample to carry out appropriately the suggested methods. The post hoc power analysis calculations produced evidence to suggest that with a sufficiently larger sample that there would be significant associations between pupil attitudes, and school and teacher factors. Therefore, whilst the null hypotheses within these research questions were accepted, this section concludes that more research should be conducted with a sufficient sample to accurately answer these research questions.

Because of poor experiences in schools and pupils opting to drop the study of mathematics when given the choice (Pampaka et al, 2012; Hillman, 2014); and with a shortage of STEM graduates, there is a need to improve attitudes to mathematics in the UK. It costs the UK an estimated £20 Billion (Pro-Bono Economics, 2014) as a result of poor mathematical proficiency, in and outside of education, (Scarpello, 2007; Chinn, 2012a). The UK is in the midst of a so called 'Numeracy Crisis' (National Numeracy, 2016a); it is culturally acceptable to proclaim a lack of skills in numeracy (Kowsun, 2008, in National Numeracy, 2016a; Royal Society, 2019) and as a result, people struggle with mathematical problems in their everyday lives (National Numeracy, 2019). The UK education system has long been criticised for forcing important choices on its pupils from an early age (Snow, 1959; Whelan, 2009) and with a long standing bias towards literacy (Nuffield Foundation, 2010), pupils opt for other subjects over mathematics and often avoid mathematics due to anxiety (Chinn, 2012a; Marshall et al, 2016).

This study has recognised and acknowledged the issue at hand and applied a quantiative methodology to assess how our attitudes are established in earlier years and influenced through external factors beyond our control. Psychological theory has concerned what constitutes as attitudes and what is required to attain a set of positive attitudes (Tapia and Marsh, 2004) in order to establish positive mathematical dispositions. Educational theory has discussed how aspects of pupils' attitudes can be affected by either factors associated with the pupil, such as gender and ethnicity, along with other factors such as experiences with teachers and the practices of schools. Additionally, the work on learner identities (Wenger, 1998; Macdonald, 2014; McMaster, 2017) has helped us come to understand how we come to value the subjects we do which is either reinforced or challenged as a result of our social context, including the role ofour parents and teachers.

Negative attitudes to mathematics are a core educational issue in the UK(Royal Society, 2019), and in order to address what is a long-standing and complex issue, there is a requirement to employ a methodological approach that recognises and attempts to measure as much of the complexity as possible. This study has opted to apply a quantiative methodology to study the observable issue at hand, and recognise how it is influenced by a complex system of variables. Attempting to maintain objectivity when studying an issue that elicits emotional and individual responses, this study has relied on quantitative methodology and statistical methods to measure and assess attitudes and their influences. There was additionally a concern to try to capture the complexity of the school conditions (Pampaka, Williams and Homer, 2016) that would have been set prior to data collection. It was felt that an experimental method would not capture this complexity (Connolly et al, 2018). Through carefully designing self-completion questionnaires (Kellet and Ding, 2004; Kellett, 2011; Mabelis, 2019), influenced by previous research instruments (Richardson and Suinn, 1972; Tapia and Marsh, 2004; Hunt et al, 2011; LaMarca, 2011), and acknowledging the influential social factors, this study has provided a methodological and theoretical contribution to knowledge concerning the measurement and assessment of attitudes to mathematics and its associated factors. If further investigated and repeated with a sufficient sample, this research can help build an understanding as to how we resolve the so-called 'Numeracy Crisis' through changing attitudes (National Numeracy, 2016a).

As the current study has produced evidence of high reliability in the attitudinal measures (Cronbach, 1951), whilst using measures and techniques previously validated to measure external factors, further research can be done with the same methodology in order to provide the evidence needed. This includes a cluster sampling method that works in line with schools and their pupils through an ethical and efficient data collection approach. Good practice can be maintained through parental information and upholding the right to withdraw (MRS, 2014). Techniques such as anonymous identification and self-completion approaches can help avoid socially desirable responses (Steenkamp, de Jong and Baumgartner, 2009; McLeod, 2009) and uphold data protection (Scott, 2013). What is needed, is a larger, more comparable sample of the population studied that also takes into account the proportions of BME pupils to White, male to females, and affluence to deprivation levels. Additionally, it is important when recruiting participants via schools, that recognition of the schools' performances are also taken into account when sampling in order to uphold a comparable sample of the population in terms of ability.

An appropriate sample can make important identifications in pupils' attitudes whilst using a high standard statistical technique that acknowledges the complex system of factors that may influence attitudes, whilst also recognising how those factors provide a clustering effect where groups of individuals are likely to exhibit particular responses (Steele, 2008). This methodology allows the opportunity to observe the world of classrooms and their pupils as objectively and as accurately as possible, aiming to methodologically capture the realism of the environment being researched, that is independent of the observer (Cohen et al, 2011; Aliyu et al, 2014). By relying on statistical method and self-completion tools to measure and assess the objects of that world, the interpretation of the researcher is driven by the analysis of data. Whilst acknowledging that the subjectivity of human interpretation is still present (Williams, 2009) the use of statistical tests allows those interpretations to become more objective (Cohen, 2007; Aliyu et al, 2014) and the findings to be deemed reliable (Ali and Chowdhury, 2015). The subjective nature of this study comes from how the findings relate to that of previous research. For that, we must rely on the objectivity of the researcher to apply a balanced viewpoint that acknowledges the issue at hand and what has previously been identified.

It is evident that more communication between policymakers and practitioners (ACME, 2016), along with plans to improve education in schools being informed by research (Sarij and Taggart, 2014) is needed to expect an improvement in mathematics education. This allows us to understand more of what may influence pupils to become opposed to mathematics as they approach the school leaving age (Hillman, 2014) or become less able to effectively use the mathematics they learnt in school (OFSTED, 2018). However, in order to build an understanding we must first identify the objects that lead to the issue. This research provides the tools and approach to do so in an objective, ethical and reliable manner. By applying this research to a larger sample, we can make the necessary identification of how young pupils' attitudes to mathematics are influenced through multiple factors in order to then build an understanding of why those factors provide positive or negative influences. By making this identification, we can then work with those factors to build positive attitudes. Building positive attitudes can resolve a great many of the issues currently affecting mathematical outcomes in the UK today, such as choosing not to study STEM subjects at A-level or university (Pampaka et al, 2012; Hillman, 2014), and potentially limiting career options. A discussion has already began on how we can improve mathematical proficiency through an acknowledgement of how we develop negative attitudes to mathematics along with mathematics anxiety (Foley et al, 2017). The need for this understanding is evident in the need for STEM graduates (UK Commission for Employment and Skills, 2013; 2015) along with the need for more adults to have basic numeracy skills (Chinn, 2012a; National Numeracy, 2016a). Increasing positive attitudes to mathematics should expect a result less people no longer choosing to study STEM related subjects after compulsory schooling (Hillman, 2014; Marshall et al, 2016). Improving attitudes towards mathematics would also enable people to feel more confident in their use of numbers in their everyday lives, thus potentially enabling them to be more financially savvy and statistically literate. By changing attitudes, we may just be able to resolve the so-called 'Numeracy Crisis' (2016a).

Concluding Remarks

This research set out to identify factors associated with attitudes to mathematics. The result of this research can be split into four key findings.

The first finding was the methodological contribution to research with children, through its use of self-completion questionnaires with children, schools as means of sampling, and use of Emojis and drawings as methods of responses. The methodological contribution of this research is the basis that can help identify key factors that contribute to attitudes within educational contexts, and through reliable measurement instruments and techniques.

The second key finding is the theoretical contribution, that is the evidence to suggest that whilst attitudes to mathematics compose of four particular components (enjoyment, confidence, value and motivation), the components intertwine and work with one another to support how each contributes to overall attitudes to mathematics. Pupils with a greater value for mathematics are more likely to enjoy mathematics in particular scenarios and possess the confidence to carry out mathematical tasks. The same can be said for pupils with higher levels of motivation. These four components not only comprise attitudes to mathematics, but also are additionally important in how they work with one another to establish positive attitude to mathematics. This was evidenced through a series of bivariate analysis with two separate measurements of attitudes to mathematics, whilst using multivariate models to asses show each component provided an effect when considering the influence of other variables.

The third key finding is the complex issue that is gender and how it affects our attitudes to mathematics. Previous research has identified attitudinal differences with males often being more positive and this has linked been with attainment, with females exceeding males in all subjects except mathematics. Additionally, sociological and educational literature has been long focused on the expectations of males that they will do better in mathematics than females, and these values have come to arguably influence younger pupils, helping establish their learner identities and attitudes as a result. The reason this is complex, however, is that multivariate models provide evidence to suggest that gender does not necessarily influence attitudes to mathematics, when considering other variables relevant to the environment being studied, such as parental support and confidence in abilities. We must therefore begin to approach to research gender in education by acknowledging the many other aspects that contribute to learner identity. By capturing the complex nature of educational environments and pupils' identities, can we then begin to build a more comprehensive understanding of how gender affects our attitudes, which our attainment clearly depends on.

The fourth and final finding stems from the sampling issues of this study. This research sought to assess the effects of teachers' attitudes and school setting on attitudes and whilst building a multivariate model that could assess these factors, did not have a sufficient sample to accurately determine whether a pupil's attitude differed according to their school when controlling aspects of pupil identity. Whilst this research did not establish a suitable sample size, it did identify the suitable sample size. It is therefore recommended that this methodology be used with a sufficient sample size, using schools and sampling them strategically to build a sample that is comparable of the population of study, to accurately identify how pupils' attitudes are influenced at year 4. Making this identification is key to understanding whether our views differ at this point in the educational life course and whether polarised learning cultures begin at this stage, or if we believe that stage could be later, or even earlier.

This research has built the basis of an understanding as to how we can change attitudes to mathematic and address the numeracy crisis within the UK. By changing attitudes, we improve our prospects of more people studying STEM related subjects and pursuing STEM related careers. The Digital Age is a challenging socio-political and economic era that requires that people be confidently numerate, not just to enable them to balance their home budgets or pursue a specific career, but in order to play a full part in civil society. Numbers are the central weapon in the 'fake news' era that shapes contemporary civil society and thus being confident with numbers is an essential defence for an informed citizen. The acute need for people to have positive attitudes to mathematics reflects the need to use methodologies that capture the real world in its complex form. The sooner we make clear identifications with comparable populations, capturing the reality of the environment, the closer we become to making realistic and well-informed solutions.

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Appendix A: Descriptive Statistics

Gender

Pupil Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	243	47.8	49.1	49.1
	Female	252	49.6	50.9	100.0
	Total	495	97.4	100.0	
Missing	-99.00	12	2.4		
	8.00	1	.2		
	Total	13	2.6		
Total		508	100.0		

A1.2: Favourite Subject (Value)

Pupil Favourite Subject

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other	305	60.0	61.7	61.7
	Maths	189	37.2	38.3	100.0
	Total	494	97.2	100.0	
Missing	-99.00	12	2.4		
	3.00	1	.2		
	9.00	1	.2		
	Total	14	2.8		
Total		508	100.0		

Ethnicity – before recoding

Pupil Ethnicity (Original Measure)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White British	293	57.7	60.8	60.8
	White Irish	3	.6	.6	61.4
	White Other	38	7.5	7.9	69.3
	Asian Indian	14	2.8	2.9	72.2
	Asian Pakistani	40	7.9	8.3	80.5

	Asian Bangladeshi	1	.2	.2	80.7
	AsianOther	17	3.3	3.5	84.2
	Black African	27	5.3	5.6	89.8
	Black Caribbean	5	1.0	1.0	90.9
	Black Other	5	1.0	1.0	91.9
	British Cinese	1	.2	.2	92.1
	Chinese	1	.2	.2	92.3
	Any Other	8	1.6	1.7	94.0
	Mixed White and Asian	8	1.6	1.7	95.6
	Mixed White and Black	18	3.5	3.7	99.4
	Mixed White and Chinese	1	.2	.2	99.6
	Mixed White and Any Other	2	.4	.4	100.0
	Total	482	94.9	100.0	
Missing	-99.00	26	5.1		
Total		508	100.0		

Ethnicity – after recoding

Ethnicity (White = 1 and BME = 0)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BME	148	29.1	30.7	30.7
	White	334	65.7	69.3	100.0
	Total	482	94.9	100.0	
Missing	System	26	5.1		
Total		508	100.0		

Self-Confidence

I am good at maths

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	46	9.1	11.2	11.2
	Yes	364	71.7	88.8	100.0

	Total	410	80.7	100.0	
Missing	System	98	19.3		
Total		508	100.0		

Motivation

I do maths at home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	106	20.9	25.3	25.3
	Yes	313	61.6	74.7	100.0
	Total	419	82.5	100.0	
Missing	System	89	17.5		
Total		508	100.0		

Parental Support

My parents help me with maths homework

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	163	32.1	36.5	36.5
	Yes	283	55.7	63.5	100.0
	Total	446	87.8	100.0	
Missing	System	62	12.2		
Total		508	100.0		

Perception of someone good at maths

Someone who is good at MATHS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Girl	202	39.8	42.3	42.3
	Boy	276	54.3	57.7	100.0
	Total	478	94.1	100.0	
Missing	-99.00	30	5.9		
Total		508	100.0		

Pereception of someone good at reading

Someone who is good at READING

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Girl	286	56.3	61.4	61.4
	Boy	180	35.4	38.6	100.0
	Total	466	91.7	100.0	
Missing	-99.00	42	8.3		
Total		508	100.0		

Gender ability beliefs (Maths Drawing – Reading Drawing)

-1 = Girl good at maths, boy good at reading

0 = Same gender for both

1 = Boy good at maths, girl gool at reading

Gender_Ability_Beliefs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1.00	72	14.2	15.5	15.5

	.00	235	46.3	50.5	66.0
	1.00	158	31.1	34.0	100.0
	Total	465	91.5	100.0	
Missing	System	43	8.5		
Total		508	100.0		

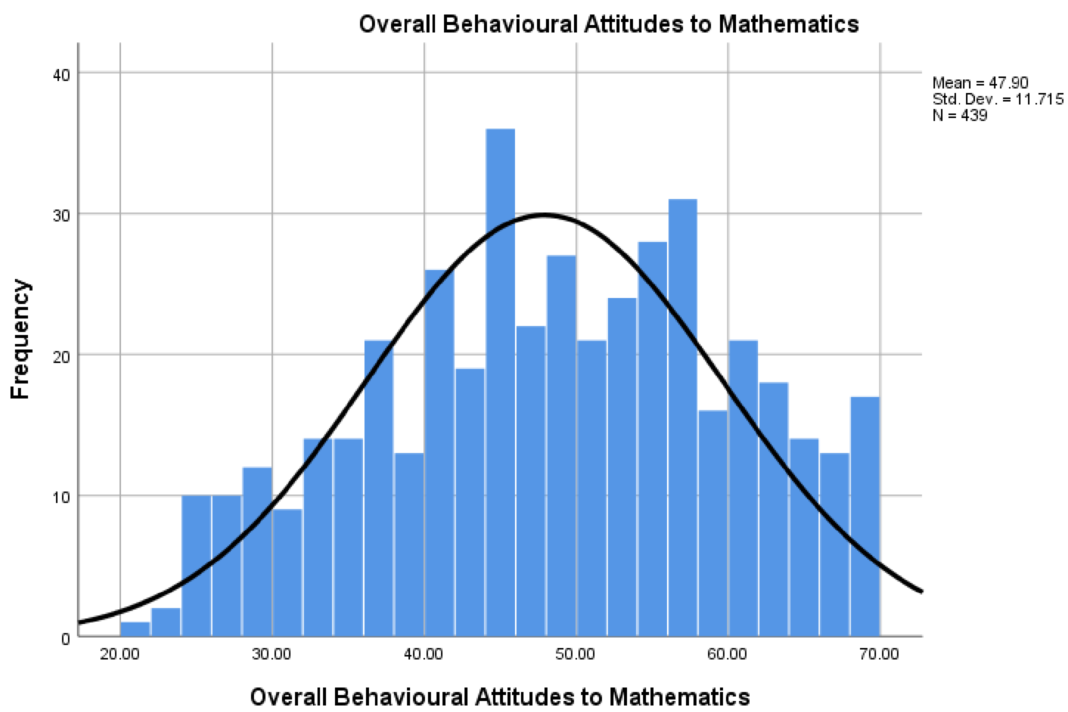
(Computed Variable) Gender and Someone good at maths

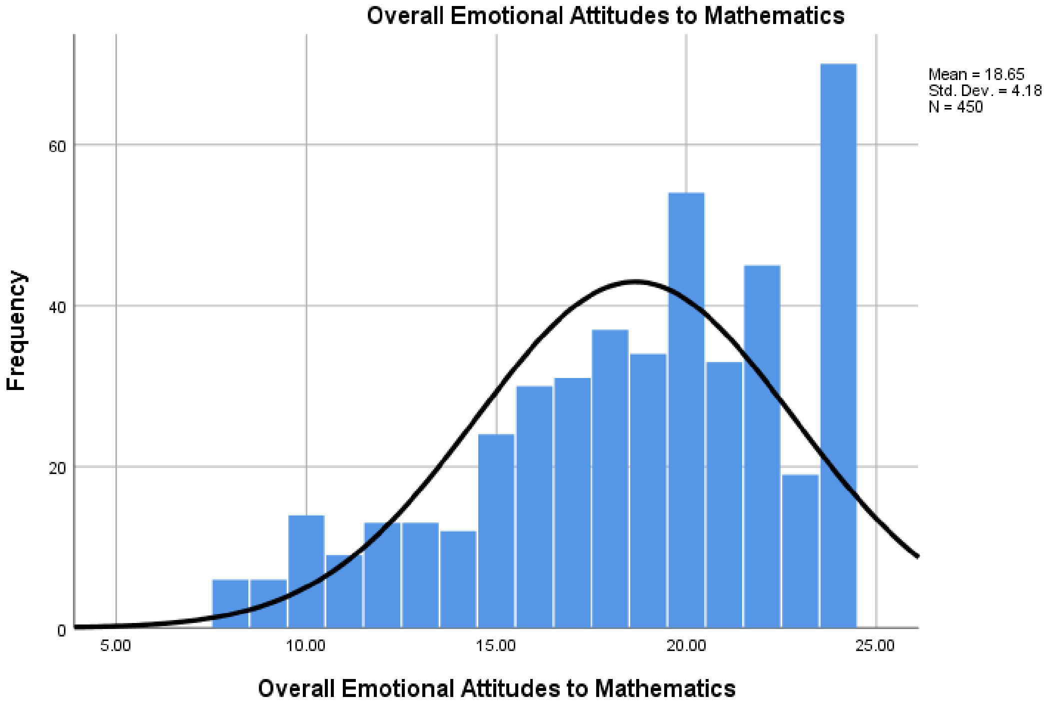
Gen_MATHS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Males - Female at Maths	32	6.3	6.8	6.8
	Males - Male at Maths	194	38.2	41.5	48.3
	Females - Female at Maths	167	32.9	35.7	84.0
	Females - Male at Maths	75	14.8	16.0	100.0
	Total	468	92.1	100.0	
Missing	System	40	7.9		
Total		508	100.0		

Statistics

		Overall Emotional Attitudes to Mathematics	Overall Behavioural Attitudes to Mathematics
N	Valid	450	439
	Missing	58	69
Mean		18.6511	47.8952
Median		19.0000	48.0000
Mode		24.00	44.00
Std. Deviation		4.18030	11.71495
Range		16.00	47.00
Minimum		8.00	21.00
Maximum		24.00	68.00

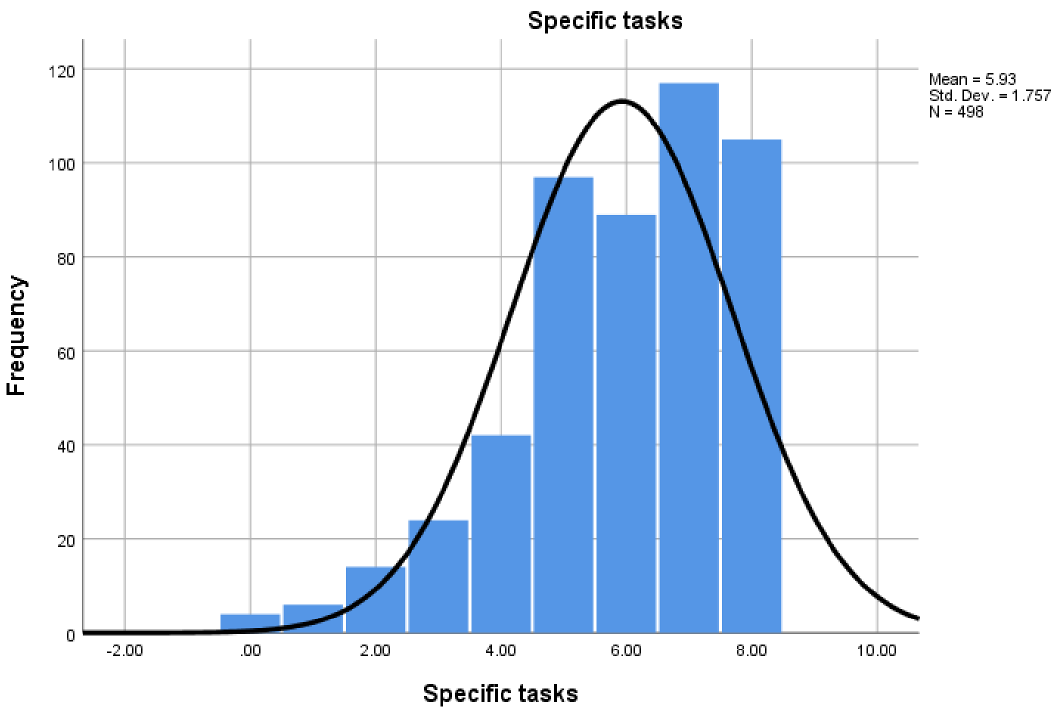


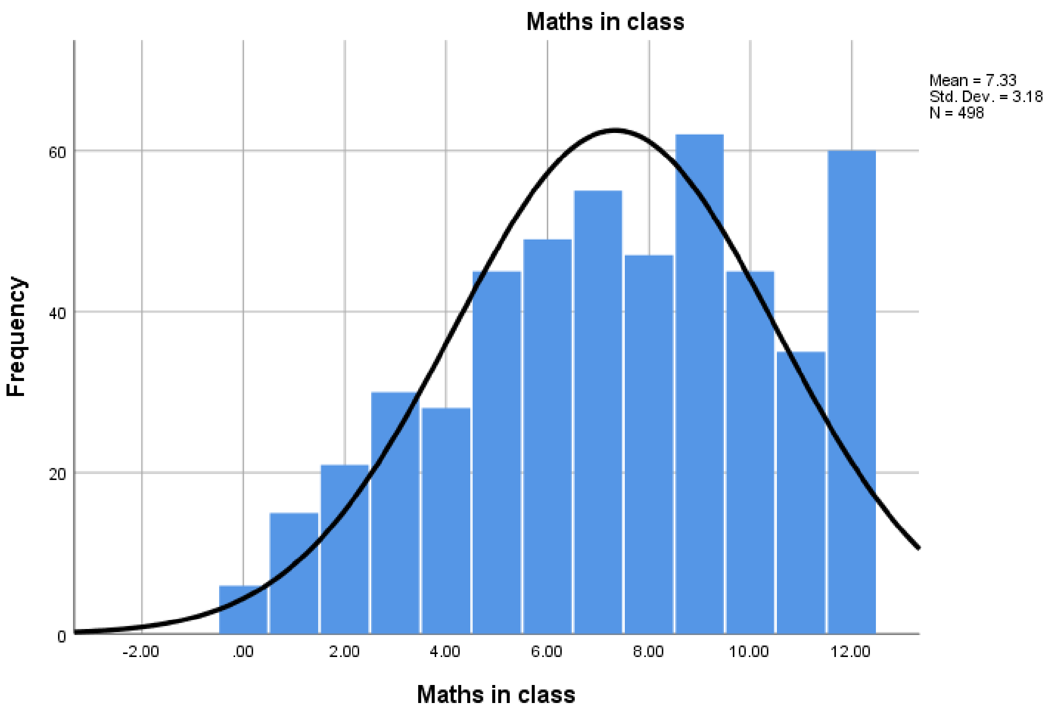


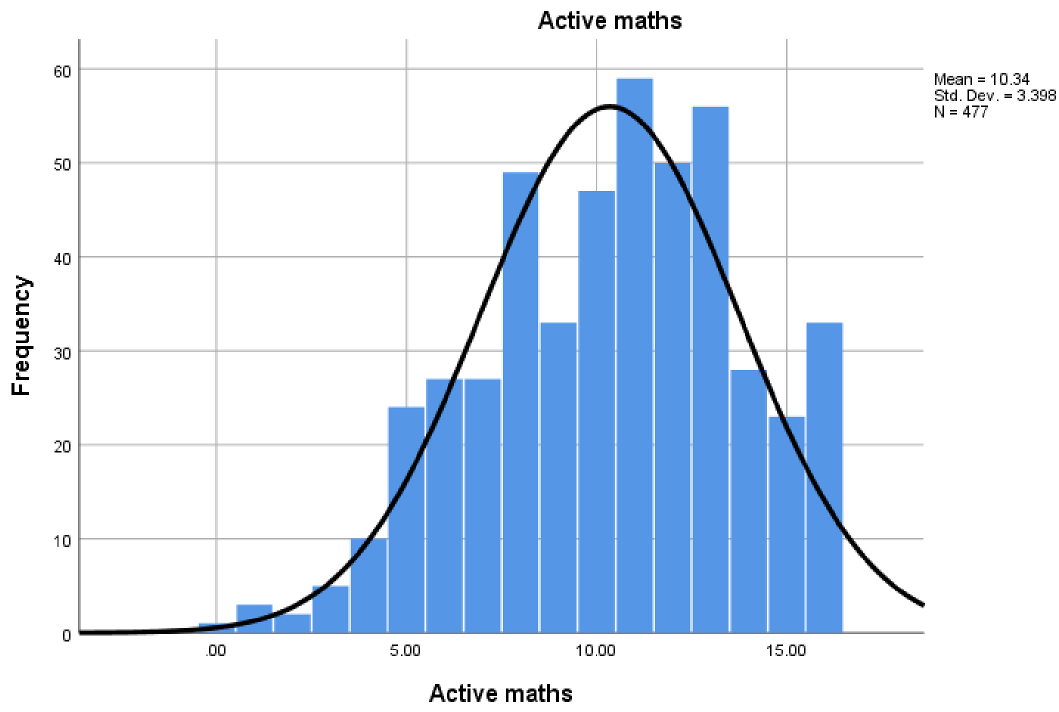
Pupil Behavioural Attitudes to Mathematics subscales

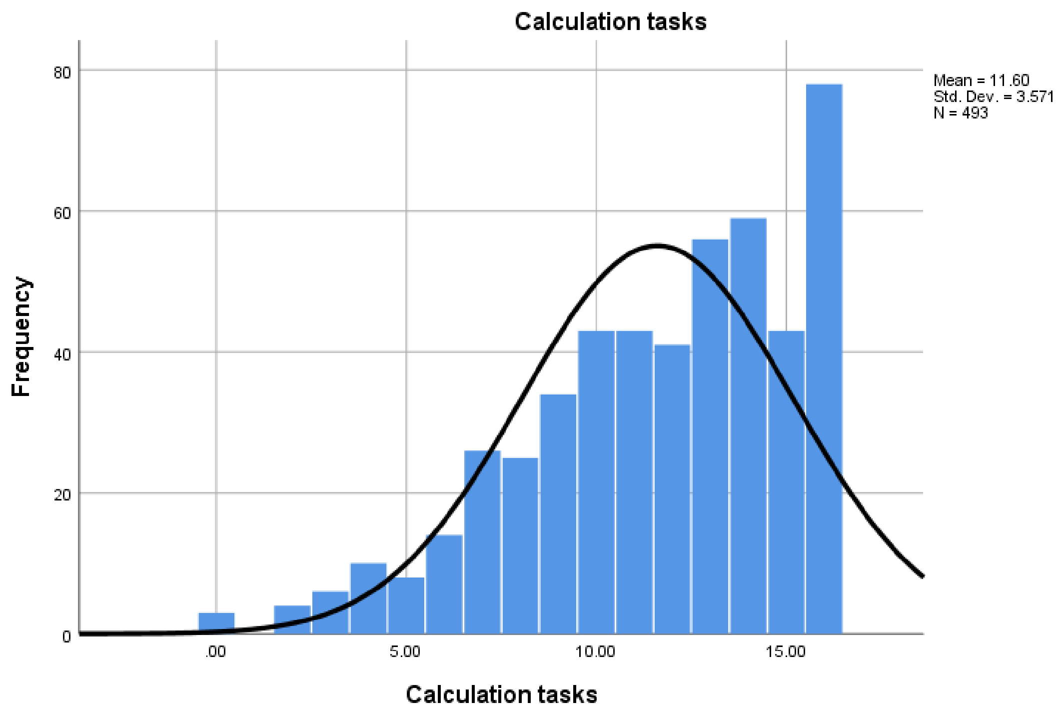
Statistics

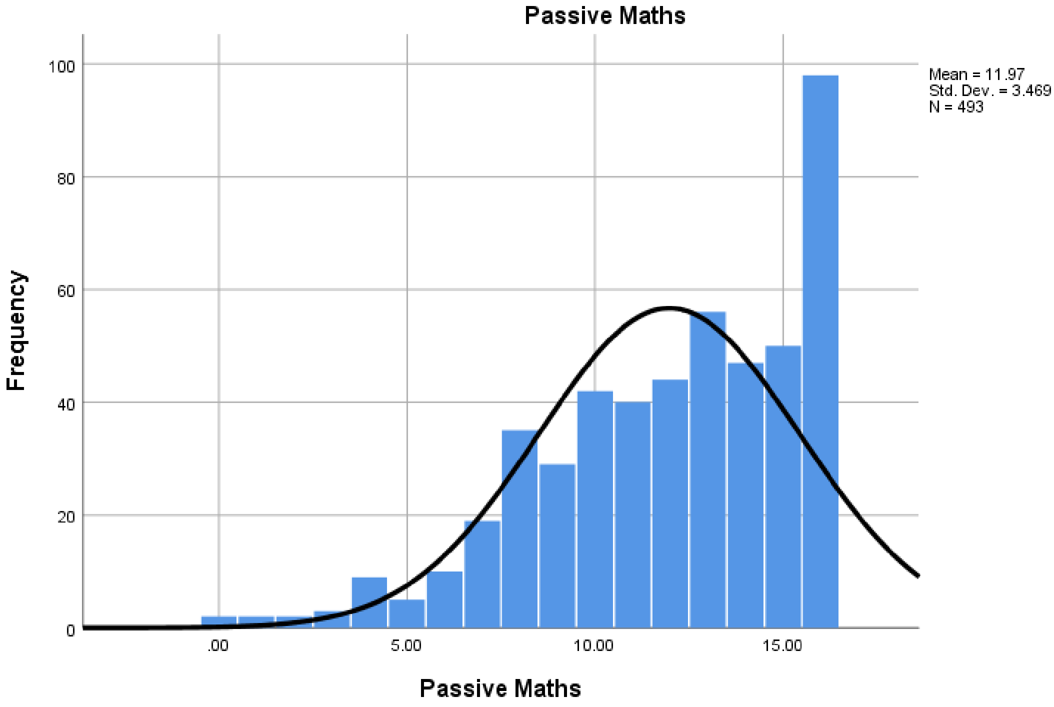
		Specific tasks	Maths in class	Active maths	Calculation tasks	Passive Maths
N	Valid	498	498	477	493	493
	Missing	10	10	31	15	15
Mean		5.9277	7.3333	10.3438	11.6024	11.9716
Median		6.0000	7.5000	11.0000	12.0000	13.0000
Mode		7.00	9.00	11.00	16.00	16.00
Std. Deviation		1.75650	3.17962	3.39847	3.57102	3.46868
Range		8.00	12.00	16.00	16.00	16.00
Minimum		.00	.00	.00	.00	.00
Maximum		8.00	12.00	16.00	16.00	16.00


Specific tasks
Mean = 5.93
Std. Dev. = 1.757
N = 498
Frequency
0
20
40
60
80
100
120
-2.00
.00
2.00
4.00
6.00
8.00
10.00
Specific tasks


Maths in class
Mean = 7.33
Std. Dev. = 3.18
N = 498
Frequency
0
20
40
60
-2.00
.00
2.00
4.00
6.00
8.00
10.00
12.00
Maths in class


Active maths
Mean = 10.34
Std. Dev. = 3.398
N = 477
Frequency
0
10
20
30
40
50
60
.00
5.00
10.00
15.00
Active maths


Calculation tasks
Mean = 11.60
Std. Dev. = 3.571
N = 493
Frequency
0
20
40
60
80
.00
5.00
10.00
15.00
Calculation tasks



School Frequencies

School ID Number

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	69	13.6	13.6	13.6
	2	57	11.2	11.2	24.8
	3	28	5.5	5.5	30.3
	4	47	9.3	9.3	39.6
	5	59	11.6	11.6	51.2
	6	28	5.5	5.5	56.7
	7	58	11.4	11.4	68.1
	9	55	10.8	10.8	78.9
	10	53	10.4	10.4	89.4
	11	54	10.6	10.6	100.0
	Total	508	100.0	100.0	

Percentage of pupils eligible for free school meals

% of free school meals

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.10	58	11.4	11.4	11.4
	4.60	47	9.3	9.3	20.7
	7.50	57	11.2	11.2	31.9
	12.70	55	10.8	10.8	42.7
	20.00	59	11.6	11.6	54.3
	20.90	54	10.6	10.6	65.0
	27.40	28	5.5	5.5	70.5
	28.50	53	10.4	10.4	80.9
	57.20	97	19.1	19.1	100.0
	Total	508	100.0	100.0	

School Index of multiple deprivation

School IMD Decile

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Deprived	182	35.8	35.8	35.8
	3	136	26.8	26.8	62.6
	5	57	11.2	11.2	73.8
	6	75	14.8	14.8	88.6
	7	58	11.4	11.4	100.0
	Total	508	100.0	100.0	

School maths progress score

Maths Progress Score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-4.00	28	5.5	5.5	5.5
	-2.00	59	11.6	11.6	17.1

	.10	55	10.8	10.8	28.0
	.30	57	11.2	11.2	39.2
	1.20	75	14.8	14.8	53.9
	1.50	69	13.6	13.6	67.5
	2.00	53	10.4	10.4	78.0
	2.50	54	10.6	10.6	88.6
	3.90	58	11.4	11.4	100.0
	Total	508	100.0	100.0	

School maths progress score 2

Maths Progress Score 2 (Average)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below Average	28	5.5	5.5	5.5
	Average	246	48.4	48.4	53.9
	Above Average	176	34.6	34.6	88.6
	Well Above Average	58	11.4	11.4	100.0
	Total	508	100.0	100.0	

School average score in maths

Average Score in Maths

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	101.00	28	5.5	5.5	5.5
	104.00	235	46.3	46.3	51.8
	105.00	134	26.4	26.4	78.1
	106.00	53	10.4	10.4	88.6
	109.00	58	11.4	11.4	100.0
	Total	508	100.0	100.0	

Crosstabulation – School ID and Ethnicity recoded

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ethnicity (White = 1 and BME = 0) * School ID Number	482	94.9%	26	5.1%	508	100.0%

Ethnicity (White = 1 and BME = 0) * School ID Number Crosstabulation

			School ID Number						
			1	2	3	4	5	6	7
Ethnicity (White = 1 and BME = 0)	BME	Count	6	2	8	3	30	1	[illegible]
		% within School ID Number	9.2%	3.6%	32.0%	6.4%	53.6%	3.7%	25.9
	White	Count	59	54	17	44	26	26	[illegible]
		% within School ID Number	90.8%	96.4%	68.0%	93.6%	46.4%	96.3%	74.1
Total		Count	65	56	25	47	56	27	[illegible]
		% within School ID Number	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0

Crosstabulation – School ID and Perecntage of Pupils Eligible for FSM

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
% of free school meals * School ID	508	100.0%	0	0.0%	508	100.0%

% of free school meals * School ID Crosstabulation

			School ID										
			1	2	3	4	5	6	7	9	10	11	Total
% of free school meals	3.10	Count	0	0	0	0	0	0	58	0	0	0	58
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	11.4%
	4.60	Count	0	0	0	47	0	0	0	0	0	0	47
		% within School ID	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
	7.50	Count	0	57	0	0	0	0	0	0	0	0	57
		% within School ID	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.2%
	12.70	Count	0	0	0	0	0	0	0	55	0	0	55
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	10.8%
	20.00	Count	0	0	0	0	59	0	0	0	0	0	59
		% within School ID	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.6%
	20.90	Count	0	0	0	0	0	0	0	0	0	54	54
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	10.6%
	27.40	Count	0	0	0	0	0	28	0	0	0	0	28
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	5.5%
	28.50	Count	0	0	0	0	0	0	0	0	53	0	53
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	10.4%
	57.20	Count	69	0	28	0	0	0	0	0	0	0	97
		% within School ID	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.1%
Total		Count	69	57	28	47	59	28	58	55	53	54	508
		% within School ID	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix B: Comparing the Sample to the National Average

One Sample T-Test for Sample Average FSM and National Average

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
% of free school meals	508	22.9463	18.56691	.82377

One-Sample Test

	Test Value = 13.7					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
% of free school meals	11.224	507	.000	9.24626	7.6278	10.8647

Crosstabulation – School ID and Average Score in Maths

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Average Score in Maths * School ID	508	100.0%	0	0.0%	508	100.0%

Average Score in Maths * School ID Crosstabulation

			School ID										
			1	2	3	4	5	6	7	9	10	11	Total
Average Score in Maths	101.00	Count	0	0	0	0	0	28	0	0	0	0	28
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	5.5%
	104.00	Count	69	57	0	0	0	0	0	55	0	54	235
		% within School ID	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	46.3%
	105.00	Count	0	0	28	47	59	0	0	0	0	0	134
		% within School ID	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	26.4%
	106.00	Count	0	0	0	0	0	0	0	0	53	0	53
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	10.4%
	109.00	Count	0	0	0	0	0	0	58	0	0	0	58
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	11.4%
Total		Count	69	57	28	47	59	28	58	55	53	54	508
		% within School ID	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

One Sample T-Test for sample average score in maths and national

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Average Score in Maths	508	104.8780	1.80752	.08020

One-Sample Test

	Test Value = 104					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Average Score in Maths	10.948	507	.000	.87795	.7204	1.0355

Crosstabulation – School ID and Maths Progression Score

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Maths Progress Score * School ID	508	100.0%	0	0.0%	508	100.0%

Maths Progress Score * School ID Crosstabulation

			School ID										
			1	2	3	4	5	6	7	9	10	11	Total
Maths Progress Score	-4.00	Count	0	0	0	0	0	28	0	0	0	0	28
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	5.5%
	-2.00	Count	0	0	0	0	59	0	0	0	0	0	59
		% within School ID	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.6%
	.10	Count	0	0	0	0	0	0	0	55	0	0	55
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	10.8%
	.30	Count	0	57	0	0	0	0	0	0	0	0	57
		% within School ID	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.2%
	1.20	Count	0	0	28	47	0	0	0	0	0	0	75
		% within School ID	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.8%
	1.50	Count	69	0	0	0	0	0	0	0	0	0	69
		% within School ID	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.6%
	2.00	Count	0	0	0	0	0	0	0	0	53	0	53
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	10.4%
	2.50	Count	0	0	0	0	0	0	0	0	0	54	54
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	10.6%
	3.90	Count	0	0	0	0	0	0	58	0	0	0	58
		% within School ID	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	11.4%
Total		Count	69	57	28	47	59	28	58	55	53	54	508
		% within School ID	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

One sample T-Test for sample average maths progression score and national average

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Maths Progress Score	508	.8923	1.97625	.08768

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Maths Progress Score	10.177	507	.000	.89232	.7201	1.0646

Teacher Characteristics

Teacher Gender

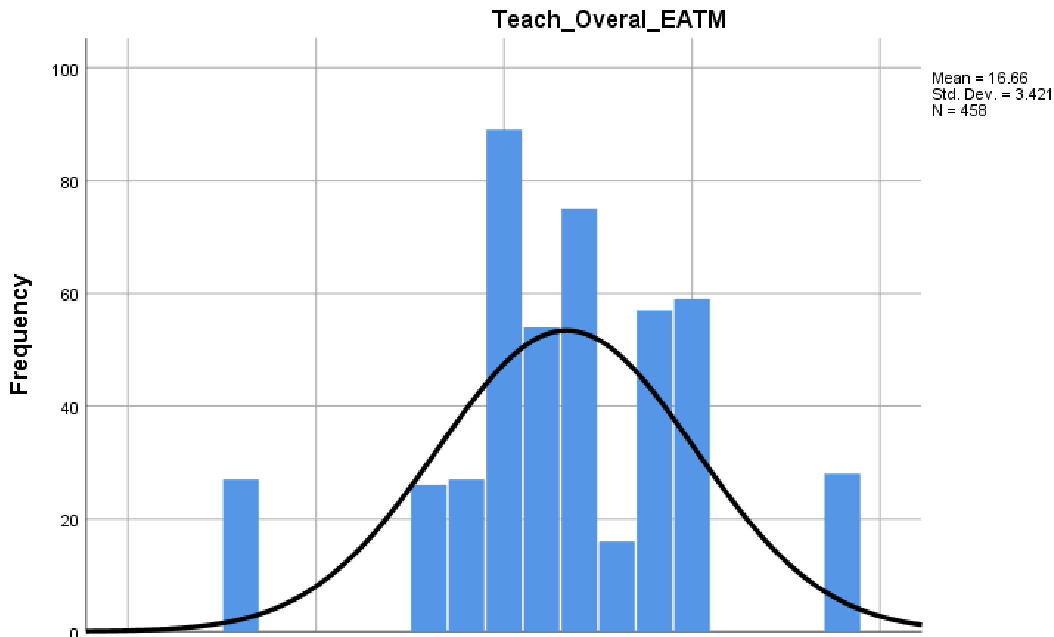
Teacher Gender

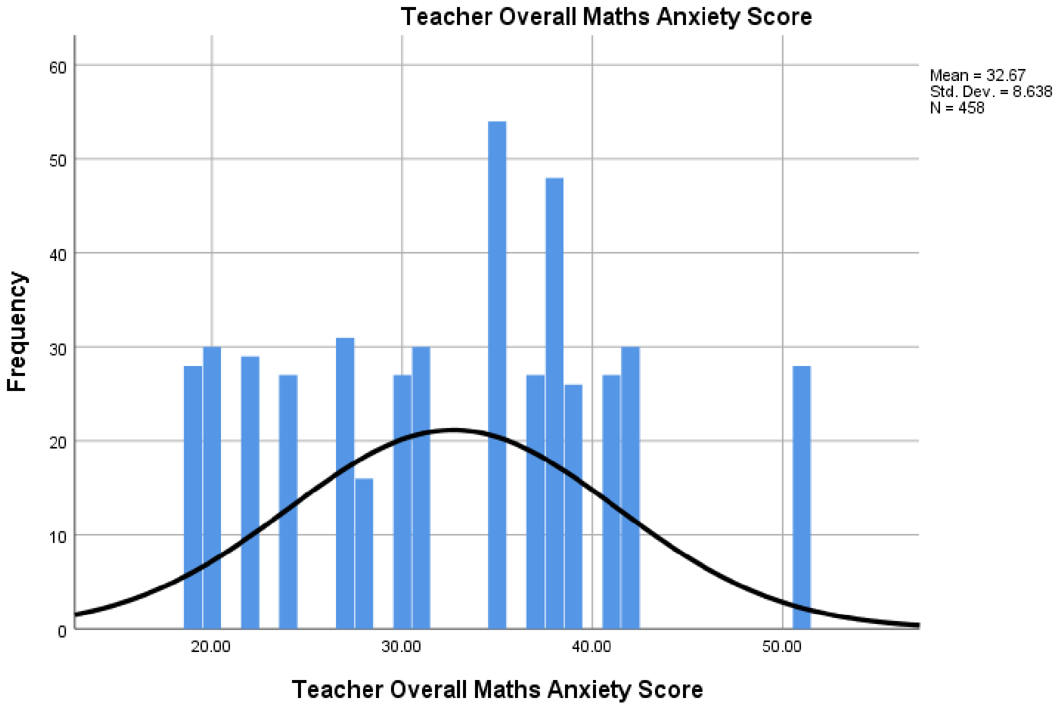
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	77	15.2	15.2	15.2
	Female	431	84.8	84.8	100.0
	Total	508	100.0	100.0	

Teacher Attitudinal Measures

Statistics

		Teacher Overall Maths Anxiety Score	Teach_Overal_EATM
N	Valid	458	458
	Missing	50	50
Mean		32.6747	16.6572
Median		35.0000	17.0000
Mode		35.00	15.00
Std. Deviation		8.63793	3.42126
Range		32.00	16.00
Minimum		19.00	8.00
Maximum		51.00	24.00





Teacher Confidence

Teacher I am good at maths

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	87	17.1	19.0	19.0
	Agree	206	40.6	45.0	64.0
	Not Sure	135	26.6	29.5	93.4
	Disagree	30	5.9	6.6	100.0
	Total	458	90.2	100.0	
Missing	-99.00	22	4.3		

		Frequency	Percent	Valid Percent	Cumulative Percent
	System	28	5.5		
	Total	50	9.8		
Total		508	100.0		

Teacher Motivation

Teacher: I do maths at home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	87	17.1	19.0	19.0
	Agree	261	51.4	57.0	76.0
	Disagree	110	21.7	24.0	100.0
	Total	458	90.2	100.0	
Missing	-99.00	22	4.3		
	System	28	5.5		
	Total	50	9.8		
Total		508	100.0		

Teacher confidence in teaching maths

Teacher: I believe I am good at teaching maths

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	87	17.1	19.0	19.0
	Agree	317	62.4	69.2	88.2
	Not Sure	54	10.6	11.8	100.0
	Total	458	90.2	100.0	
Missing	-99.00	22	4.3		
	System	28	5.5		
	Total	50	9.8		
Total		508	100.0		

Appendix C: Reliability Analysis, Factor Analysis and Average Variance Extracted Calculations

Reliability analysis

BAM Sub Scale 2

Reliability Statistics

Cronbach's Alpha	N of Items
.704	3

BAM Sub Scale 3

Reliability Statistics

Cronbach's Alpha	N of Items
.627	4

BAM Sub Scale 4

Reliability Statistics

Cronbach's Alpha	N of Items
.708	4

BAM Sub Scale 5

Reliability Statistics

Cronbach's Alpha	N of Items
.747	4

Pupil BAM Whole Scale

Reliability Statistics

Cronbach's Alpha	N of Items
.894	17

Pupil EAM Whole Scale

Reliability Statistics

Cronbach's Alpha	N of Items
.827	6

Exploratory Factor Analysis of BAM

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.924
Bartlett's Test of Sphericity	Approx. Chi-Square	2499.220
	df	136
	Sig.	.000

Communalities

	Initial	Extraction
Having a teacher watch you multiply 4x3 on paper	1.000	.414
Being asked to add up the number of people in a room	1.000	.349
Being asked to write an answer on the board in front of your class	1.000	.463
Being asked to calculate £10 divided by four in front of your teacher	1.000	.528
Being asked a maths question by a teacher in front of your class	1.000	.546
Taking a maths test	1.000	.476
Being asked to calculate a percentage	1.000	.402
Working out how much time you have left before you set off to school	1.000	.427
Deciding how many sweets each friend can have if you are all sharing	1.000	.632
Calclulating with a pencil on paper	1.000	.573
Adding up a pile of change	1.000	.453
Calculating how many days until somebodys birthday	1.000	.448

Working out how much change you should have after buying sweets	1.000	.528
Listening to someone talk about maths	1.000	.629
Watching someone multiply a one-digit number by a two-digit number	1.000	.518
Sitting in a maths class	1.000	.580
Watching the teacher doing times table on the board	1.000	.653

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.339	37.288	37.288	6.339	37.288	37.288	5.691
2	1.242	7.307	44.595	1.242	7.307	44.595	4.244
3	1.037	6.099	50.693	1.037	6.099	50.693	1.465
4	.978	5.750	56.444				
5	.867	5.100	61.544				
6	.745	4.381	65.925				
7	.705	4.146	70.071				
8	.649	3.820	73.891				
9	.623	3.663	77.554				
10	.608	3.576	81.130				
11	.558	3.285	84.414				
12	.536	3.153	87.568				
13	.505	2.972	90.539				
14	.451	2.655	93.194				
15	.436	2.562	95.757				
16	.387	2.275	98.031				
17	.335	1.969	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix[a]

	Component		
	1	2	3
Having a teacher watch you multiply 4x3 on paper	.599		
Being asked to add up the number of people in a room	.550		
Being asked to write an answer on the board in front of your class	.597		
Being asked to calculate £10 divided by four in front of your teacher	.647		
Being asked a maths question by a teacher in front of your class	.703		
Taking a maths test	.680		
Being asked to calculate a percentage	.567		
Working out how much time you have left before you set off to school	.614		
Deciding how many sweets each friend can have if you are all sharing	.430		.666
Calclulating with a pencil on paper	.648		
Adding up a pile of change	.625		
Calculating how many days until somebodys birthday	.526		.413
Working out how much change you should have after buying sweets	.653		
Listening to someone talk about maths	.629	.481	
Watching someone multiply a one-digit number by a two-digit number	.592		
Sitting in a maths class	.711		
Watching the teacher doing times table on the board	.545	.596	

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Exploratory Factor Analysis of BAM Sub Scales

S2

Factor Analysis

Correlation Matrix

		Being asked to write an answer on the board in front of your class	Being asked to calculate £10 divided by four in front of your teacher	Being asked a maths question by a teacher in front of your class
Correlation	Being asked to write an answer on the board in front of your class	1.000	.380	.508
	Being asked to calculate £10 divided by four in front of your teacher	.380	1.000	.440
	Being asked a maths question by a teacher in front of your class	.508	.440	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.661
Bartlett's Test of Sphericity	Approx. Chi-Square	275.214
	df	3
	Sig.	.000

Communalities

	Initial	Extraction
Being asked to write an answer on the board in front of your class	1.000	.635
Being asked to calculate £10 divided by four in front of your teacher	1.000	.566
Being asked a maths question by a teacher in front of your class	1.000	.687

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.888	62.924	62.924	1.888	62.924	62.924
2	.630	20.994	83.918			
3	.482	16.082	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component 1
Being asked to write an answer on the board in front of your class	.797
Being asked to calculate £10 divided by four in front of your teacher	.752
Being asked a maths question by a teacher in front of your class	.829

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

S3

Correlation Matrix

		Taking a maths test	Being asked to calculate a percentage	Working out how much time you have left before you set off to school	Deciding how many sweets each friend can have if you are all sharing
Correlation	Taking a maths test	1.000	.356	.363	.232
	Being asked to calculate a percentage	.356	1.000	.304	.223
	Working out how much time you have left before you set off to school	.363	.304	1.000	.284
	Deciding how many sweets each friend can have if you are all sharing	.232	.223	.284	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.701
Bartlett's Test of Sphericity	Approx. Chi-Square	207.012
	df	6
	Sig.	.000

Communalities

	Initial	Extraction
Taking a maths test	1.000	.628
Being asked to calculate a percentage	1.000	.606
Working out how much time you have left before you set off to school	1.000	.527
Deciding how many sweets each friend can have if you are all sharing	1.000	.939

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	1.888	47.202	47.202	1.888	47.202	47.202	1.749
2	.811	20.277	67.479	.811	20.277	67.479	1.234
3	.685	17.119	84.598				
4	.616	15.402	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix[a]

	Component 1	Component 2
Taking a maths test	.729	-.310
Being asked to calculate a percentage	.690	-.360
Working out how much time you have left before you set off to school	.725	.027
Deciding how many sweets each friend can have if you are all sharing	.595	.764

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

S4

Correlation Matrix

		Calclulating with a pencil on paper	Adding up a pile of change	Calculating how many days until somebodys birthday	Working out how much change you should have after buying sweets
Correlation	Calclulating with a pencil on paper	1.000	.394	.279	.374
	Adding up a pile of change	.394	1.000	.397	.513
	Calculating how many days until somebodys birthday	.279	.397	1.000	.303
	Working out how much change you should have after buying sweets	.374	.513	.303	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.730
Bartlett's Test of Sphericity	Approx. Chi-Square	354.967
	df	6
	Sig.	.000

Communalities

	Initial	Extraction
Calclulating with a pencil on paper	1.000	.635
Adding up a pile of change	1.000	.655
Calculating how many days until somebodys birthday	1.000	.944
Working out how much change you should have after buying sweets	1.000	.644

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.140	53.505	53.505	2.140	53.505	53.505	1.964
2	.737	18.427	71.933	.737	18.427	71.933	1.360
3	.651	16.269	88.202				
4	.472	11.798	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix[a]

	Component	
	1	2
Calclulating with a pencil on paper	.689	-.399
Adding up a pile of change	.809	-.007
Calculating how many days until somebodys birthday	.653	.719
Working out how much change you should have after buying sweets	.764	-.247

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

S5

Correlation Matrix

		Listening to someone talk about maths	Watching someone multiply a one-digit number by a two-digit number	Sitting in a maths class	Watching the teacher doing times table on the board
Correlation	Listening to someone talk about maths	1.000	.433	.486	.484
	Watching someone multiply a one-digit number by a two-digit number	.433	1.000	.352	.406
	Sitting in a maths class	.486	.352	1.000	.408
	Watching the teacher doing times table on the board	.484	.406	.408	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.766
Bartlett's Test of Sphericity	Approx. Chi-Square	430.060
	df	6
	Sig.	.000

Communalities

	Initial	Extraction
Listening to someone talk about maths	1.000	.649
Watching someone multiply a one-digit number by a two-digit number	1.000	.509
Sitting in a maths class	1.000	.548
Watching the teacher doing times table on the board	1.000	.581

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.288	57.203	57.203	2.288	57.203	57.203
2	.654	16.352	73.555			
3	.574	14.348	87.903			
4	.484	12.097	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Listening to someone talk about maths	.806
Watching someone multiply a one-digit number by a two-digit number	.714
Sitting in a maths class	.740
Watching the teacher doing times table on the board	.762

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

CFA of EAM

Correlation Matrix

		I like Maths	I think Maths is important	I think Maths is easy	I enjoy Maths when I am in class	I do not like Maths	I think Maths is hard
Correlation	I like Maths	1.000	.385	.552	.730	.665	.388
	I think Maths is important	.385	1.000	.282	.387	.336	.190
	I think Maths is easy	.552	.282	1.000	.419	.381	.635
	I enjoy Maths when I am in class	.730	.387	.419	1.000	.598	.308
	I do not like Maths	.665	.336	.381	.598	1.000	.430
	I think Maths is hard	.388	.190	.635	.308	.430	1.000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.767
Bartlett's Test of Sphericity	Approx. Chi-Square	1212.795
	df	15
	Sig.	.000

Communalities

	Initial	Extraction
I like Maths	1.000	.752
I think Maths is important	1.000	.296
I think Maths is easy	1.000	.544
I enjoy Maths when I am in class	1.000	.640
I do not like Maths	1.000	.622
I think Maths is hard	1.000	.428

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component 1
I like Maths	.867
I think Maths is important	.544
I think Maths is easy	.737
I enjoy Maths when I am in class	.800
I do not like Maths	.789
I think Maths is hard	.654

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Average Variance Extracted Calculations for BAM Sub Scales

K8 =F14/4

	A	B	C	D	E	F	G	H	I	J	K
1	BAM Sub Scale Factor Analyses									AVE	
2	BAM SS2	BAM SS2^2			BAM SS4	^2				S2	0.629318
3	0.797	0.635209			0.689	0.474721					
4	0.752	0.565504			0.809	0.654481				S3	0.471798
5	0.829	0.687241			0.653	0.426409					
6	2.378	1.887954			0.764	0.583696				S4	0.534827
7					2.915	2.139307					
8	BAM SS3	^2								S5	0.571919
9	0.729	0.531441			BAM SS5	^2					
10	0.69	0.4761			0.806	0.649636					
11	0.725	0.525625			0.714	0.509796					
12	0.595	0.354025			0.74	0.5476					
13	2.739	1.887191			0.762	0.580644					
14					3.022	2.287676					
15											
16											
17											
18											

Average Variance Extracted Calculations for BAM Whole Scale and EAM

I4 | f_x =E9/I3

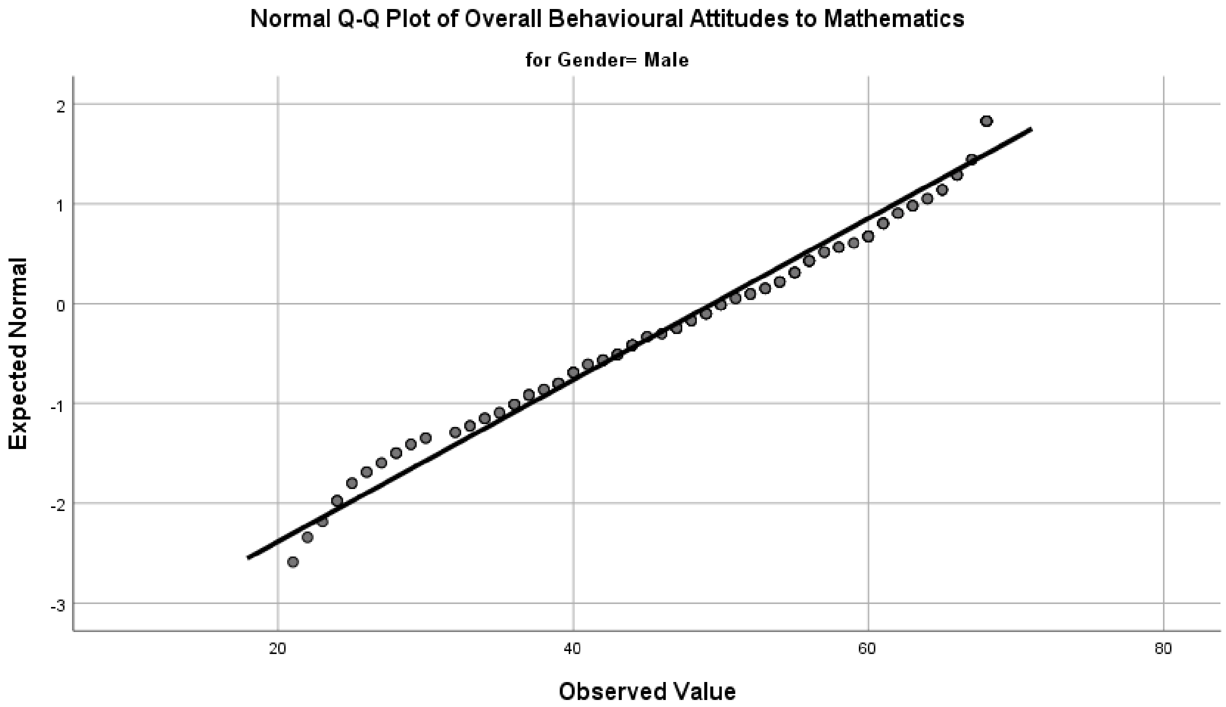
	A	B	C	D	E	F	G	H	I
1	BAM Factor Loadings				EAM Factor Loadings			AVE Calculations	
2	BAM	BAM2		EAM	EAM2	E		EAM	
3	0.599	0.358801		0.867	0.751689	0.248311		N	6
4	0.55	0.3025		0.544	0.295936	0.704064		AVE	0.5468385
5	0.597	0.356409		0.737	0.543169	0.456831			
6	0.647	0.418609		0.8	0.64	0.36		BAM	
7	0.703	0.494209		0.789	0.622521	0.377479		N	17
8	0.68	0.4624		0.654	0.427716	0.572284		AVE	0.372857529
9	0.567	0.321489		4.391	3.281031	-2.28103			
10	0.614	0.376996							
11	0.43	0.1849							
12	0.648	0.419904							
13	0.625	0.390625							
14	0.526	0.276676							
15	0.653	0.426409							
16	0.629	0.395641							
17	0.592	0.350464							
18	0.711	0.505521							
19	0.545	0.297025							
20	10.316	6.338578							

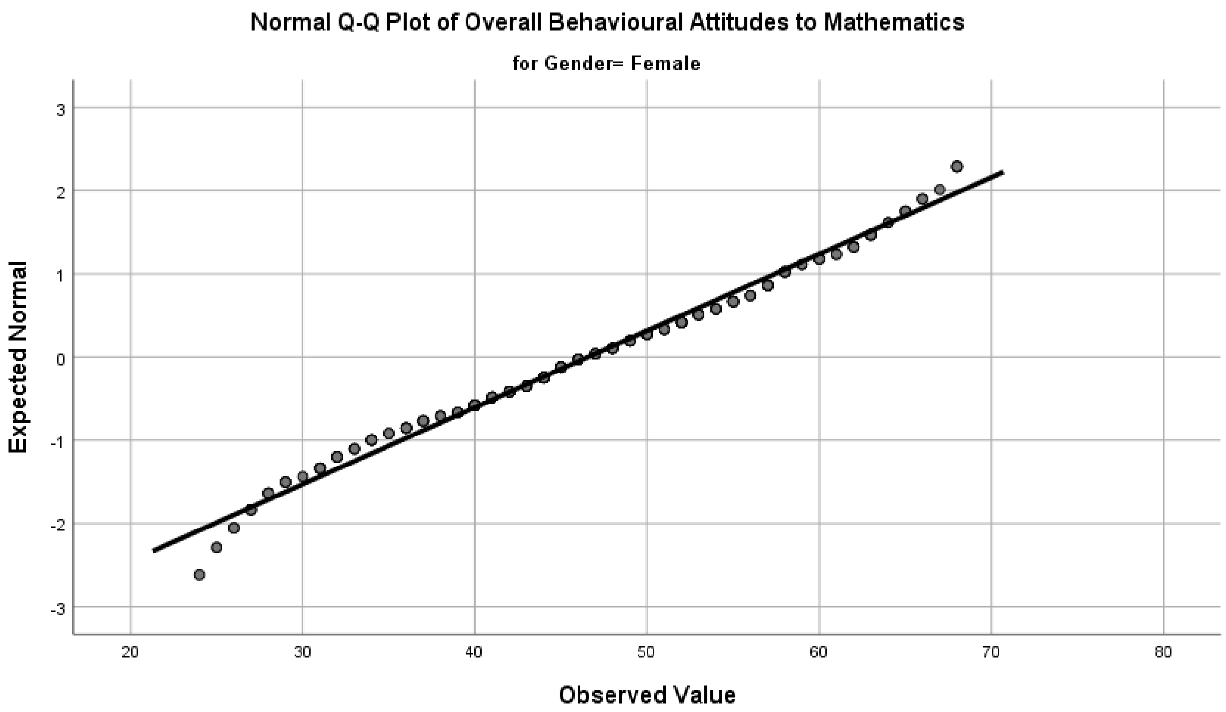
Appendix D: Bivariate Analysis for All Independent Variables and BAM

Descriptives

	Pupil Gender			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Male	Mean		49.4541	.85906
		95% Confidence Interval for Mean	Lower Bound	47.7604	
			Upper Bound	51.1478	
		5% Trimmed Mean		49.8323	
		Median		50.0000	
		Variance		152.764	
		Std. Deviation		12.35976	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		20.00	
		Skewness		-.325	.169
		Kurtosis		-.772	.337
	Female	Mean		46.5733	.72294
		95% Confidence Interval for Mean	Lower Bound	45.1487	
			Upper Bound	47.9980	
		5% Trimmed Mean		46.5975	
		Median		46.0000	
		Variance		117.594	

	Std. Deviation	10.84407	
	Minimum	24.00	
	Maximum	68.00	
	Range	44.00	
	Interquartile Range	16.00	
	Skewness	-.059	.162
	Kurtosis	-.802	.323

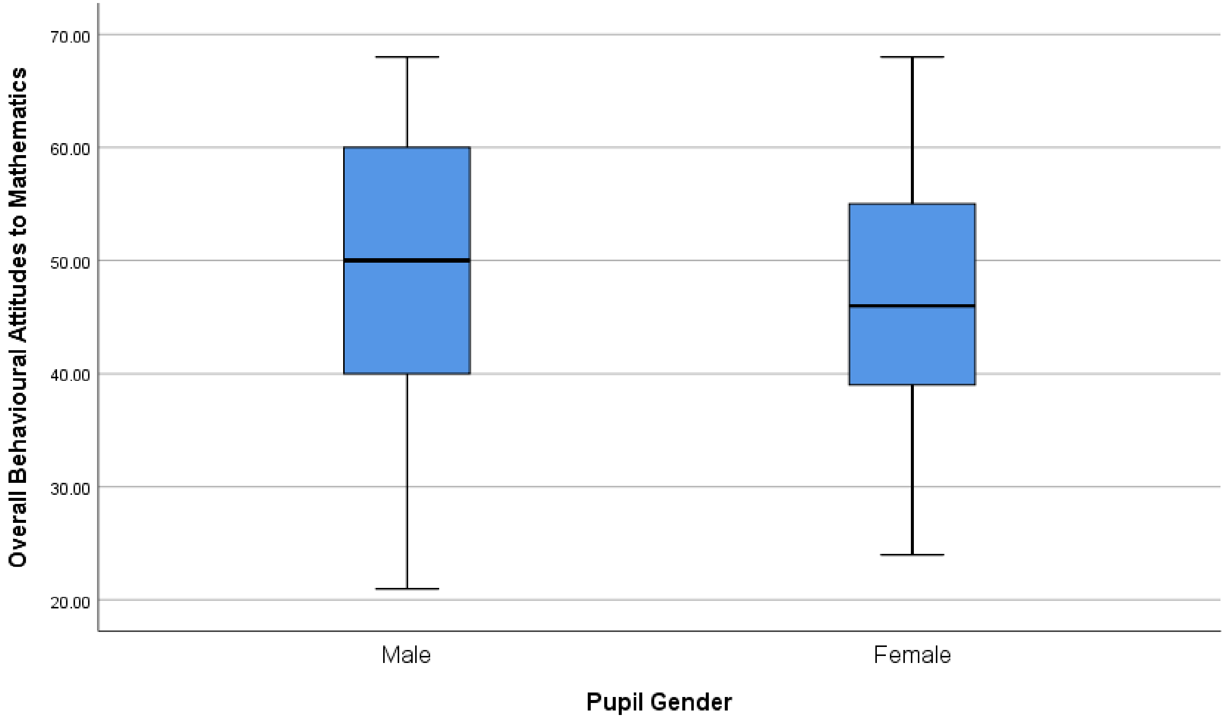



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gender= Female
Expected Normal
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
80
Observed Value

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Male	207	49.4541	12.35976	.85906	47.7604	51.1478	21.00	68.00
Female	225	46.5733	10.84407	.72294	45.1487	47.9980	24.00	68.00
Total	432	47.9537	11.67076	.56151	46.8501	49.0573	21.00	68.00



Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	4.696	1	430	.031
	Based on Median	4.473	1	430	.035
	Based on Median and with adjusted df	4.473	1	424.241	.035
	Based on trimmed mean	4.524	1	430	.034

Ranks

	Pupil Gender	N	Mean Rank	Sum of Ranks
Overall Behavioural Attitudes to Mathematics	Male	207	233.26	48284.00
	Female	225	201.08	45244.00
	Total	432		

Test Statistics[a]

	Overall Behavioural Attitudes to Mathematics
Mann-Whitney U	19819.000
Wilcoxon W	45244.000
Z	-2.677
Asymp. Sig. (2-tailed)	.007

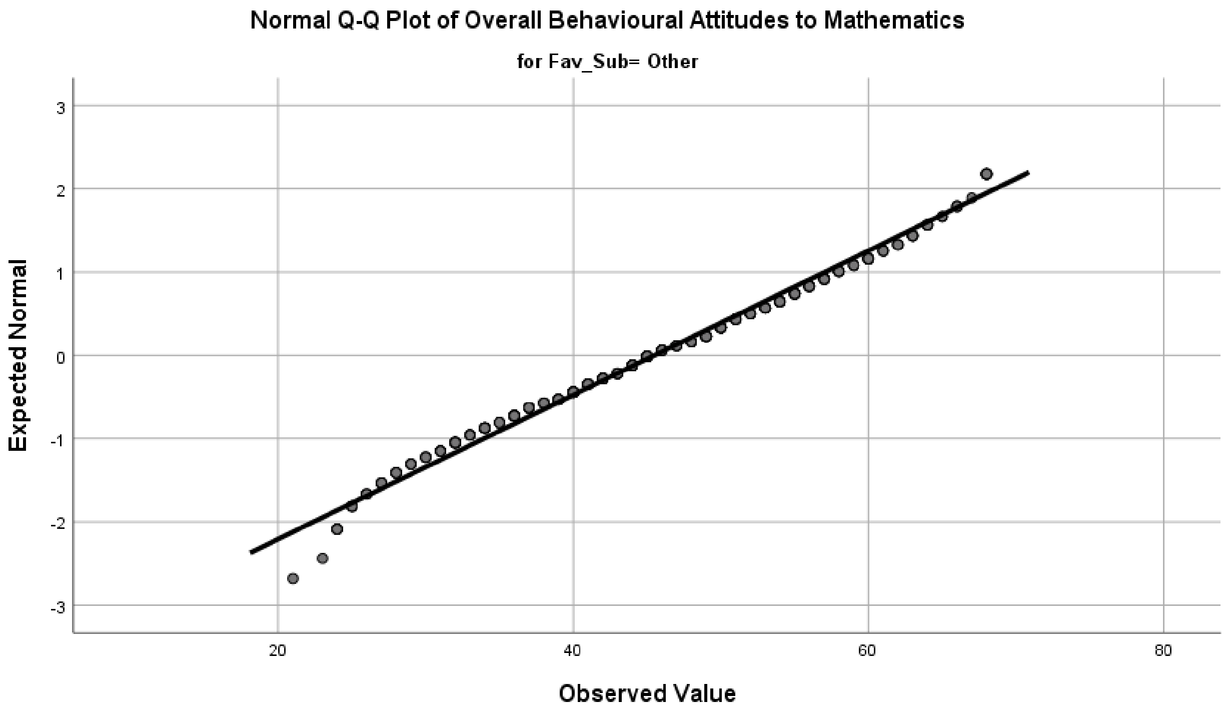
a. Grouping Variable: Pupil Gender

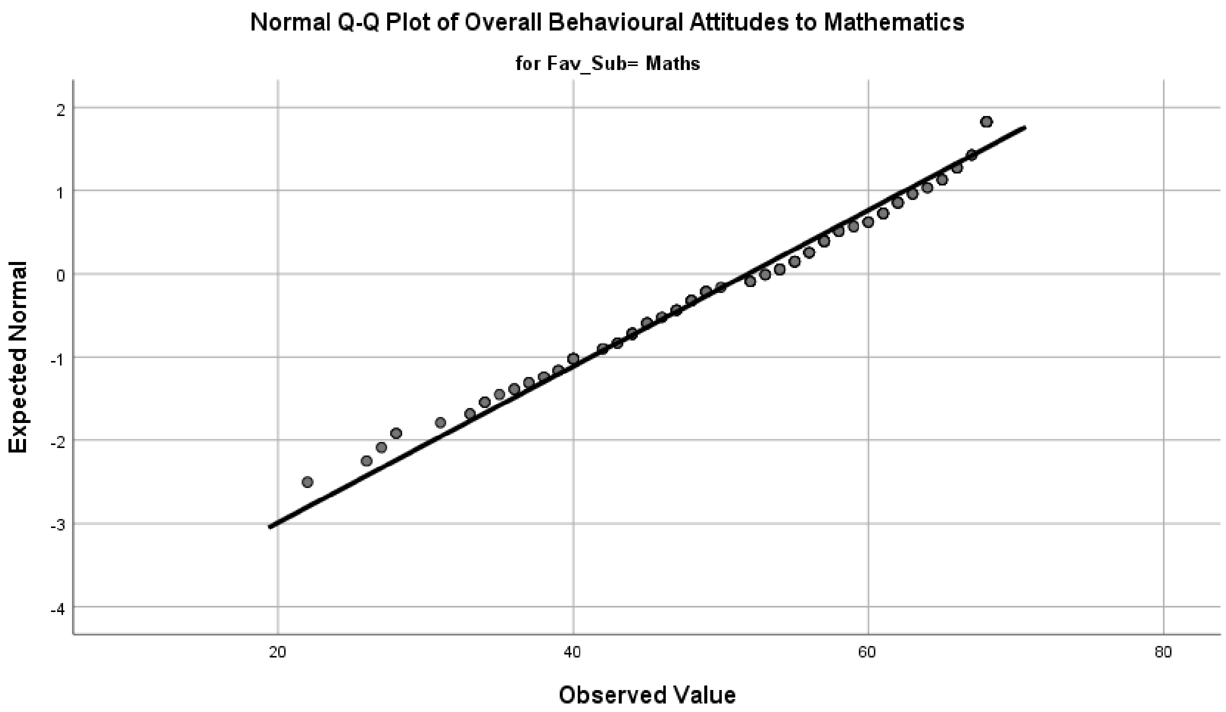
Favourite Subject and BA

Descriptives

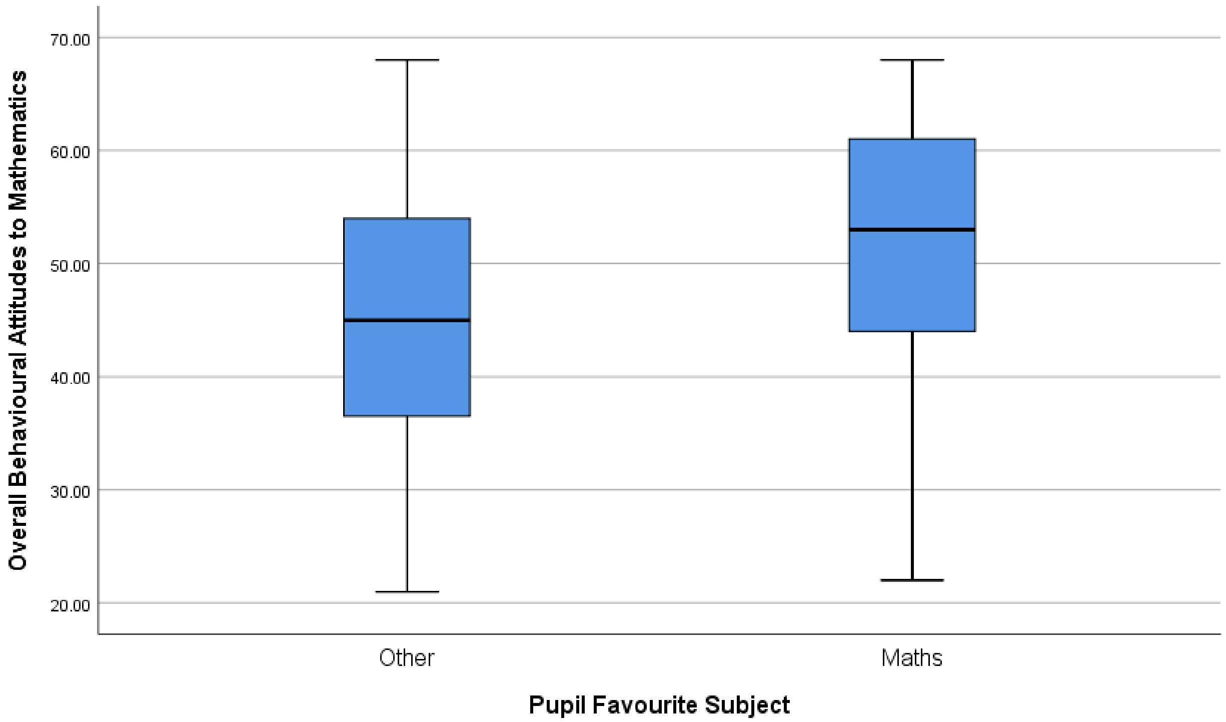
	Pupil Favourite Subject			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Other	Mean		45.4982	.70145
		95% Confidence Interval for Mean	Lower Bound	44.1172	
			Upper Bound	46.8792	
		5% Trimmed Mean		45.4815	
		Median		45.0000	
		Variance		133.340	
		Std. Deviation		11.54729	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.00	
		Skewness		-.007	.148
		Kurtosis		-.816	.295
	Maths	Mean		51.8457	.83693
		95% Confidence Interval for Mean	Lower Bound	50.1929	
			Upper Bound	53.4985	
		5% Trimmed Mean		52.2414	
		Median		53.0000	
		Variance		113.473	

	Std. Deviation	10.65237	
	Minimum	22.00	
	Maximum	68.00	
	Range	46.00	
	Interquartile Range	17.00	
	Skewness	-.396	.191
	Kurtosis	-.475	.379





Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Fav_Sub= Maths
Expected Normal
2
1
0
-1
-2
-3
-4
20
40
60
80
Observed Value



Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Other	271	45.4982	11.54729	.70145	44.1172	46.8792	21.00	68.00
Maths	162	51.8457	10.65237	.83693	50.1929	53.4985	22.00	68.00
Total	433	47.8730	11.62254	.55854	46.7752	48.9708	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	1.424	1	431	.233
	Based on Median	1.520	1	431	.218
	Based on Median and with adjusted df	1.520	1	429.545	.218
	Based on trimmed mean	1.513	1	431	.219

Group Statistics

	Pupil Favourite Subject	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	Other	271	45.4982	11.54729	.70145
	Maths	162	51.8457	10.65237	.83693

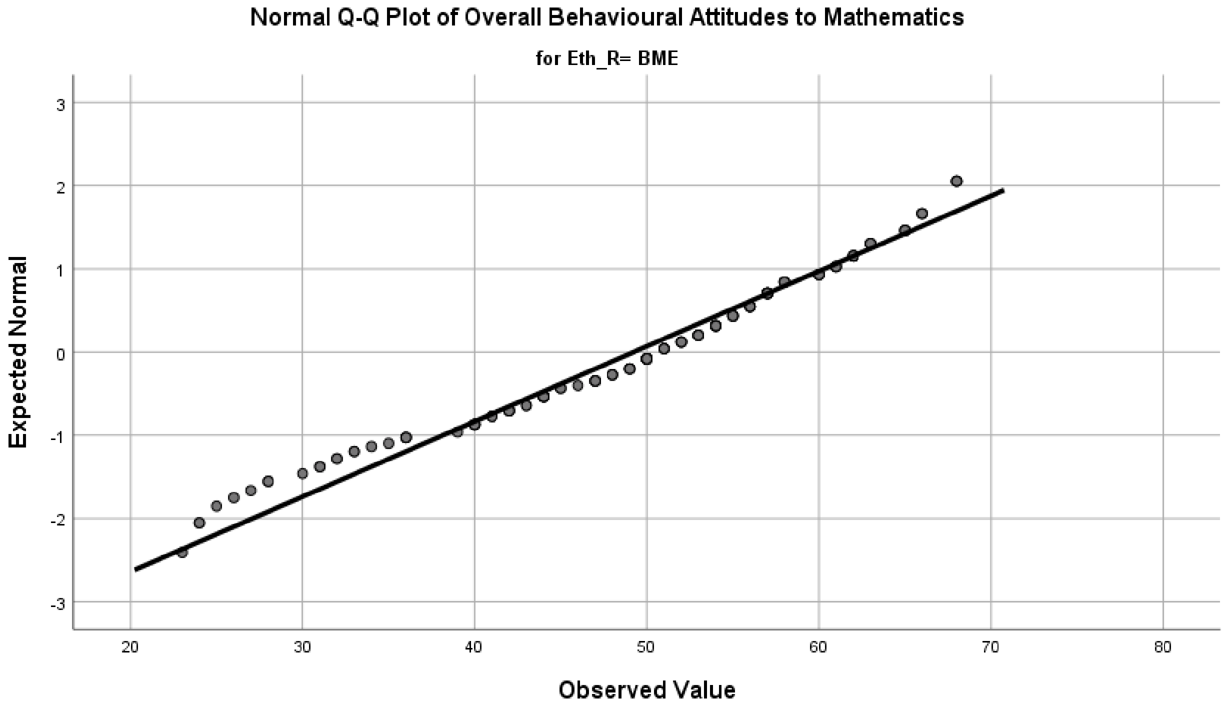
Independent Samples Test

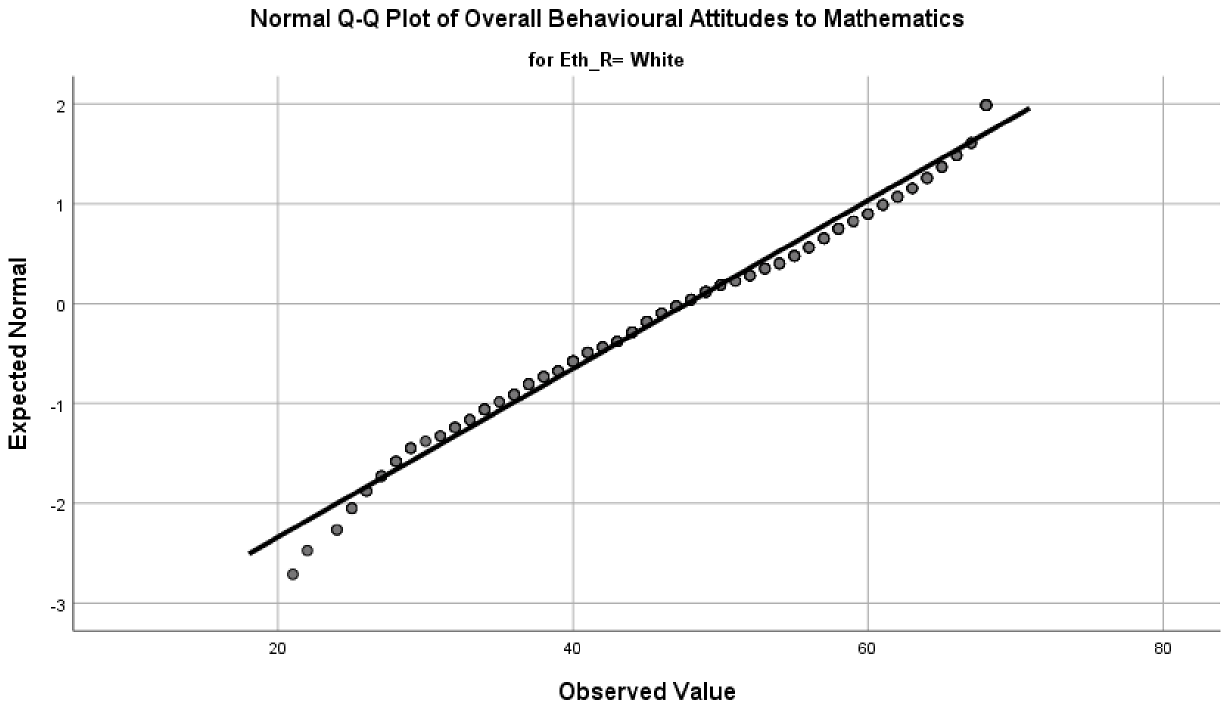
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	1.424	.233	-5.696	431	.000	-6.34752	1.11441	-8.53789	-4.15716
	Equal variances not assumed			-5.813	360.546	.000	-6.34752	1.09201	-8.49503	-4.20002

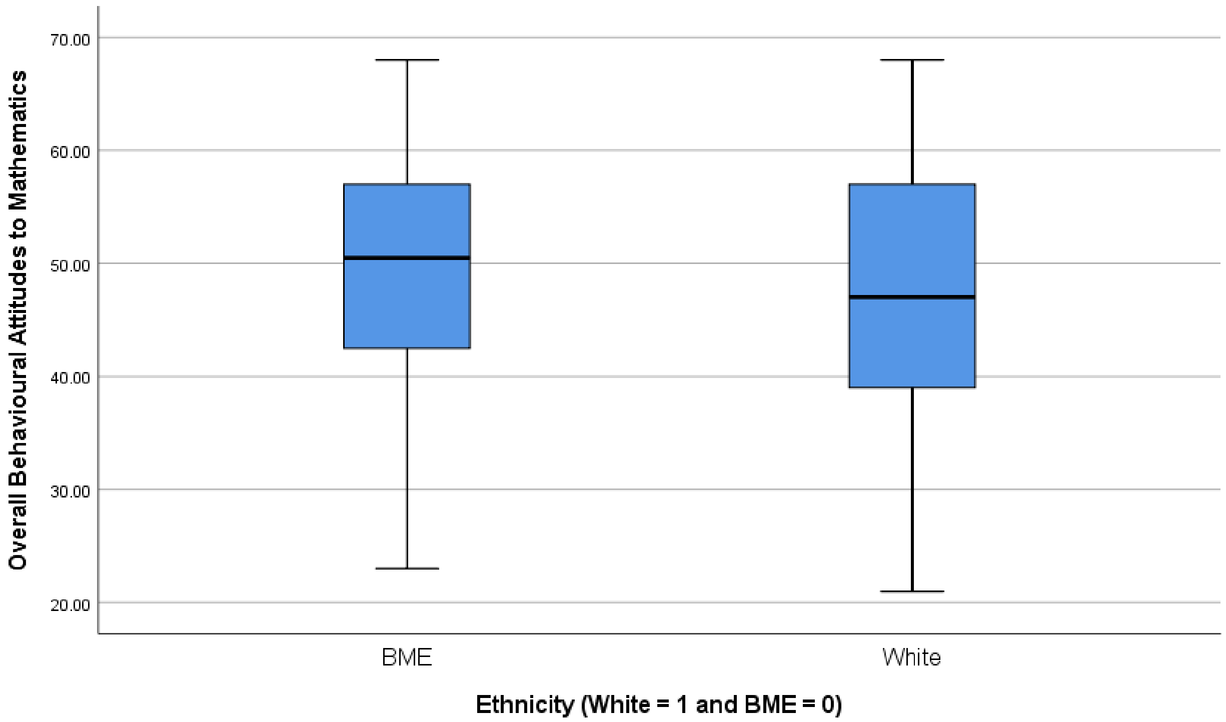
Ethnicity and BA

Descriptives

	Ethnicity (White = 1 and BME = 0)			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	BME	Mean		49.2339	.99402
		95% Confidence Interval for Mean	Lower Bound	47.2663	
			Upper Bound	51.2015	
		5% Trimmed Mean		49.5806	
		Median		50.5000	
		Variance		122.522	
		Std. Deviation		11.06897	
		Minimum		23.00	
		Maximum		68.00	
		Range		45.00	
		Interquartile Range		14.75	
		Skewness		-.496	.217
		Kurtosis		-.344	.431
	White	Mean		47.7374	.68822
		95% Confidence Interval for Mean	Lower Bound	46.3829	
			Upper Bound	49.0918	
		5% Trimmed Mean		47.8648	
		Median		47.0000	
		Variance		140.674	
		Std. Deviation		11.86061	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.00	
		Skewness		-.085	.141
		Kurtosis		-.882	.282


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Eth_R= BME
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Eth_R= White
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
40
60
80


70.00
60.00
50.00
40.00
30.00
20.00
Overall Behavioural Attitudes to Mathematics
BME
White
Ethnicity (White = 1 and BME = 0)

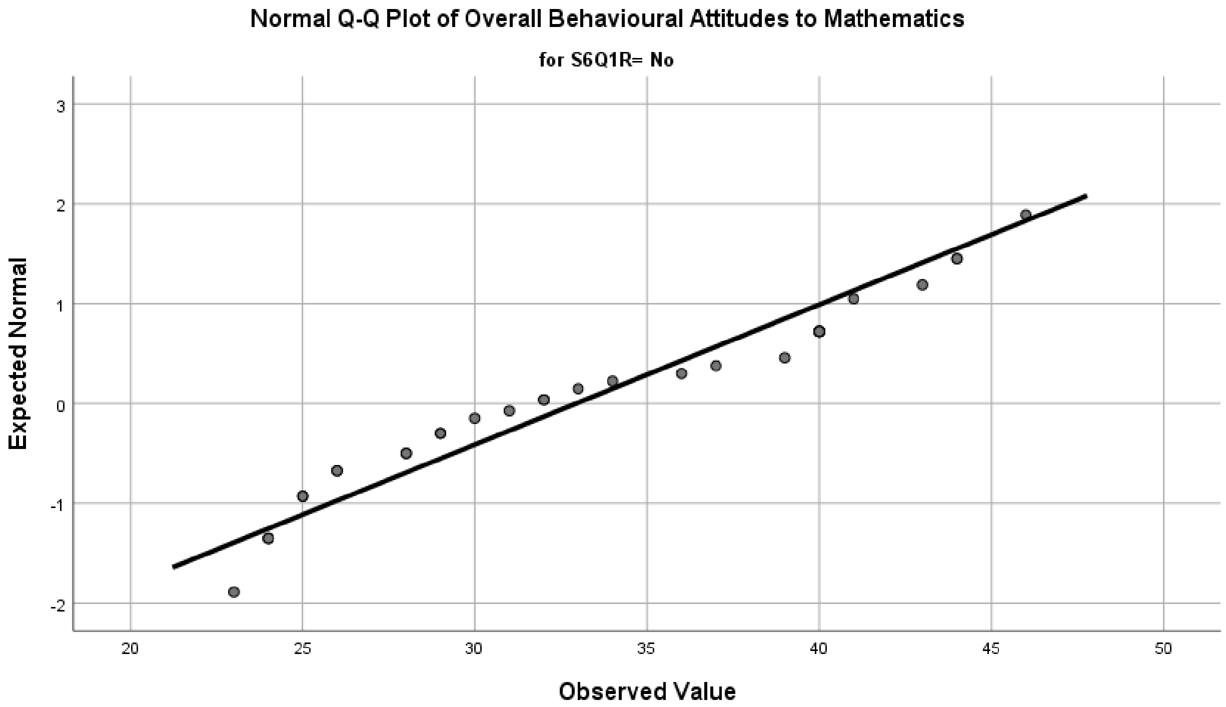
Group Statistics

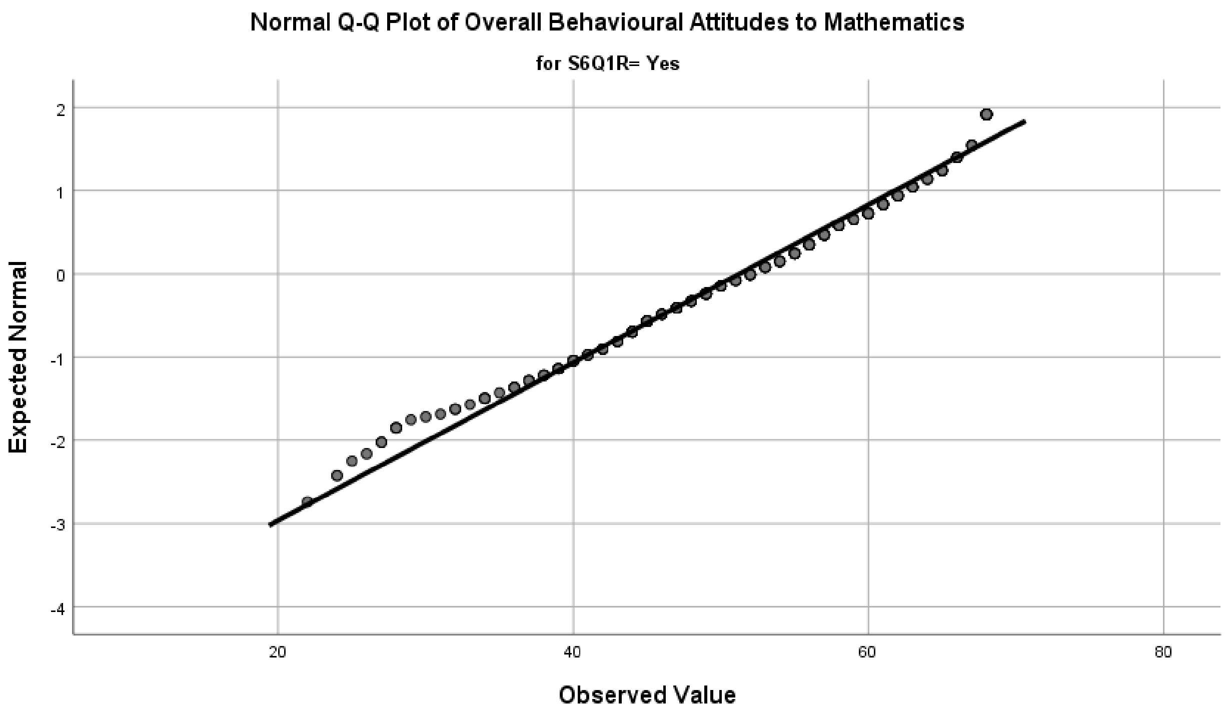
	Ethnicity (White = 1 and BME = 0)	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	BME	124	49.2339	11.06897	.99402
	White	297	47.7374	11.86061	.68822

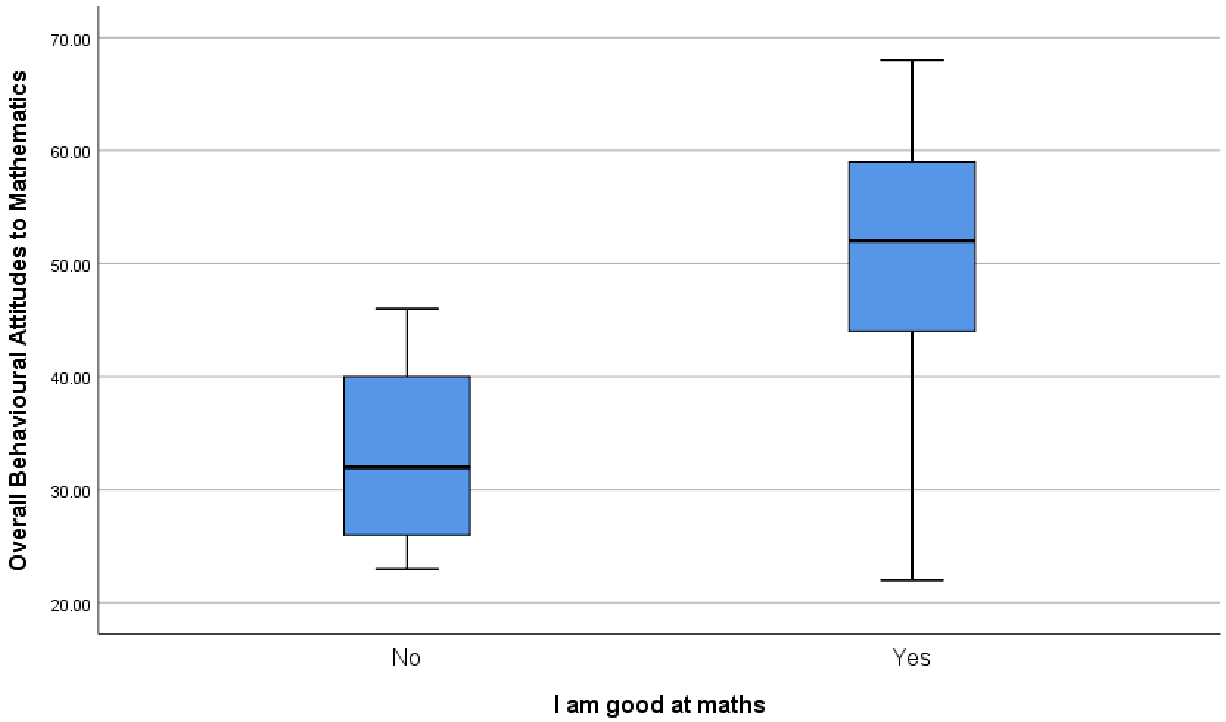
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	2.432	.120	1.203	419	.230	1.49650	1.24387	-.94850	3.94149
	Equal variances not assumed			1.238	245.724	.217	1.49650	1.20902	-.88487	3.87786

I am good at maths and BA




Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for S6Q1R= Yes
Expected Normal
2
1
0
-1
-2
-3
-4
20
40
60
80
Observed Value



Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	5.080	1	357	.025
	Based on Median	5.092	1	357	.025
	Based on Median and with adjusted df	5.092	1	343.211	.025

	Based on trimmed mean	4.988	1	357	.026

Ranks

	I am good at maths	N	Mean Rank	Sum of Ranks
Overall Behavioural Attitudes to Mathematics	No	33	44.47	1467.50
	Yes	326	193.72	63152.50
	Total	359		

Test Statistics[a]

	Overall Behavioural Attitudes to Mathematics
Mann-Whitney U	906.500
Wilcoxon W	1467.500
Z	-7.876
Asymp. Sig. (2-tailed)	.000

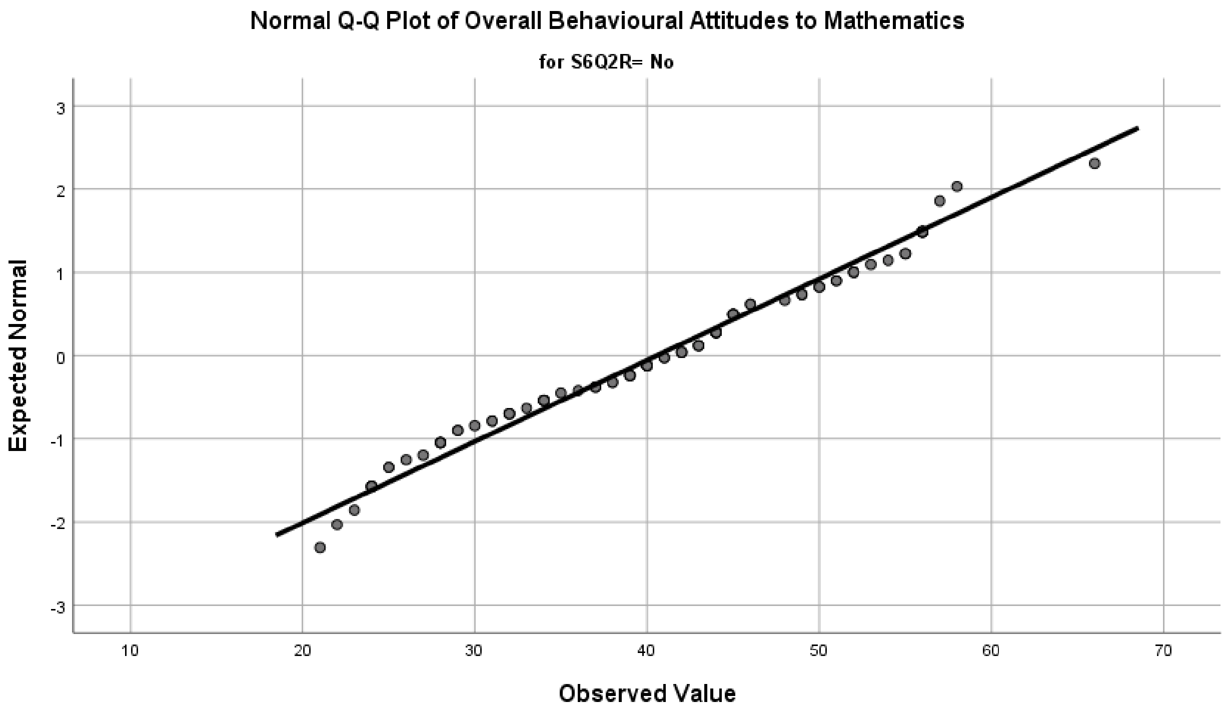
a. Grouping Variable: I am good at maths

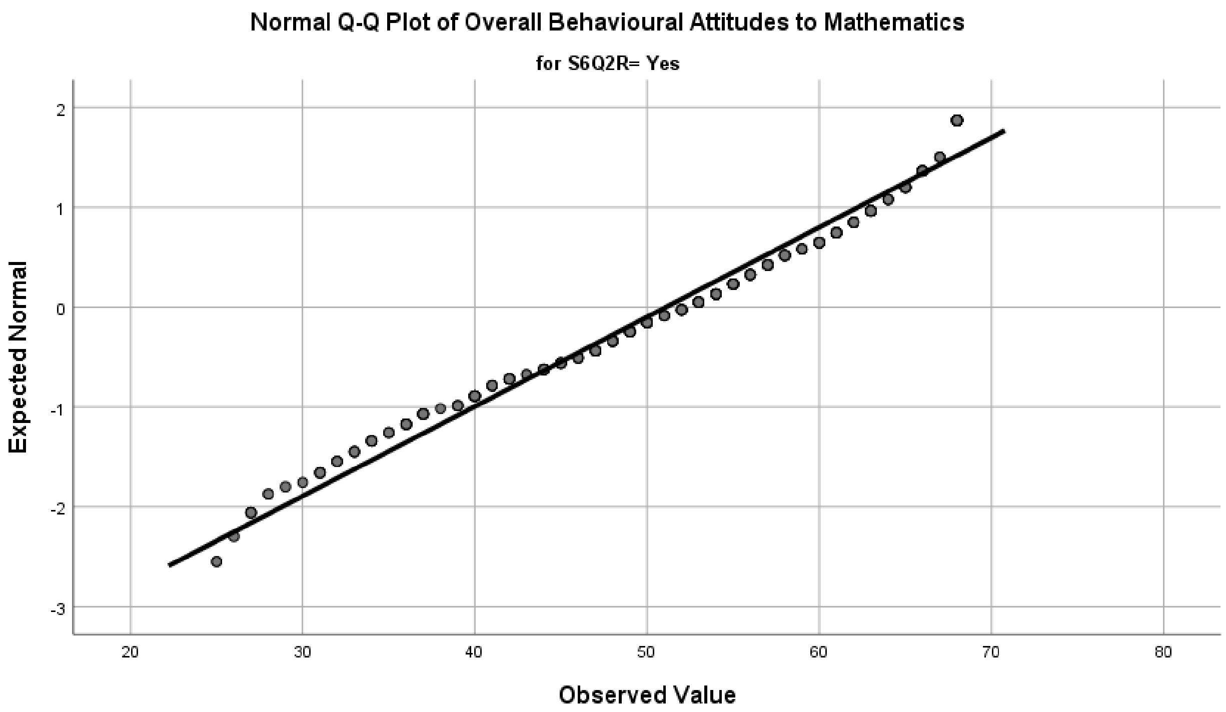
Maths at home and BA

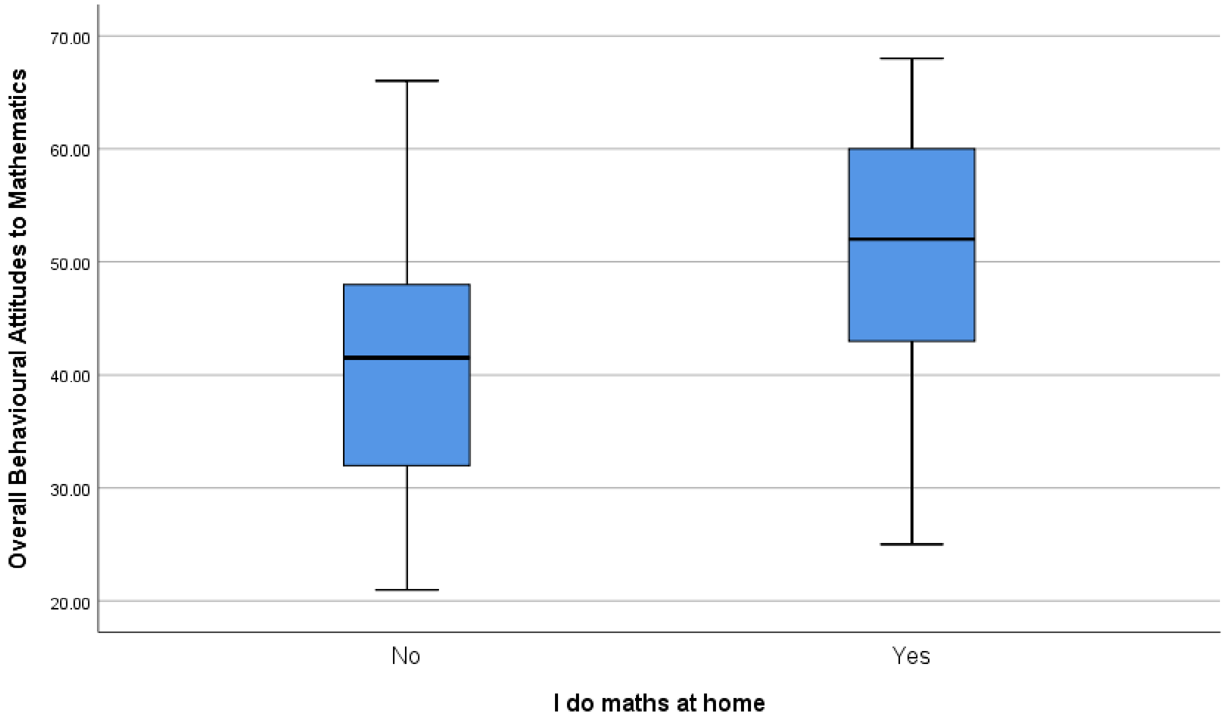
Descriptives

	I do maths at home			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	No	Mean		40.5638	1.05484
		95% Confidence Interval for Mean	Lower Bound	38.4691	
			Upper Bound	42.6585	
		5% Trimmed Mean		40.5437	
		Median		41.5000	
		Variance		104.593	
		Std. Deviation		10.22706	
		Minimum		21.00	
		Maximum		66.00	
		Range		45.00	
		Interquartile Range		16.25	
		Skewness		-.001	.249
		Kurtosis		-.729	.493
	Yes	Mean		51.0939	.66949
		95% Confidence Interval for Mean	Lower Bound	49.7759	
			Upper Bound	52.4118	
		5% Trimmed Mean		51.4394	
		Median		52.0000	
		Variance		124.158	
		Std. Deviation		11.14261	
		Minimum		25.00	
		Maximum		68.00	

	Range	43.00	
	Interquartile Range	17.00	
	Skewness	-.373	.146
	Kurtosis	-.725	.292




Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for S6Q2R= Yes
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


70.00
60.00
50.00
40.00
30.00
20.00
Overall Behavioural Attitudes to Mathematics
No
Yes
I do maths at home

Group Statistics

	I do maths at home	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	No	94	40.5638	10.22706	1.05484
	Yes	277	51.0939	11.14261	.66949

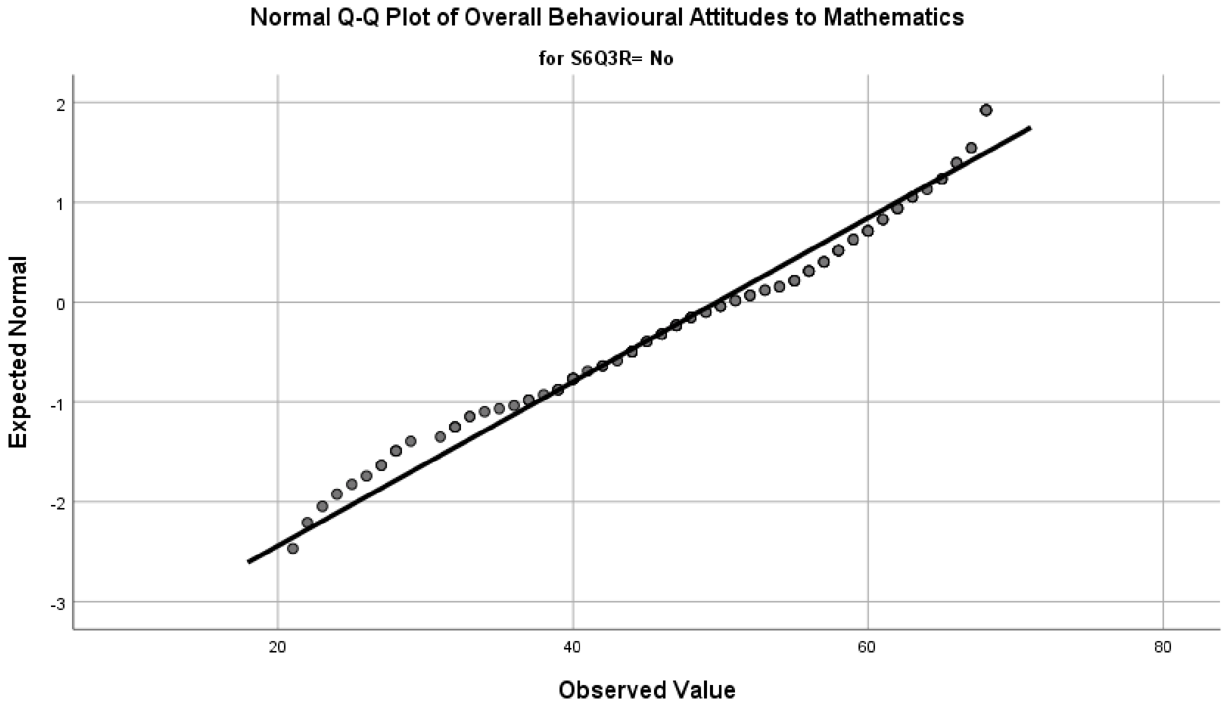
Independent Samples Test

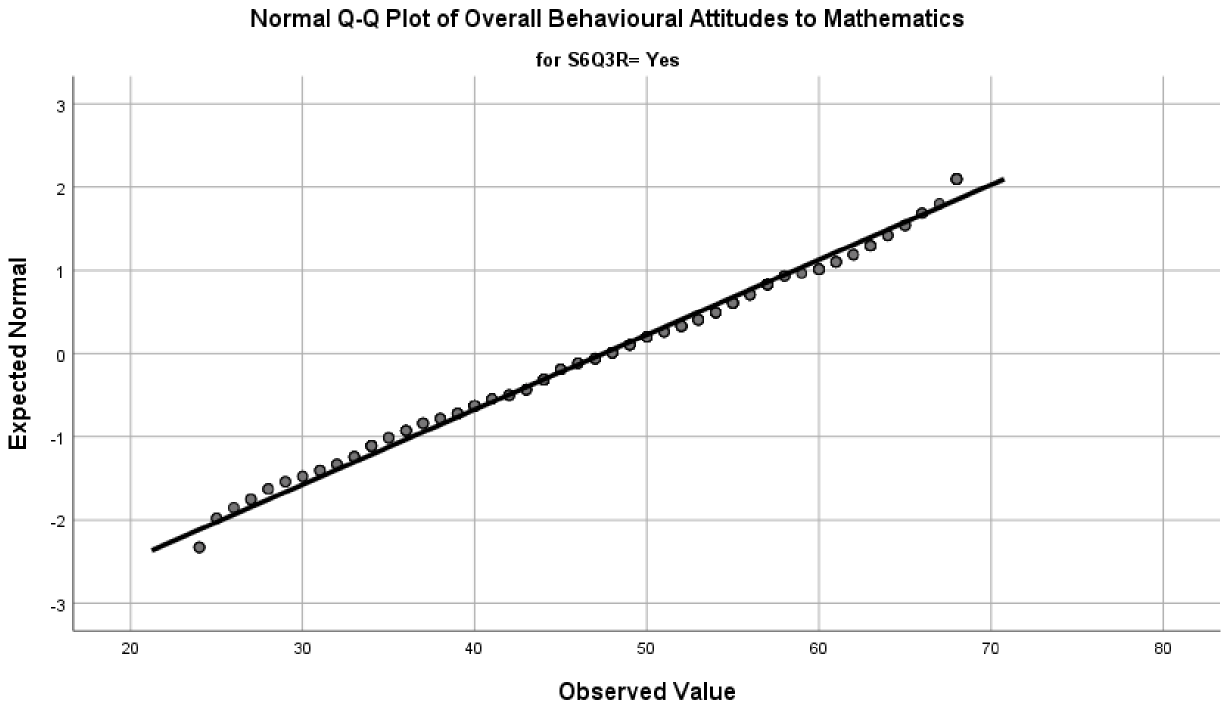
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	1.430	.233	-8.079	369	.000	-10.53003	1.30338	-13.09301	-7.96705
	Equal variances not assumed			-8.428	173.529	.000	-10.53003	1.24936	-12.99594	-8.06413

Parental help and BA

Descriptives

	Parents help			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	No	Mean		49.7329	1.00848
		95% Confidence Interval for Mean	Lower Bound	47.7397	
			Upper Bound	51.7261	
		5% Trimmed Mean		50.1431	
		Median		50.5000	
		Variance		148.487	
		Std. Deviation		12.18551	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.25	
		Skewness		-.429	.201
		Kurtosis		-.667	.399
	Yes	Mean		47.4840	.70202
		95% Confidence Interval for Mean	Lower Bound	46.1014	
			Upper Bound	48.8666	
		5% Trimmed Mean		47.5956	
		Median		48.0000	
		Variance		123.207	
		Std. Deviation		11.09985	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		16.00	
		Skewness		-.110	.154
		Kurtosis		-.710	.307


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for S6Q3R= No
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for S6Q3R= Yes
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
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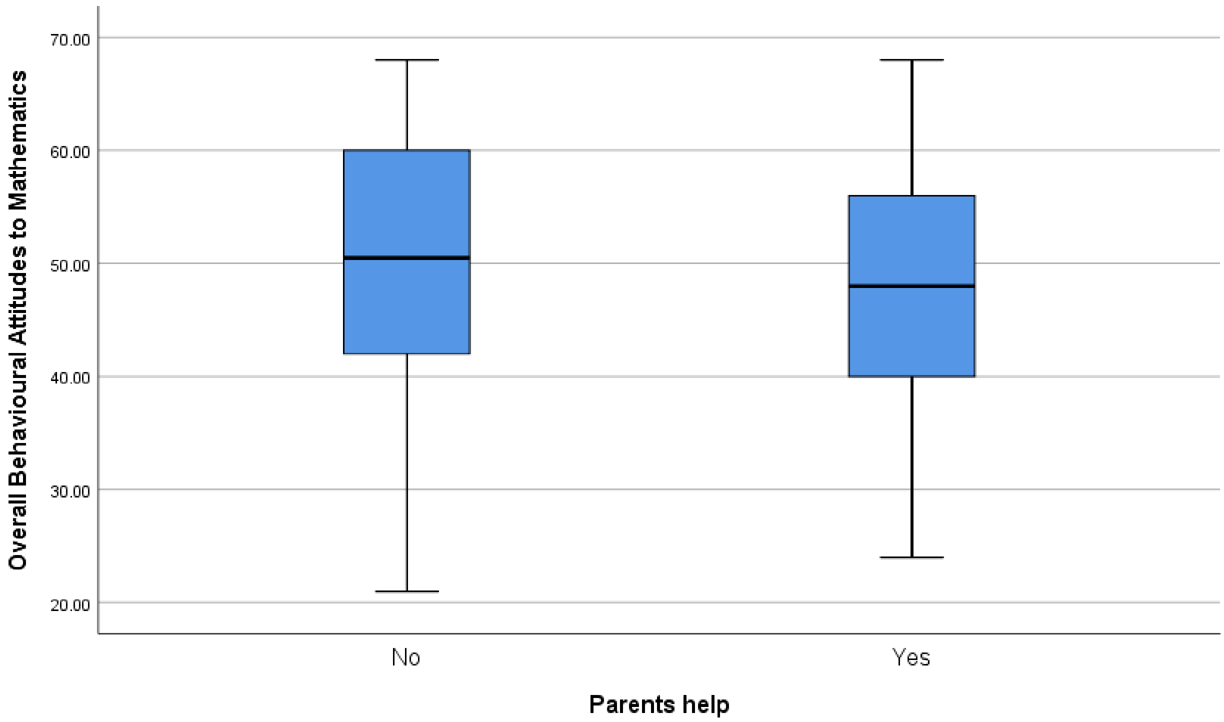
40
50
60
70
80


70.00
60.00
50.00
40.00
30.00
20.00
Overall Behavioural Attitudes to Mathematics
No
Yes
Parents help

Group Statistics

	Parents help	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	No	146	49.7329	12.18551	1.00848
	Yes	250	47.4840	11.09985	.70202

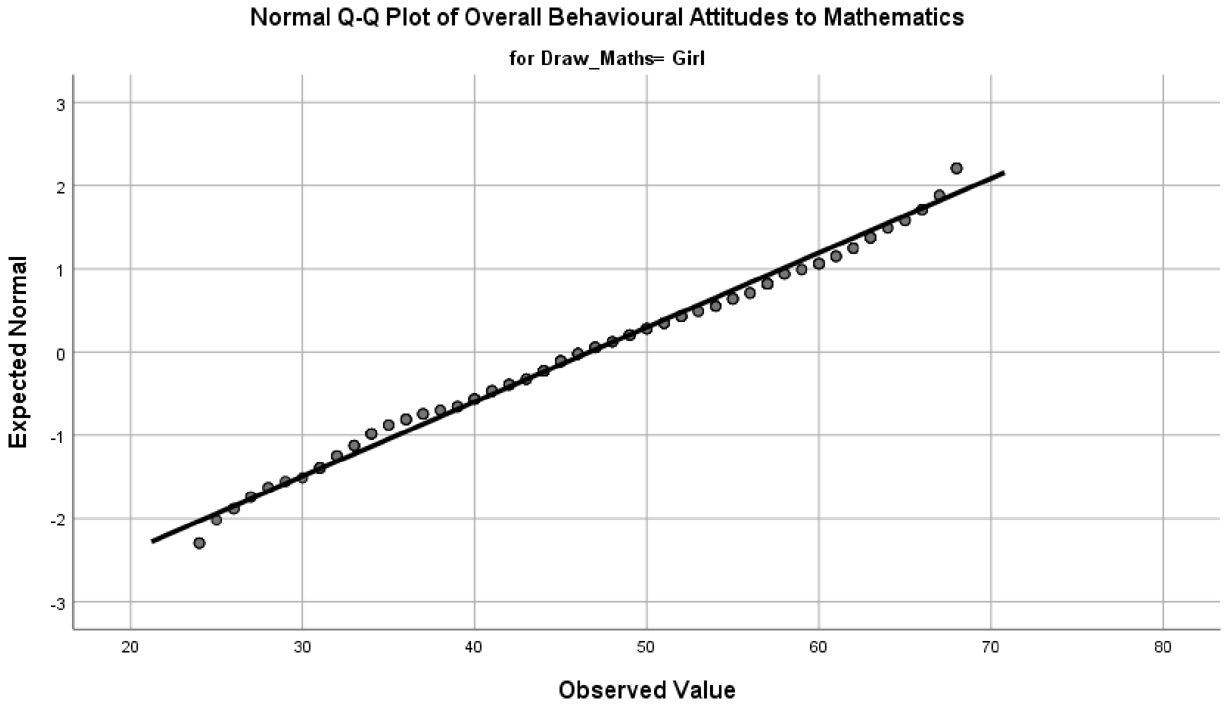
Independent Samples Test

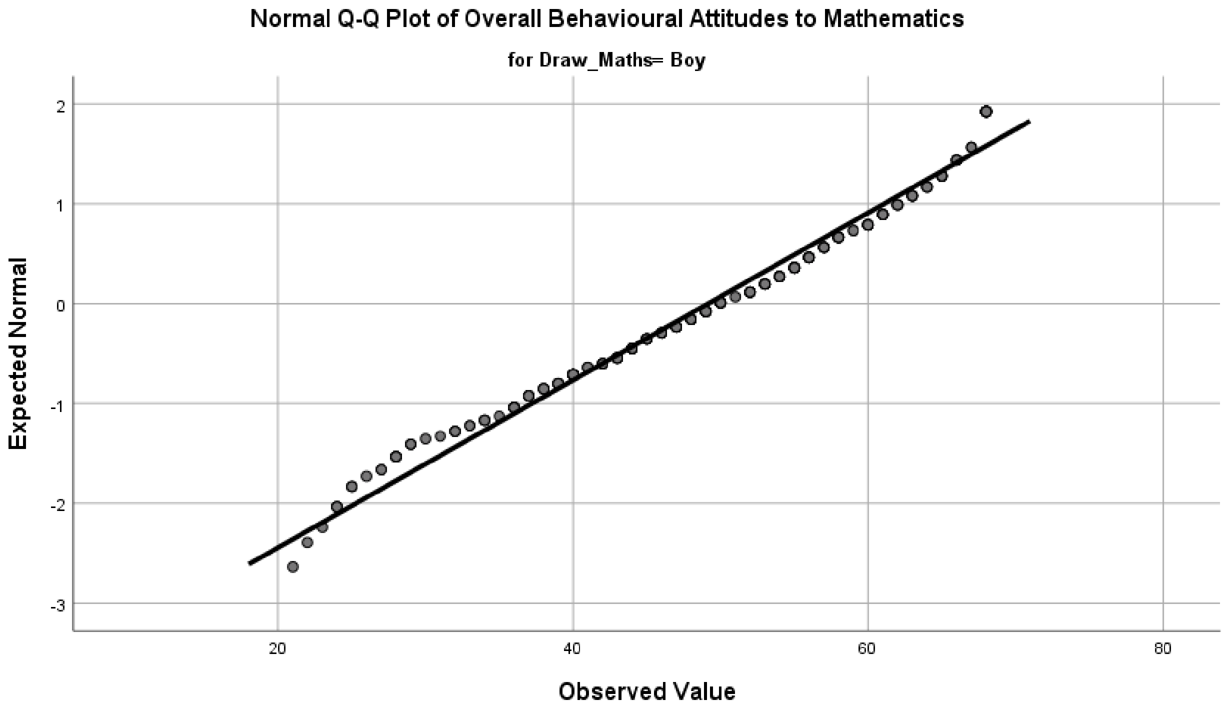
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	2.393	.123	1.876	394	.061	2.24888	1.19902	-.10840	4.60615
	Equal variances not assumed			1.830	281.132	.068	2.24888	1.22876	-.16987	4.66762

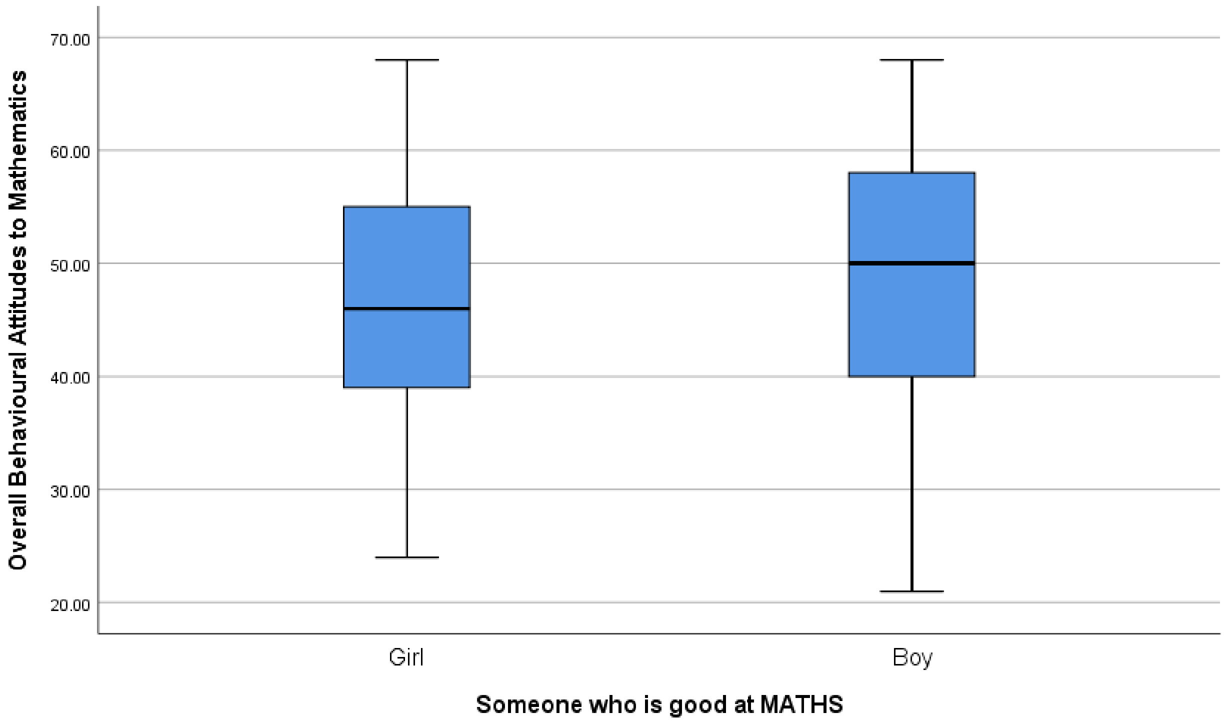
Good at maths and BA

Descriptives

	Someone who is good at MATHS			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Girl	Mean		46.6831	.82570
		95% Confidence Interval for Mean	Lower Bound	45.0539	
			Upper Bound	48.3122	
		5% Trimmed Mean		46.7155	
		Median		46.0000	
		Variance		124.767	
		Std. Deviation		11.16992	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		16.00	
		Skewness		-.009	.180
		Kurtosis		-.809	.357
	Boy	Mean		49.1555	.77326
		95% Confidence Interval for Mean	Lower Bound	47.6321	
			Upper Bound	50.6788	
		5% Trimmed Mean		49.4841	
		Median		50.0000	
		Variance		142.309	
		Std. Deviation		11.92934	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.00	
		Skewness		-.338	.158
		Kurtosis		-.680	.314


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Draw_Maths= Girl
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Draw_Maths= Boy
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
40
60
80



Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Girl
Boy
Someone who is good at MATHS

Group Statistics

	Someone who is good at MATHS	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	Girl	183	46.6831	11.16992	.82570
	Boy	238	49.1555	11.92934	.77326

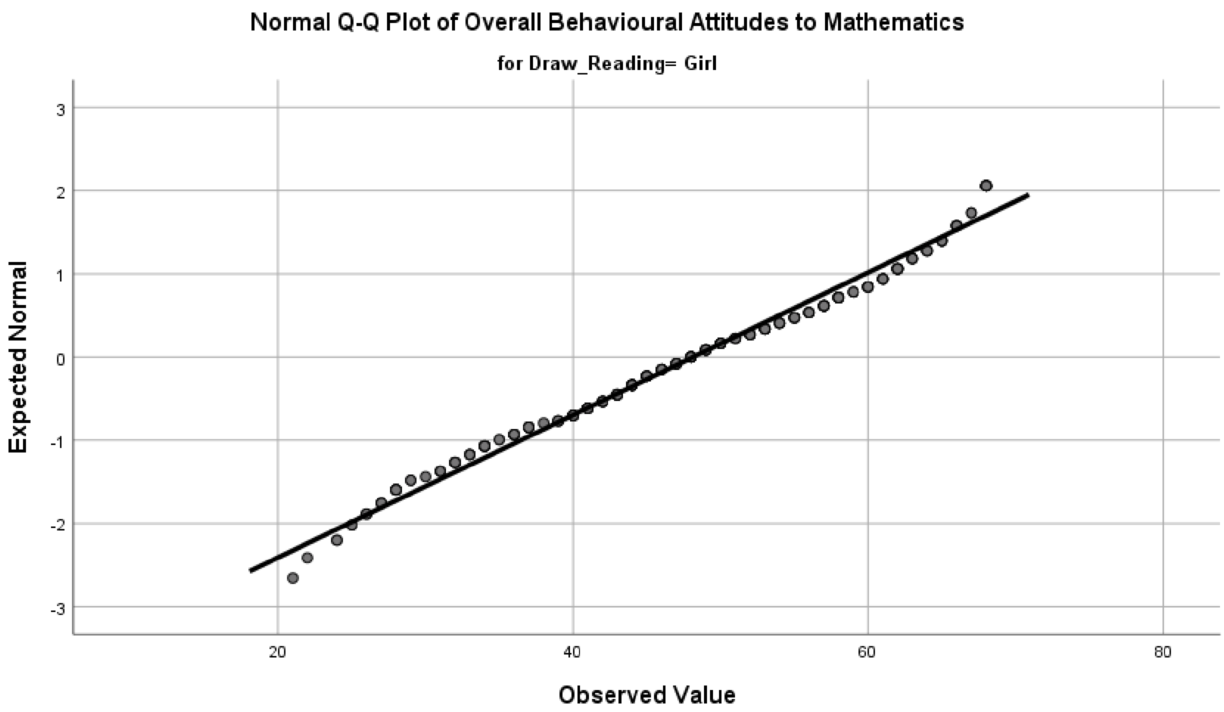
Independent Samples Test

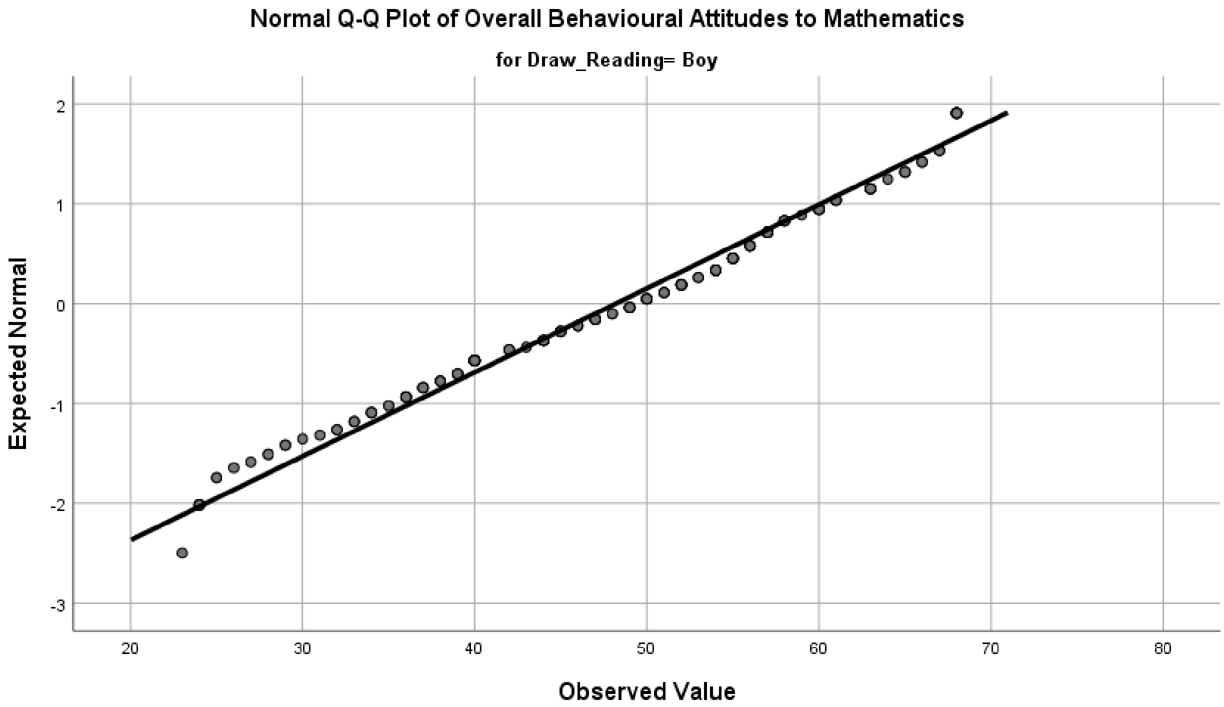
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	.952	.330	-2.167	419	.031	-2.47240	1.14102	-4.71524	-.22956
	Equal variances not assumed			-2.186	403.116	.029	-2.47240	1.13125	-4.69629	-.24852

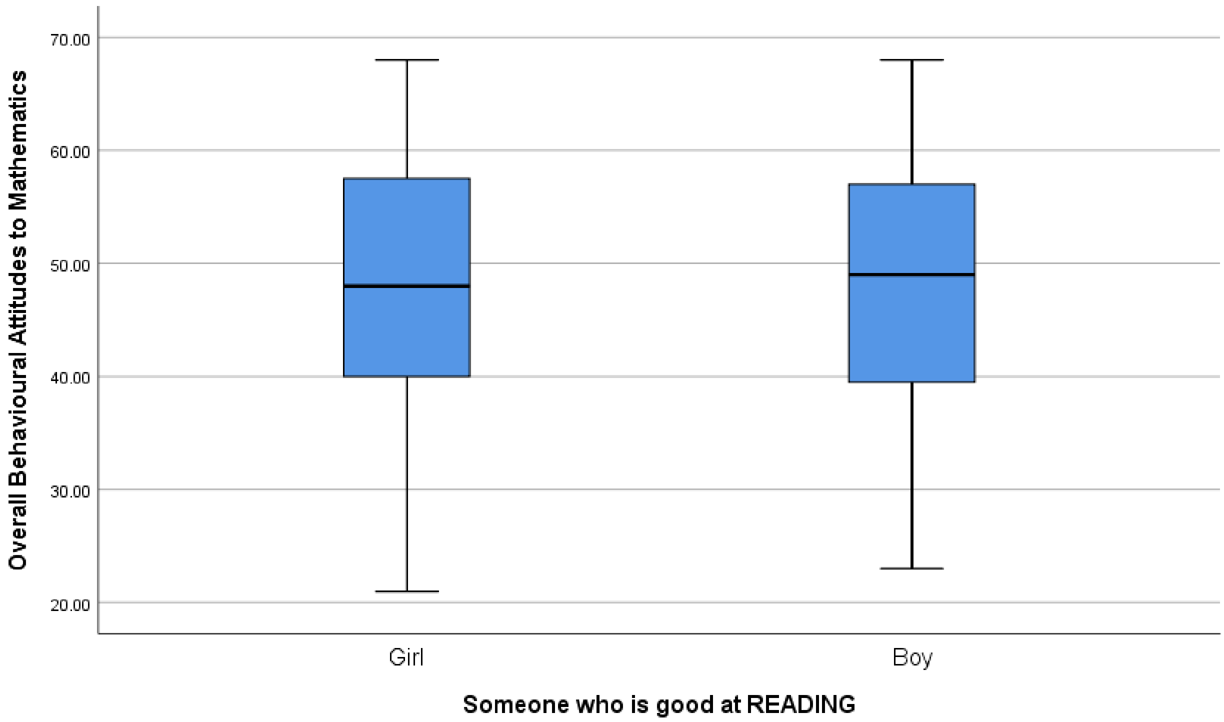
Someone good at reading and BAM

Descriptives

	Someone who is good at READING			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Girl	Mean		48.1389	.73547
		95% Confidence Interval for Mean	Lower Bound	46.6904	
			Upper Bound	49.5874	
		5% Trimmed Mean		48.3272	
		Median		48.0000	
		Variance		136.311	
		Std. Deviation		11.67524	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		17.75	
		Skewness		-.163	.153
		Kurtosis		-.806	.306
	Boy	Mean		48.1950	.94366
		95% Confidence Interval for Mean	Lower Bound	46.3312	
			Upper Bound	50.0588	
		5% Trimmed Mean		48.4186	
		Median		49.0000	
		Variance		141.588	
		Std. Deviation		11.89909	
		Minimum		23.00	
		Maximum		68.00	
		Range		45.00	
		Interquartile Range		18.00	
		Skewness		-.229	.192
		Kurtosis		-.762	.383


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Draw_Reading= Girl
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Draw_Reading= Boy
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
30
40
50
60
70
80



Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Girl
Boy
Someone who is good at READING

Group Statistics

	Someone who is good at READING	N	Mean	Std. Deviation	Std. Error Mean
Overall Behavioural Attitudes to Mathematics	Girl	252	48.1389	11.67524	.73547
	Boy	159	48.1950	11.89909	.94366

Independent Samples Test

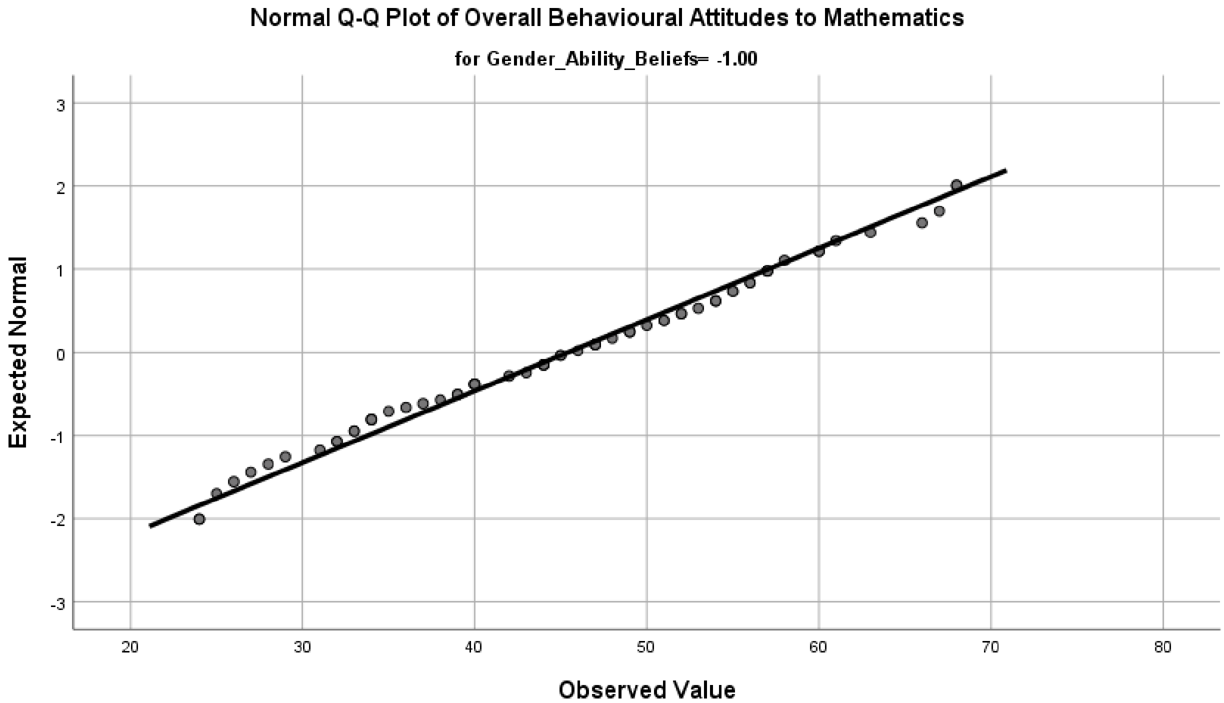
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Behavioural Attitudes to Mathematics	Equal variances assumed	.139	.709	-.047	409	.962	-.05608	1.19127	-2.39786	2.28570
	Equal variances not assumed			-.047	331.299	.963	-.05608	1.19642	-2.40961	2.29745

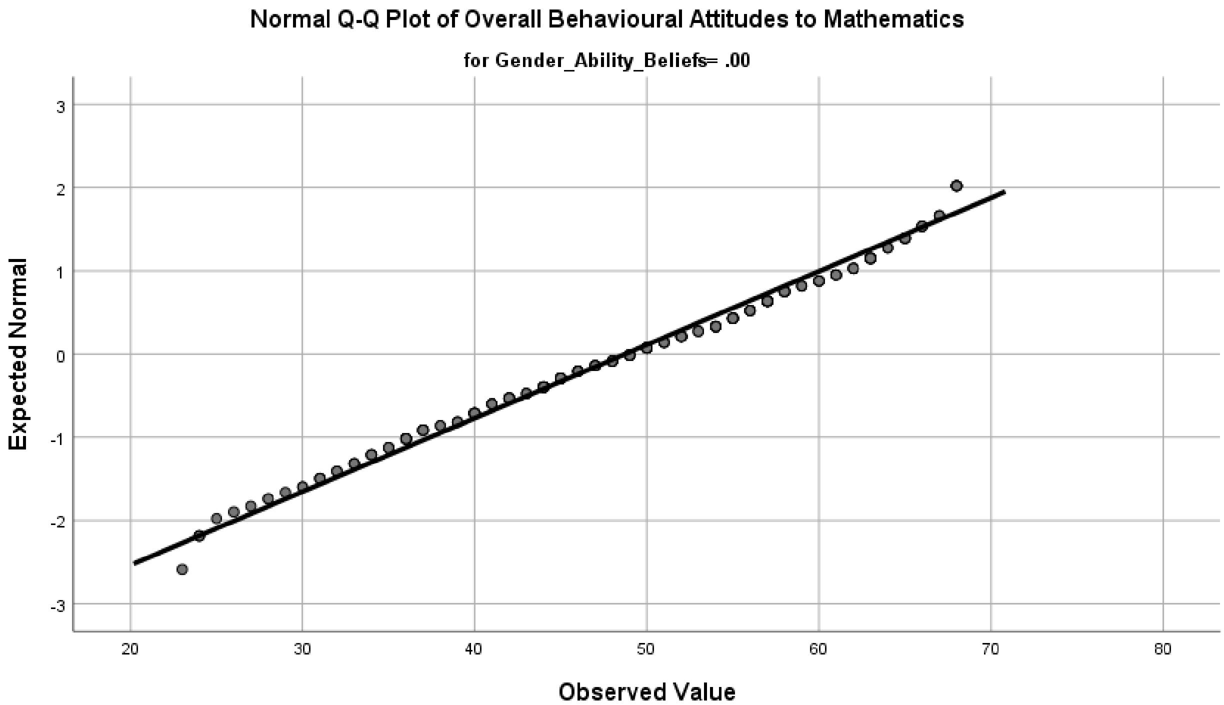
GAB and BAM

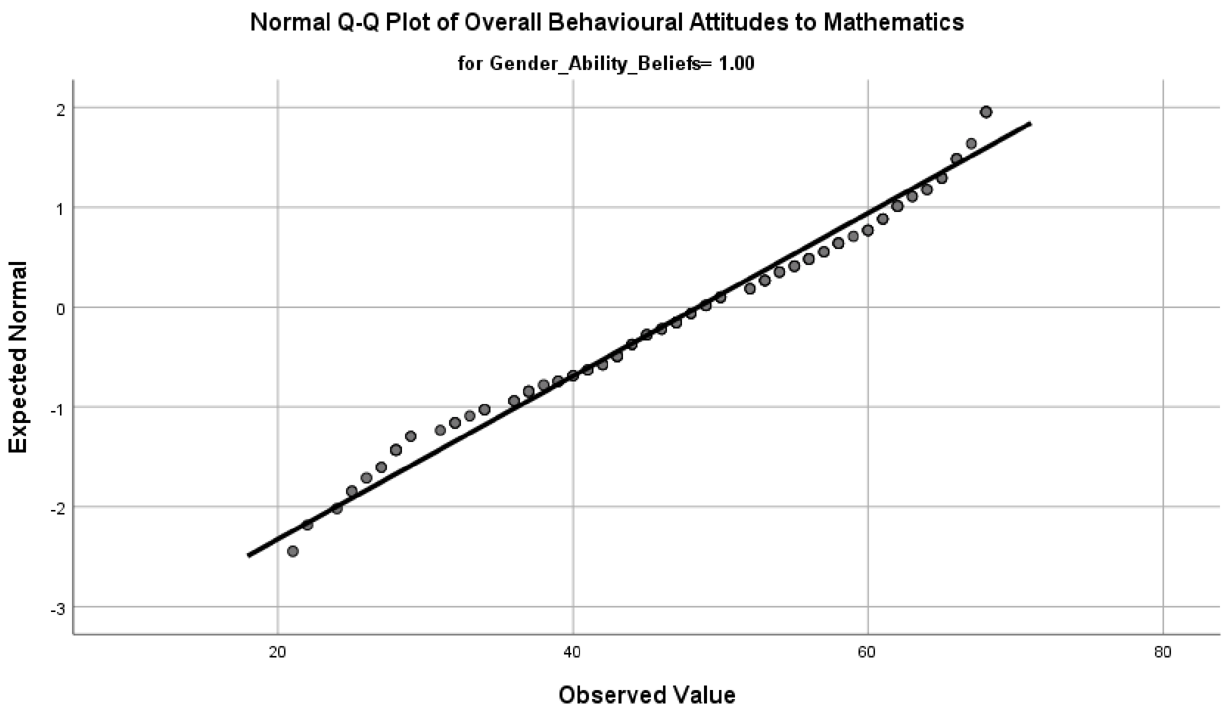
Descriptives

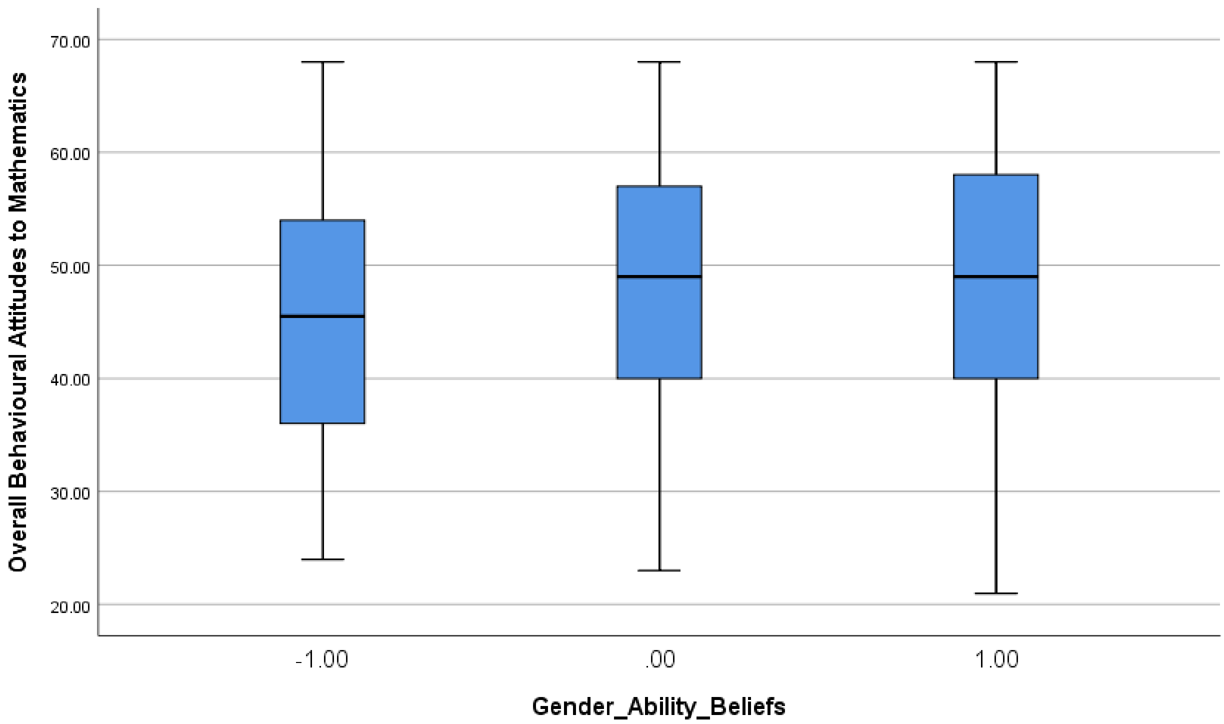
	Gender_Ability_Beliefs			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	-1.00	Mean		45.4242	1.43191
		95% Confidence Interval for Mean	Lower Bound	42.5645	
			Upper Bound	48.2840	
		5% Trimmed Mean		45.3603	
		Median		45.5000	
		Variance		135.325	
		Std. Deviation		11.63292	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		18.50	
		Skewness		-.004	.295
		Kurtosis		-.779	.582
	.00	Mean		48.7391	.78707
		95% Confidence Interval for Mean	Lower Bound	47.1874	
			Upper Bound	50.2909	
		5% Trimmed Mean		48.9482	
		Median		49.0000	
		Variance		128.233	
		Std. Deviation		11.32398	
		Minimum		23.00	
		Maximum		68.00	
		Range		45.00	
		Interquartile Range		17.00	
		Skewness		-.180	.169
		Kurtosis		-.771	.337
	1.00	Mean		48.4599	1.04647
		95% Confidence Interval for Mean	Lower Bound	46.3904	
			Upper Bound	50.5293	
		5% Trimmed Mean		48.7275	
		Median		49.0000	
		Variance		150.030	
		Std. Deviation		12.24866	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.00	

	Skewness	-.282	.207
	Kurtosis	-.782	.411






Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gender_Ability_Beliefs= 1.00
Expected Normal
2
1
0
-1
-2
-3
20
40
60
80
Observed Value


Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
-1.00
.00
1.00
Gender_Ability_Beliefs

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
-1.00	66	45.4242	11.63292	1.43191	42.5645	48.2840	24.00	68.00
.00	207	48.7391	11.32398	.78707	47.1874	50.2909	23.00	68.00
1.00	137	48.4599	12.24866	1.04647	46.3904	50.5293	21.00	68.00
Total	410	48.1122	11.72117	.57887	46.9743	49.2501	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	.458	2	407	.633
	Based on Median	.464	2	407	.629
	Based on Median and with adjusted df	.464	2	403.732	.629
	Based on trimmed mean	.465	2	407	.628

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	574.776	2	287.388	2.103	.123
Within Groups	55616.063	407	136.649		
Total	56190.839	409			

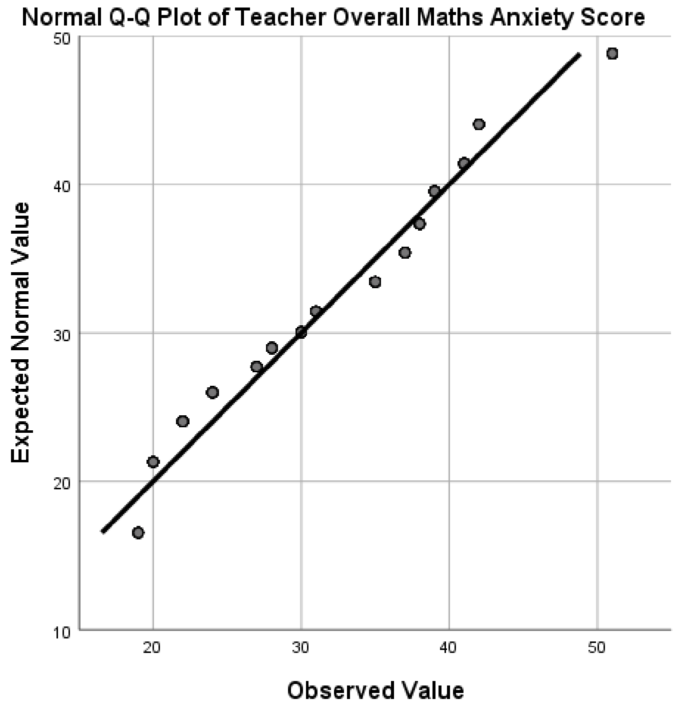
Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

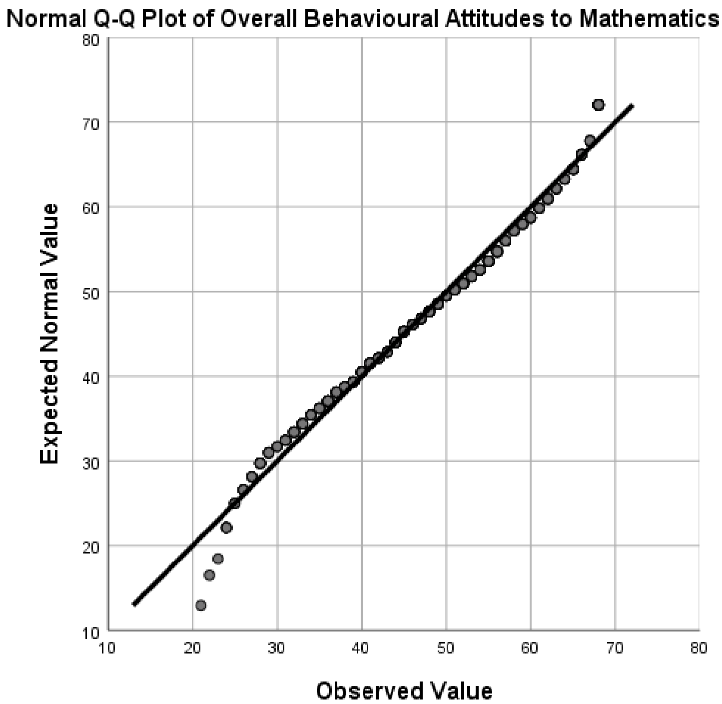
Scheffe

(I) Gender_Ability_Beliefs	(J) Gender_Ability_Beliefs	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
-1.00	.00	-3.31489	1.65245	.135	-7.3746	.7448
	1.00	-3.03561	1.75153	.224	-7.3388	1.2675
.00	-1.00	3.31489	1.65245	.135	-.7448	7.3746
	1.00	.27928	1.28747	.977	-2.8838	3.4423
1.00	-1.00	3.03561	1.75153	.224	-1.2675	7.3388
	.00	-.27928	1.28747	.977	-3.4423	2.8838

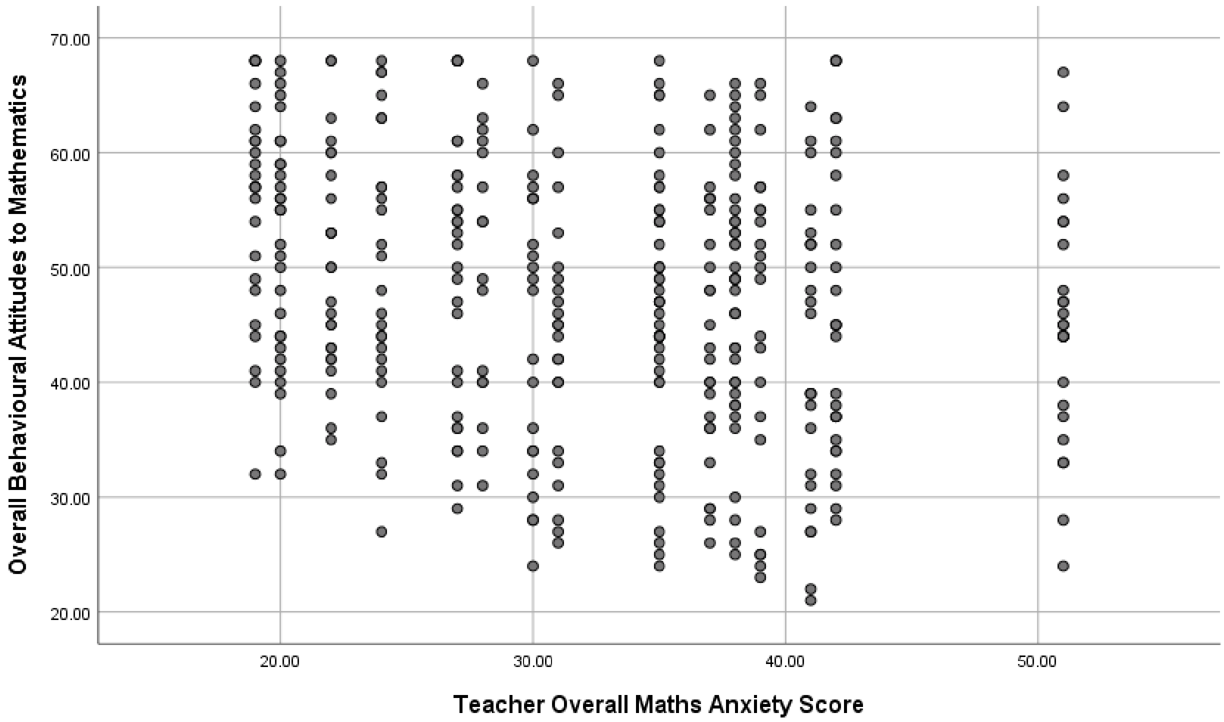
TMA and BAM



Normal Q-Q Plot of Teacher Overall Maths Anxiety Score
Expected Normal Value
Observed Value
50
40
30
20
10
20
30
40
50



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
Expected Normal Value
Observed Value
80
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80

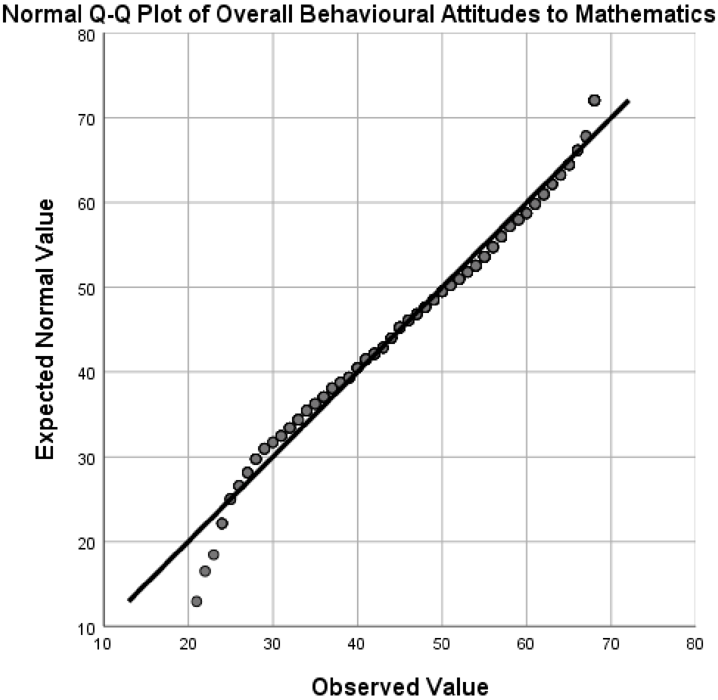


Correlations

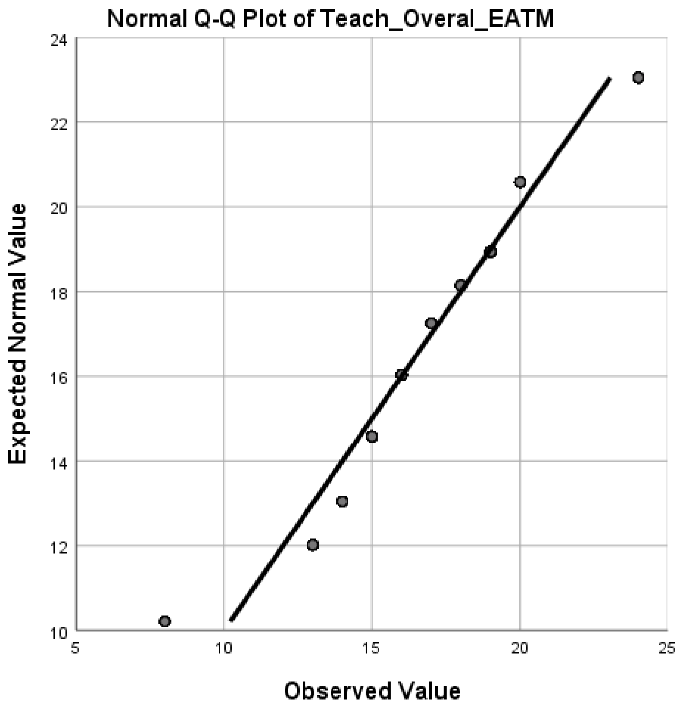
			Overall Behavioural Attitudes to Mathematics	Teacher Overall Maths Anxiety Score
Spearman's rho	Overall Behavioural Attitudes to Mathematics	Correlation Coefficient	1.000	-.217**
		Sig. (2-tailed)	.	.000
		N	439	407
	Teacher Overall Maths Anxiety Score	Correlation Coefficient	-.217**	1.000
		Sig. (2-tailed)	.000	.
		N	407	458

**. Correlation is significant at the 0.01 level (2-tailed).

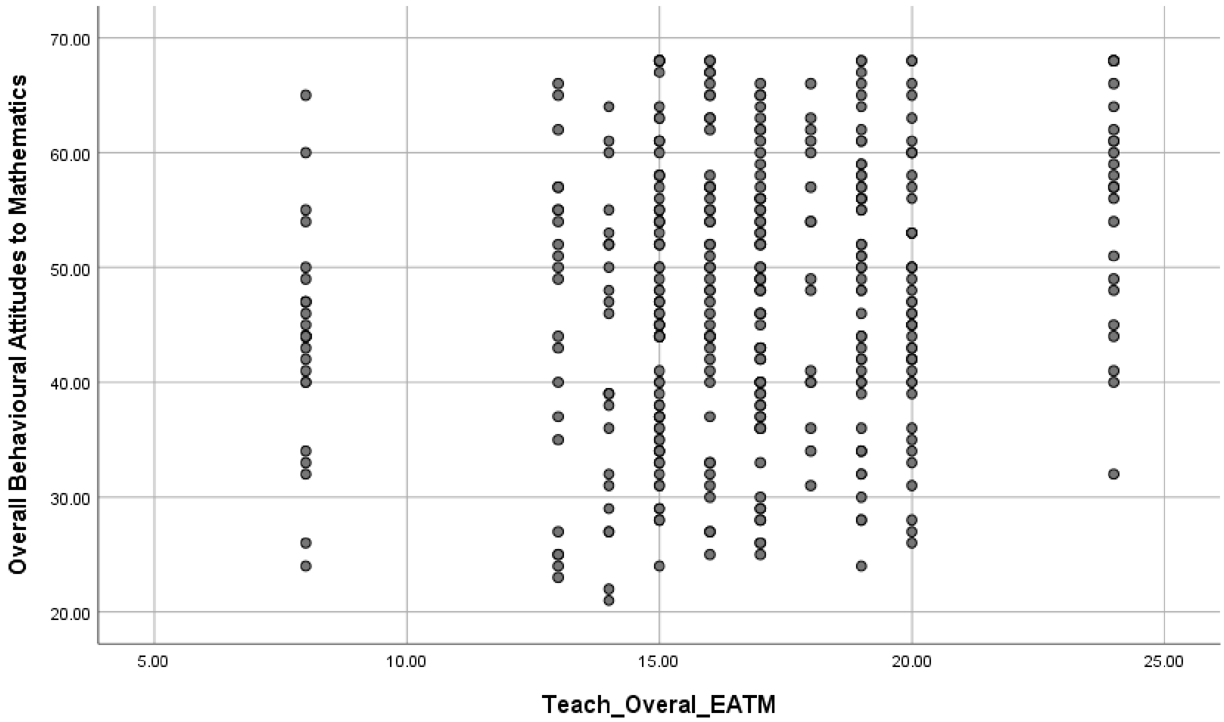
TEAM and BAM



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
Expected Normal Value
Observed Value
80
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80



Normal Q-Q Plot of Teach_Overal_EATM
Expected Normal Value
Observed Value
24
22
20
18
16
14
12
10
5
10
15
20
25

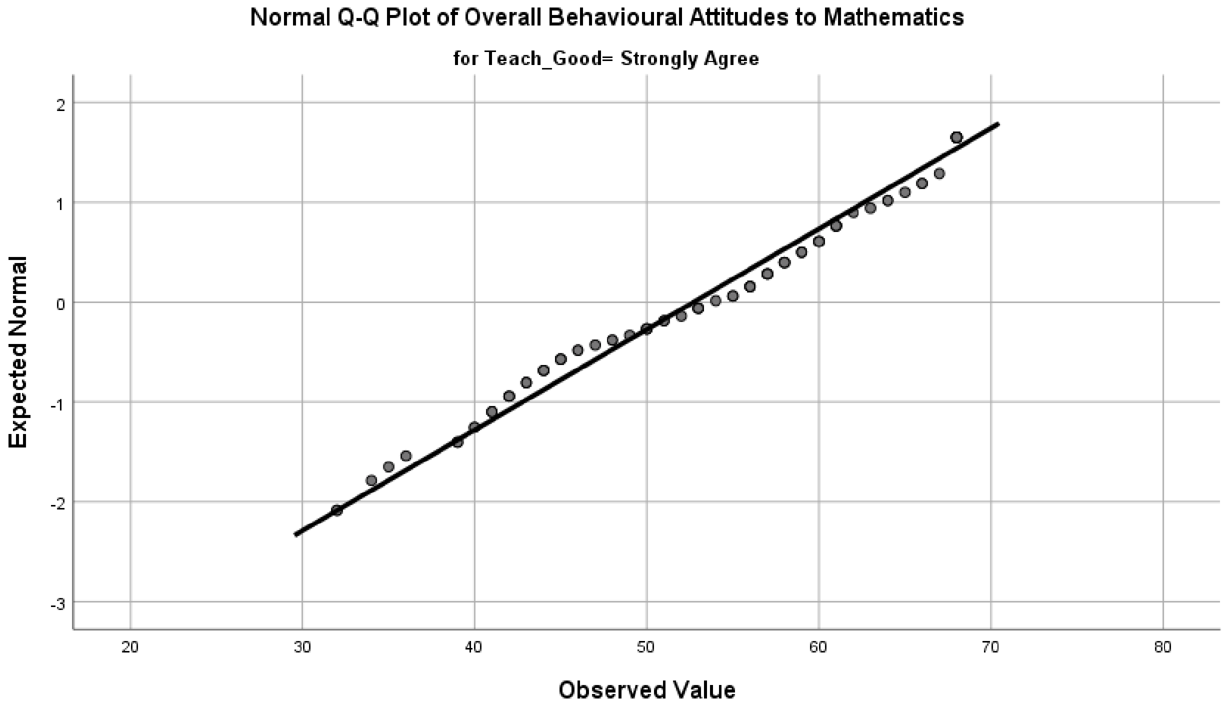


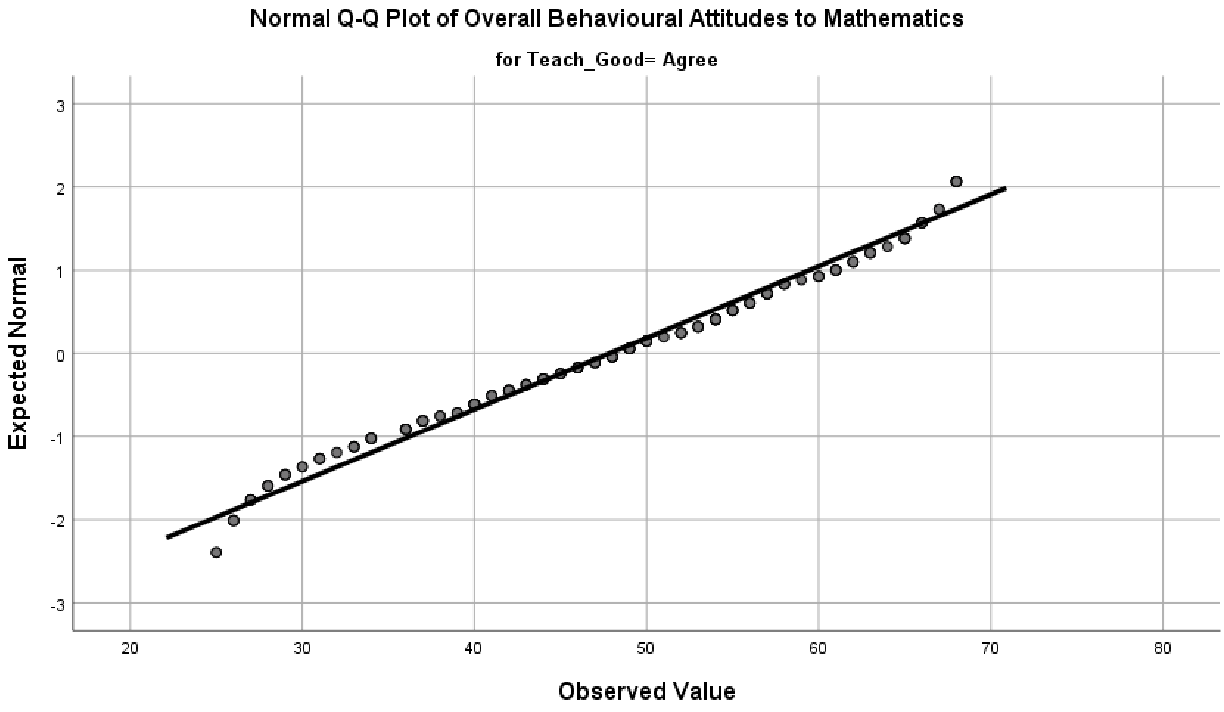
Correlations

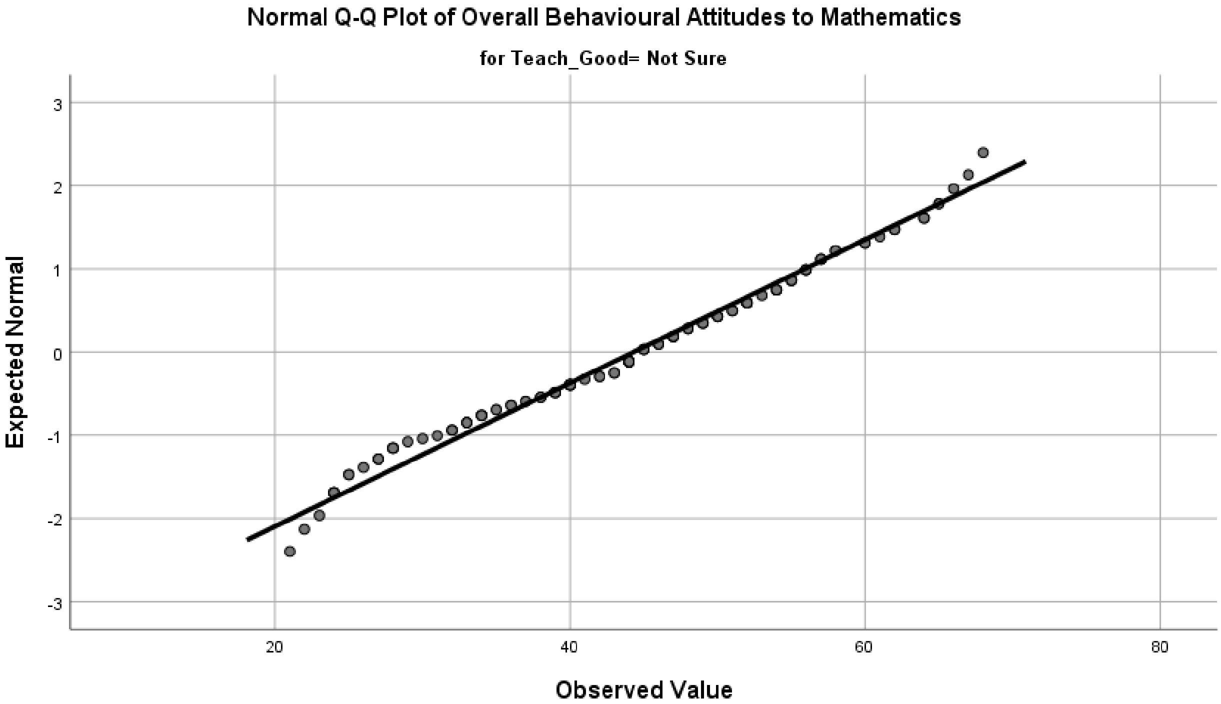
			Overall Behavioural Attitudes to Mathematics	Teach_Overal_EATM
Spearman's rho	Overall Behavioural Attitudes to Mathematics	Correlation Coefficient	1.000	.162**
		Sig. (2-tailed)	.	.001
		N	439	407
	Teach_Overal_EATM	Correlation Coefficient	.162**	1.000
		Sig. (2-tailed)	.001	.
		N	407	458

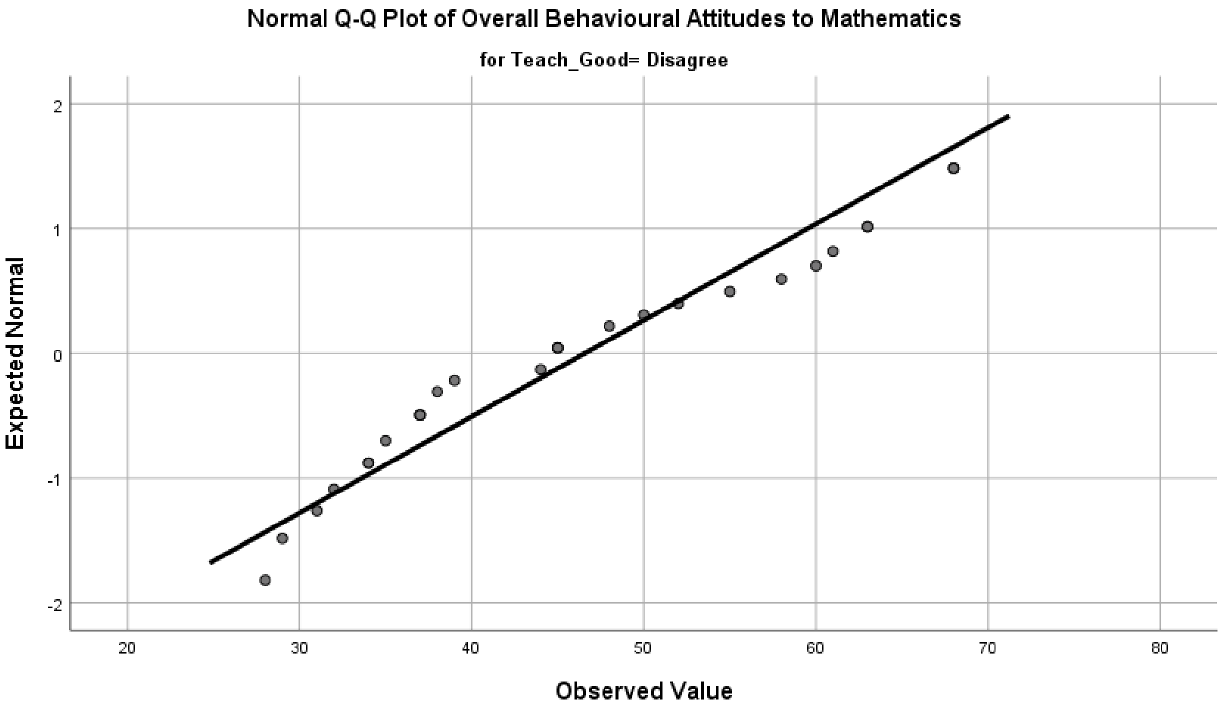
**. Correlation is significant at the 0.01 level (2-tailed).

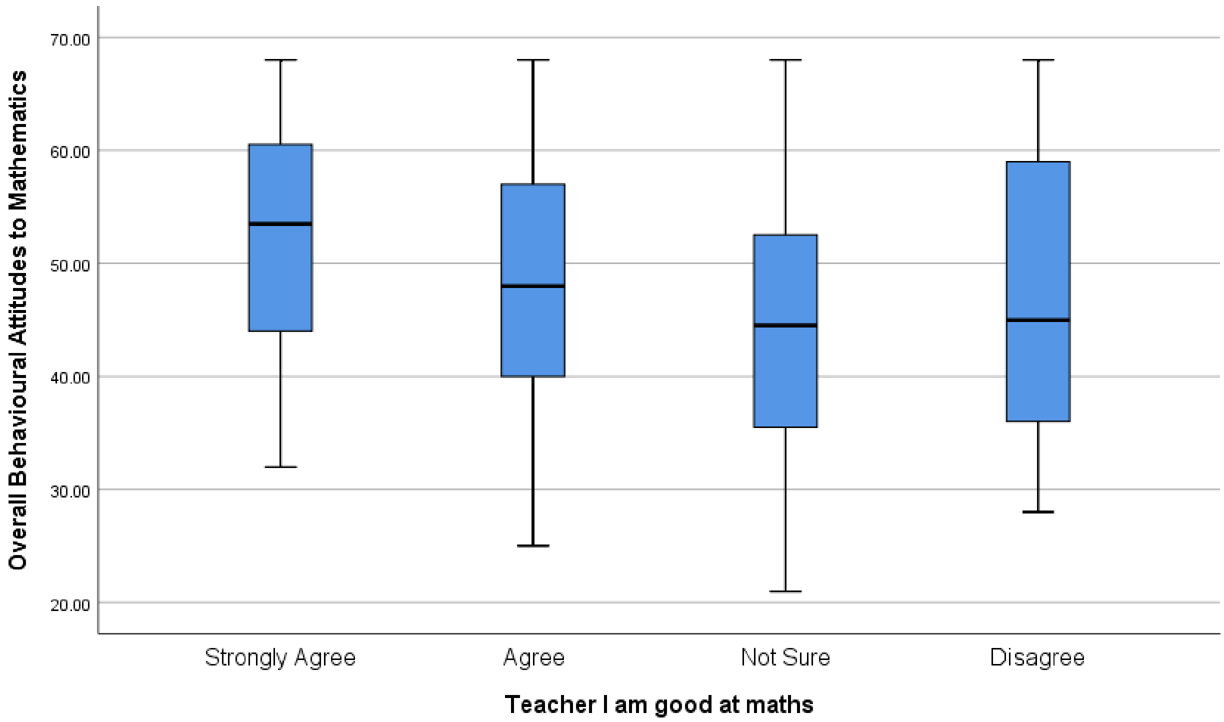
Teacher I am good at maths


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_Good= Strongly Agree
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_Good= Agree
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_Good= Not Sure
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_Good= Disagree
Expected Normal
Observed Value
2
1
0
-1
-2
20
30
40
50
60
70
80



70.00
60.00
50.00
40.00
30.00
20.00
Overall Behavioural Attitudes to Mathematics
Strongly Agree
Agree
Not Sure
Disagree
Teacher I am good at maths

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	52.7125	9.92401	1.10954	50.5040	54.9210	32.00	68.00
Agree	179	47.8547	11.61030	.86779	46.1423	49.5672	25.00	68.00
Not Sure	120	44.3167	11.60265	1.05917	42.2194	46.4139	21.00	68.00
Disagree	28	46.5714	12.95127	2.44756	41.5494	51.5934	28.00	68.00
Total	407	47.6781	11.71783	.58083	46.5363	48.8199	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	1.428	3	403	.234
	Based on Median	1.270	3	403	.284
	Based on Median and with adjusted df	1.270	3	392.269	.284
	Based on trimmed mean	1.429	3	403	.234

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3423.401	3	1141.134	8.789	.000
Within Groups	52323.435	403	129.835		

Total	55746.835	406			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) Teacher I am good at maths	(J) Teacher I am good at maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Strongly Agree	Agree	4.85775*	1.53241	.019	.5558	9.1597
	Not Sure	8.39583*	1.64466	.000	3.7787	13.0129
	Disagree	6.14107	2.50198	.112	-.8828	13.1650
Agree	Strongly Agree	-4.85775*	1.53241	.019	-9.1597	-.5558
	Not Sure	3.53808	1.34436	.076	-.2360	7.3121
	Disagree	1.28332	2.31566	.959	-5.2175	7.7842
Not Sure	Strongly Agree	-8.39583*	1.64466	.000	-13.0129	-3.7787
	Agree	-3.53808	1.34436	.076	-7.3121	.2360
	Disagree	-2.25476	2.39143	.828	-8.9683	4.4588
Disagree	Strongly Agree	-6.14107	2.50198	.112	-13.1650	.8828
	Agree	-1.28332	2.31566	.959	-7.7842	5.2175
	Not Sure	2.25476	2.39143	.828	-4.4588	8.9683

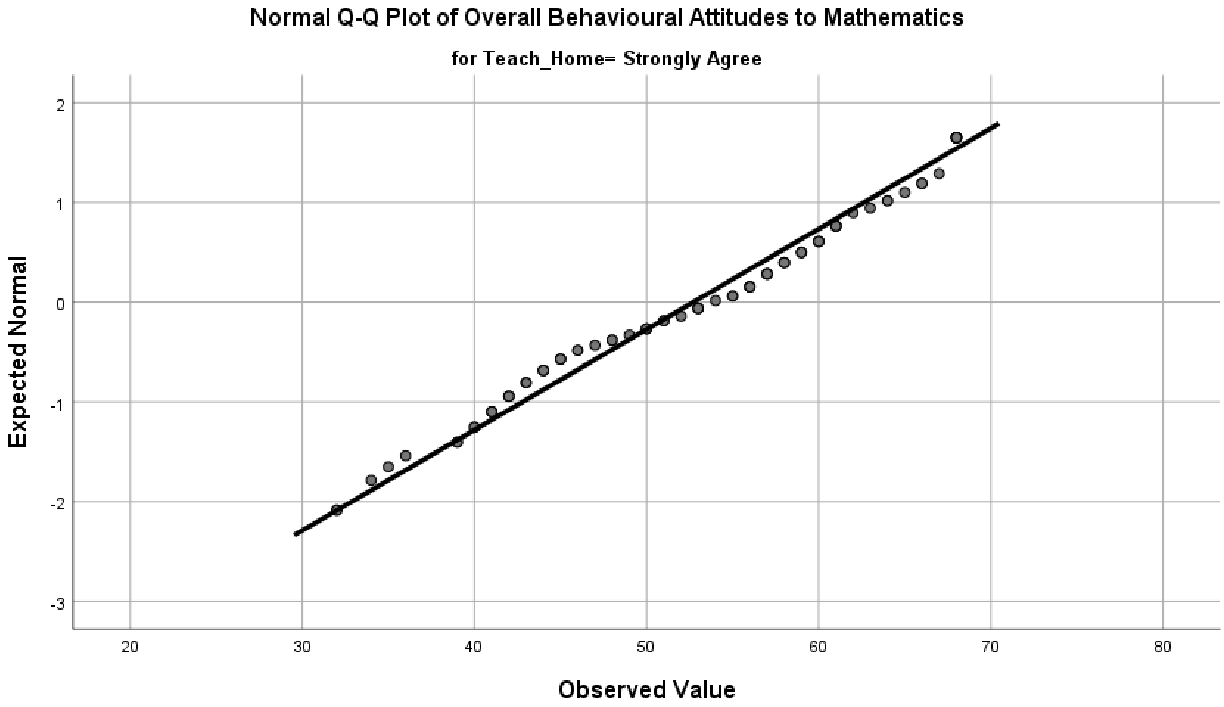
*. The mean difference is significant at the 0.05 level.

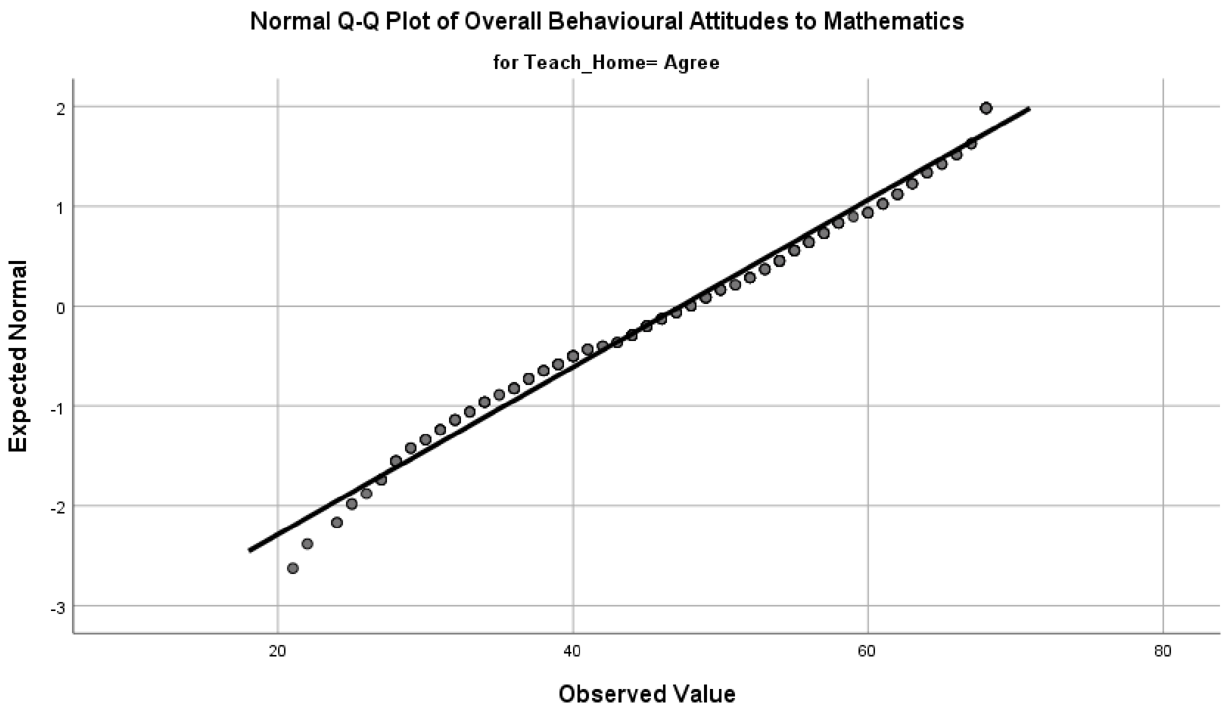
Teacher motivation and BAM

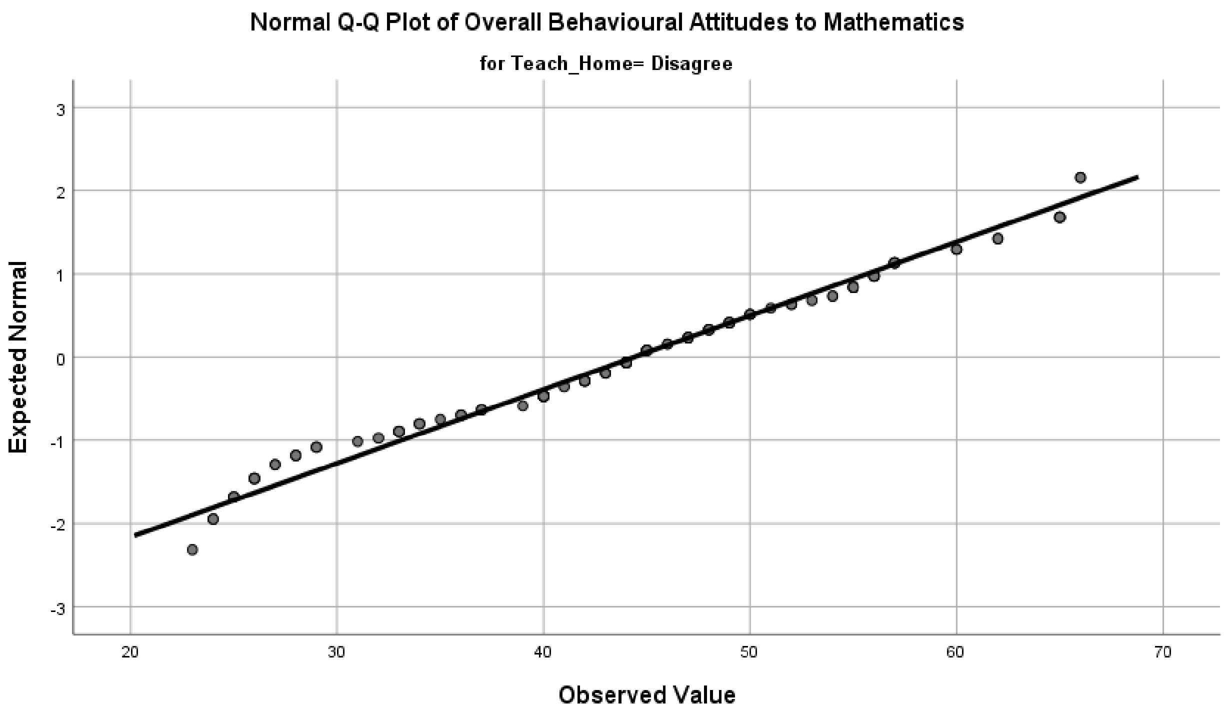
Descriptives

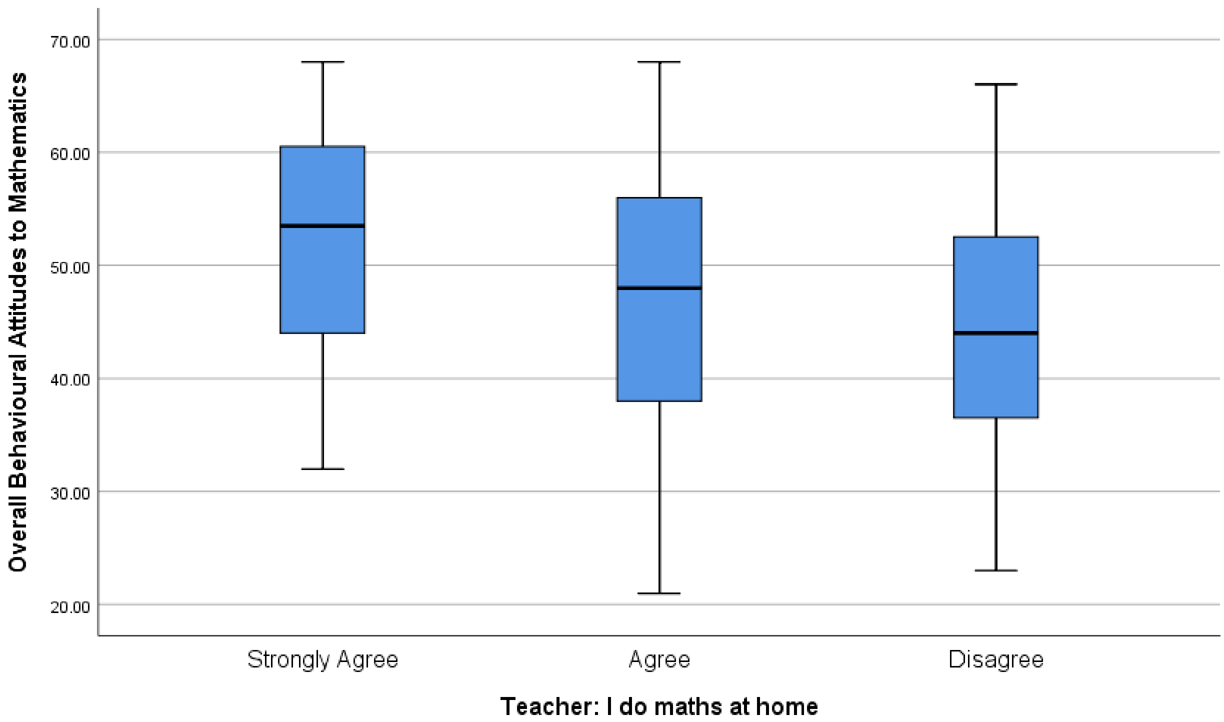
	Teacher: I do maths at home			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Strongly Agree	Mean		52.7125	1.10954
		95% Confidence Interval for Mean	Lower Bound	50.5040	
			Upper Bound	54.9210	
		5% Trimmed Mean		52.9444	
		Median		53.5000	
		Variance		98.486	
		Std. Deviation		9.92401	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.75	
		Skewness		-.194	.269
		Kurtosis		-.937	.532
	Agree	Mean		47.2987	.78580
		95% Confidence Interval for Mean	Lower Bound	45.7504	
			Upper Bound	48.8470	
		5% Trimmed Mean		47.3870	
		Median		48.0000	
		Variance		142.636	
		Std. Deviation		11.94305	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		18.00	
		Skewness		-.104	.160
		Kurtosis		-.903	.319
	Disagree	Mean		44.3958	1.15018
		95% Confidence Interval for Mean	Lower Bound	42.1124	
			Upper Bound	46.6792	
		5% Trimmed Mean		44.3519	
		Median		44.0000	
		Variance		127.000	
		Std. Deviation		11.26941	
		Minimum		23.00	
		Maximum		66.00	
		Range		43.00	
		Interquartile Range		16.50	

	Skewness	-.041	.246
	Kurtosis	-.671	.488






Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_Home= Disagree
Expected Normal
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
Observed Value


Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Strongly Agree
Agree
Disagree
Teacher: I do maths at home

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	52.7125	9.92401	1.10954	50.5040	54.9210	32.00	68.00
Agree	231	47.2987	11.94305	.78580	45.7504	48.8470	21.00	68.00
Disagree	96	44.3958	11.26941	1.15018	42.1124	46.6792	23.00	66.00
Total	407	47.6781	11.71783	.58083	46.5363	48.8199	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	2.219	2	404	.110
	Based on Median	2.175	2	404	.115
	Based on Median and with adjusted df	2.175	2	393.958	.115
	Based on trimmed mean	2.253	2	404	.106

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3095.100	2	1547.550	11.874	.000
Within Groups	52651.735	404	130.326		

Total	55746.835	406			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) Teacher: I do maths at home	(J) Teacher: I do maths at home	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Strongly Agree	Agree	5.41380*	1.48097	.001	1.7753	9.0523
	Disagree	8.31667*	1.72819	.000	4.0708	12.5626
Agree	Strongly Agree	-5.41380*	1.48097	.001	-9.0523	-1.7753
	Disagree	2.90287	1.38627	.113	-.5030	6.3087
Disagree	Strongly Agree	-8.31667*	1.72819	.000	-12.5626	-4.0708
	Agree	-2.90287	1.38627	.113	-6.3087	.5030

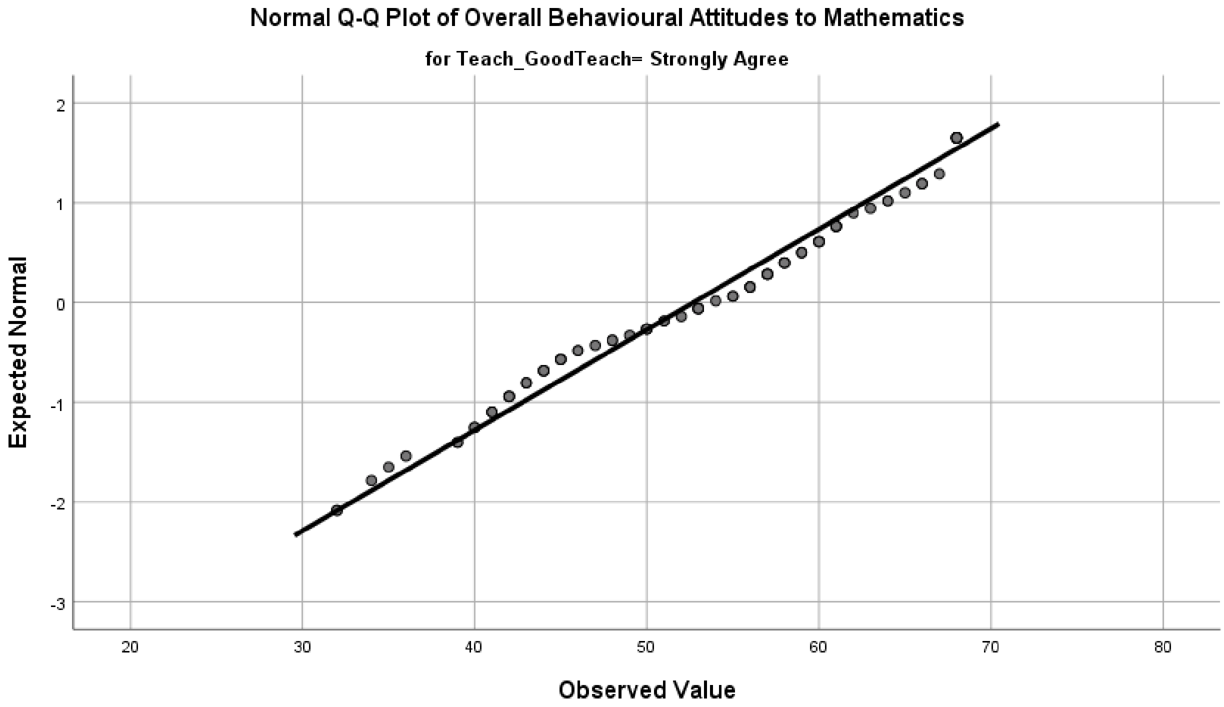
*. The mean difference is significant at the 0.05 level.

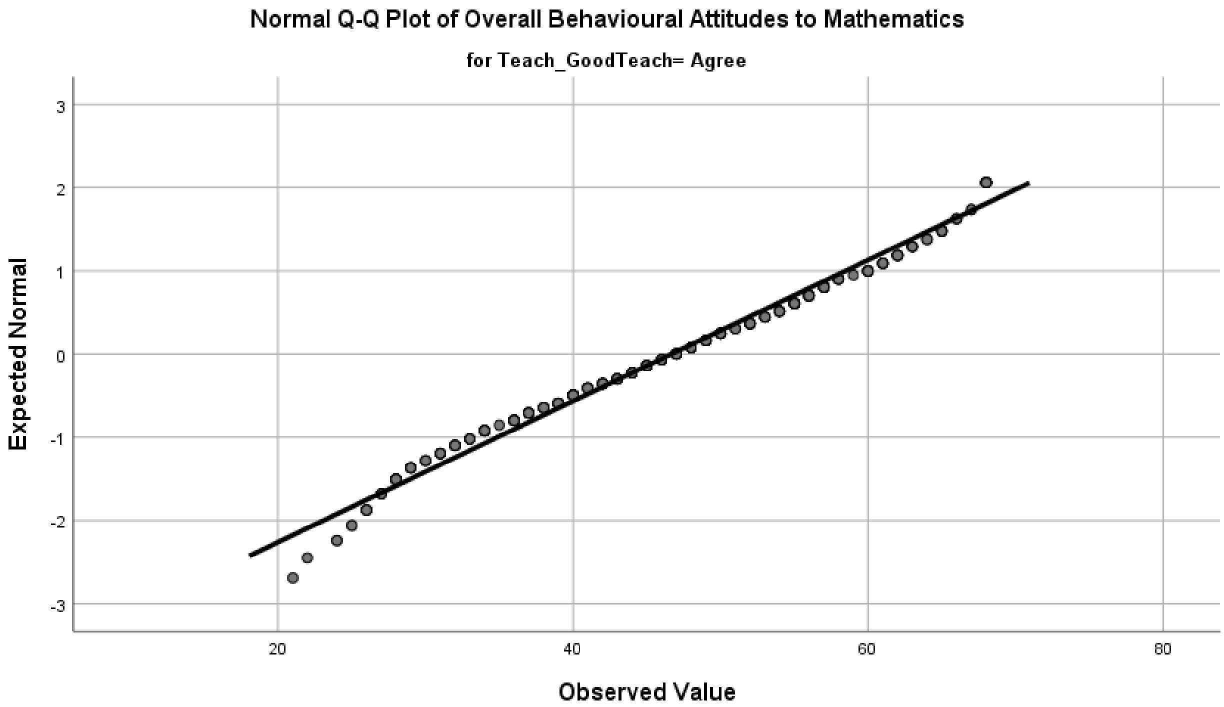
Good at teaching maths and BAM

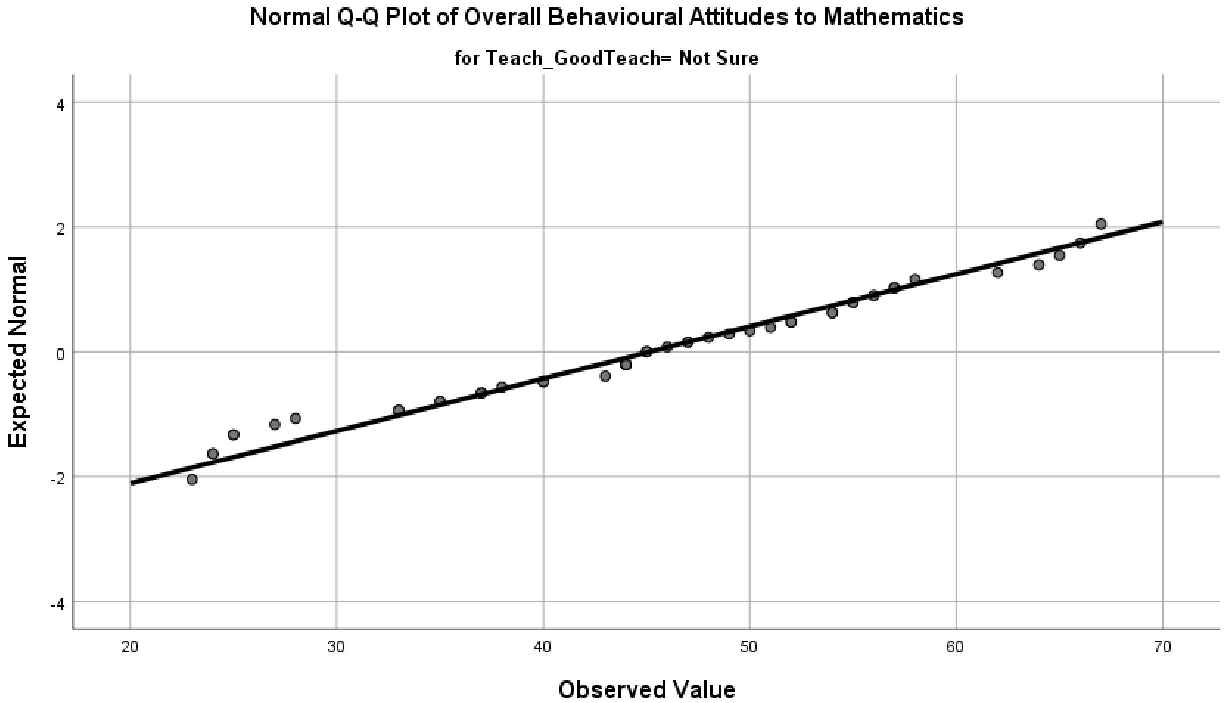
Descriptives

	Teacher: I believe I am good at teaching maths			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Strongly Agree	Mean		52.7125	1.10954
		95% Confidence Interval for Mean	Lower Bound	50.5040	
			Upper Bound	54.9210	
		5% Trimmed Mean		52.9444	
		Median		53.5000	
		Variance		98.486	
		Std. Deviation		9.92401	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.75	
		Skewness		-.194	.269
		Kurtosis		-.937	.532
	Agree	Mean		46.6703	.70596
		95% Confidence Interval for Mean	Lower Bound	45.2805	
			Upper Bound	48.0600	
		5% Trimmed Mean		46.7011	
		Median		47.0000	
		Variance		139.049	
		Std. Deviation		11.79191	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		19.00	
		Skewness		-.050	.146
		Kurtosis		-.883	.291
	Not Sure	Mean		45.1458	1.72230
		95% Confidence Interval for Mean	Lower Bound	41.6810	
			Upper Bound	48.6106	
		5% Trimmed Mean		45.1713	
		Median		45.0000	
		Variance		142.383	
		Std. Deviation		11.93242	
		Minimum		23.00	
		Maximum		67.00	
		Range		44.00	
		Interquartile Range		17.00	

	Skewness	-.182	.343
	Kurtosis	-.642	.674






Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Teach_GoodTeach= Not Sure
Expected Normal
Observed Value
4
2
0
-2
-4
20
30
40
50
60
70


Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Strongly Agree
Agree
Not Sure
Teacher: I believe I am good at teaching maths

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	52.7125	9.92401	1.10954	50.5040	54.9210	32.00	68.00
Agree	279	46.6703	11.79191	.70596	45.2805	48.0600	21.00	68.00
Not Sure	48	45.1458	11.93242	1.72230	41.6810	48.6106	23.00	67.00
Total	407	47.6781	11.71783	.58083	46.5363	48.8199	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	1.557	2	404	.212
	Based on Median	1.585	2	404	.206
	Based on Median and with adjusted df	1.585	2	392.644	.206
	Based on trimmed mean	1.602	2	404	.203

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2618.806	2	1309.403	9.957	.000

Within Groups	53128.030	404	131.505		
Total	55746.835	406			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) Teacher: I believe I am good at teaching maths	(J) Teacher: I believe I am good at teaching maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strongly Agree	Agree	6.04225*	1.45436	.000	2.4691	9.6154
	Not Sure	7.56667*	2.09368	.002	2.4228	12.7105
Agree	Strongly Agree	-6.04225*	1.45436	.000	-9.6154	-2.4691
	Not Sure	1.52442	1.79194	.697	-2.8781	5.9269
Not Sure	Strongly Agree	-7.56667*	2.09368	.002	-12.7105	-2.4228
	Agree	-1.52442	1.79194	.697	-5.9269	2.8781

*. The mean difference is significant at the 0.05 level.

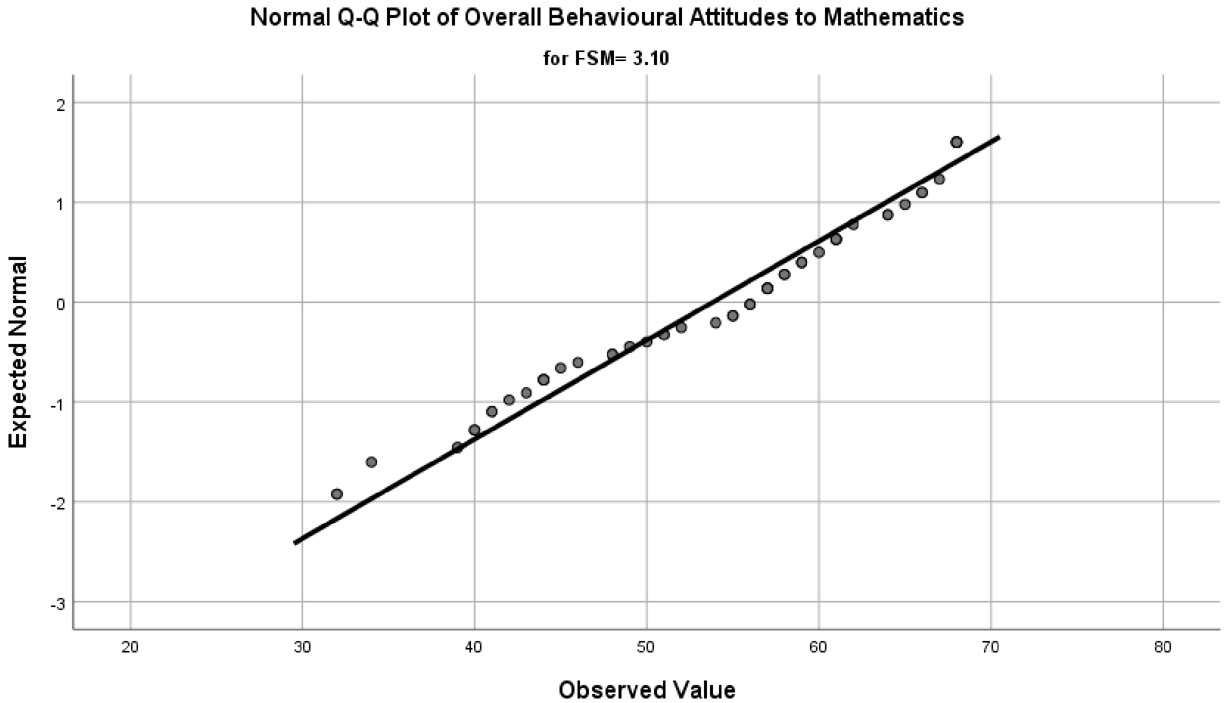
FSM and BAM

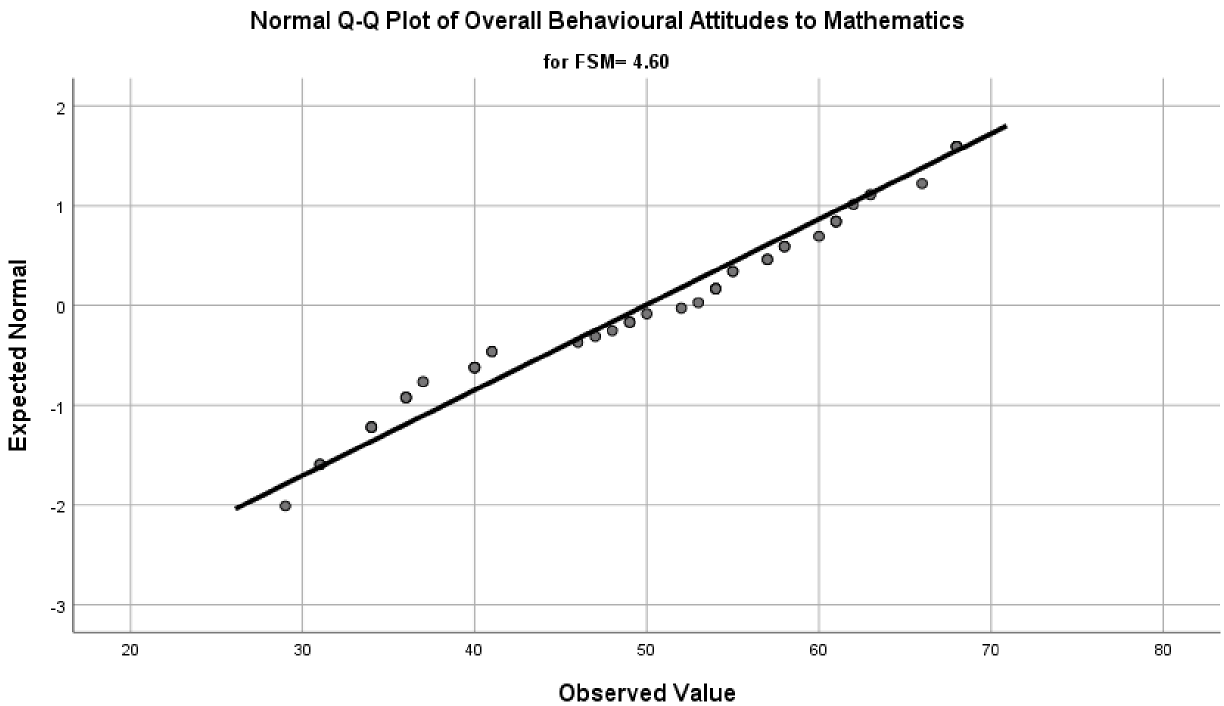
Descriptives

	% of free school meals			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	3.10	Mean		53.8333	1.37074
		95% Confidence Interval for Mean	Lower Bound	51.0840	
			Upper Bound	56.5827	
		5% Trimmed Mean		54.2305	
		Median		56.0000	
		Variance		101.462	
		Std. Deviation		10.07285	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.25	
		Skewness		-.430	.325
		Kurtosis		-.732	.639
	4.60	Mean		49.9091	1.76015
		95% Confidence Interval for Mean	Lower Bound	46.3594	
			Upper Bound	53.4588	
		5% Trimmed Mean		50.0051	
		Median		52.5000	
		Variance		136.317	
		Std. Deviation		11.67549	
		Minimum		29.00	
		Maximum		68.00	
		Range		39.00	
		Interquartile Range		19.50	
		Skewness		-.154	.357
		Kurtosis		-1.150	.702
	7.50	Mean		48.0566	1.70469
		95% Confidence Interval for Mean	Lower Bound	44.6359	
			Upper Bound	51.4773	
		5% Trimmed Mean		48.0702	
		Median		45.0000	
		Variance		154.016	
		Std. Deviation		12.41032	
		Minimum		27.00	
		Maximum		68.00	
		Range		41.00	

		Interquartile Range		22.00	
		Skewness		.143	.327
		Kurtosis		-1.174	.644
	12.70	Mean		44.6863	1.48707
		95% Confidence Interval for Mean	Lower Bound	41.6994	
			Upper Bound	47.6731	
		5% Trimmed Mean		44.5839	
		Median		44.0000	
		Variance		112.780	
		Std. Deviation		10.61977	
		Minimum		24.00	
		Maximum		67.00	
		Range		43.00	
		Interquartile Range		17.00	
		Skewness		.079	.333
		Kurtosis		-.584	.656
	20.00	Mean		47.5102	1.52533
		95% Confidence Interval for Mean	Lower Bound	44.4433	
			Upper Bound	50.5771	
		5% Trimmed Mean		47.5442	
		Median		46.0000	
		Variance		114.005	
		Std. Deviation		10.67732	
		Minimum		26.00	
		Maximum		68.00	
		Range		42.00	
		Interquartile Range		13.00	
		Skewness		.039	.340
		Kurtosis		-.463	.668
	20.90	Mean		47.0444	1.88132
		95% Confidence Interval for Mean	Lower Bound	43.2529	
			Upper Bound	50.8360	
		5% Trimmed Mean		47.1296	
		Median		50.0000	
		Variance		159.271	
		Std. Deviation		12.62025	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		22.50	
		Skewness		-.288	.354

		Kurtosis		-1.007	.695
	27.40	Mean		45.2727	2.43814
		95% Confidence Interval for Mean	Lower Bound	40.2023	
			Upper Bound	50.3431	
		5% Trimmed Mean		45.2525	
		Median		46.0000	
		Variance		130.779	
		Std. Deviation		11.43587	
		Minimum		25.00	
		Maximum		66.00	
		Range		41.00	
		Interquartile Range		15.50	
		Skewness		.047	.491
		Kurtosis		-.544	.953
	28.50	Mean		44.5000	1.66258
		95% Confidence Interval for Mean	Lower Bound	41.1553	
			Upper Bound	47.8447	
		5% Trimmed Mean		44.5000	
		Median		44.0000	
		Variance		132.681	
		Std. Deviation		11.51872	
		Minimum		23.00	
		Maximum		66.00	
		Range		43.00	
		Interquartile Range		15.75	
		Skewness		-.194	.343
		Kurtosis		-.508	.674
	57.20	Mean		48.2192	1.40669
		95% Confidence Interval for Mean	Lower Bound	45.4150	
			Upper Bound	51.0234	
		5% Trimmed Mean		48.6629	
		Median		50.0000	
		Variance		144.451	
		Std. Deviation		12.01879	
		Minimum		21.00	
		Maximum		67.00	
		Range		46.00	
		Interquartile Range		18.50	
		Skewness		-.534	.281
		Kurtosis		-.547	.555


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 3.10
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 4.60
Expected Normal
Observed Value
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-1
-2
-3
20
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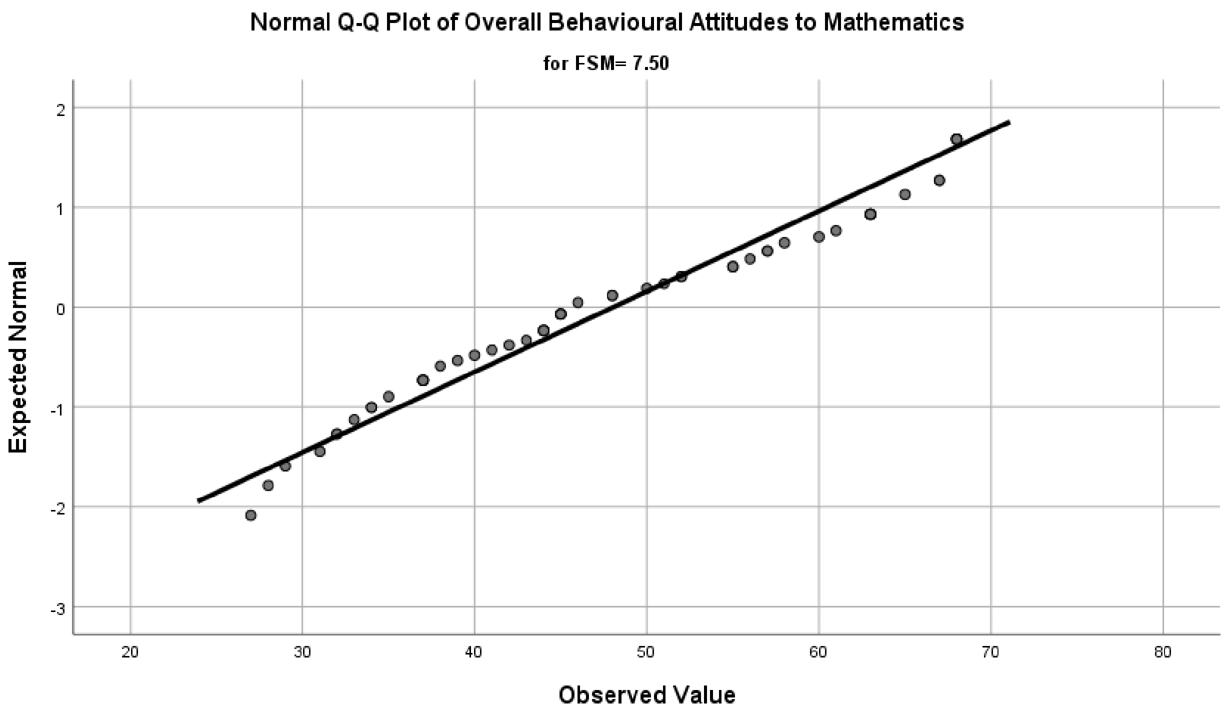
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 7.50
Expected Normal
Observed Value
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1
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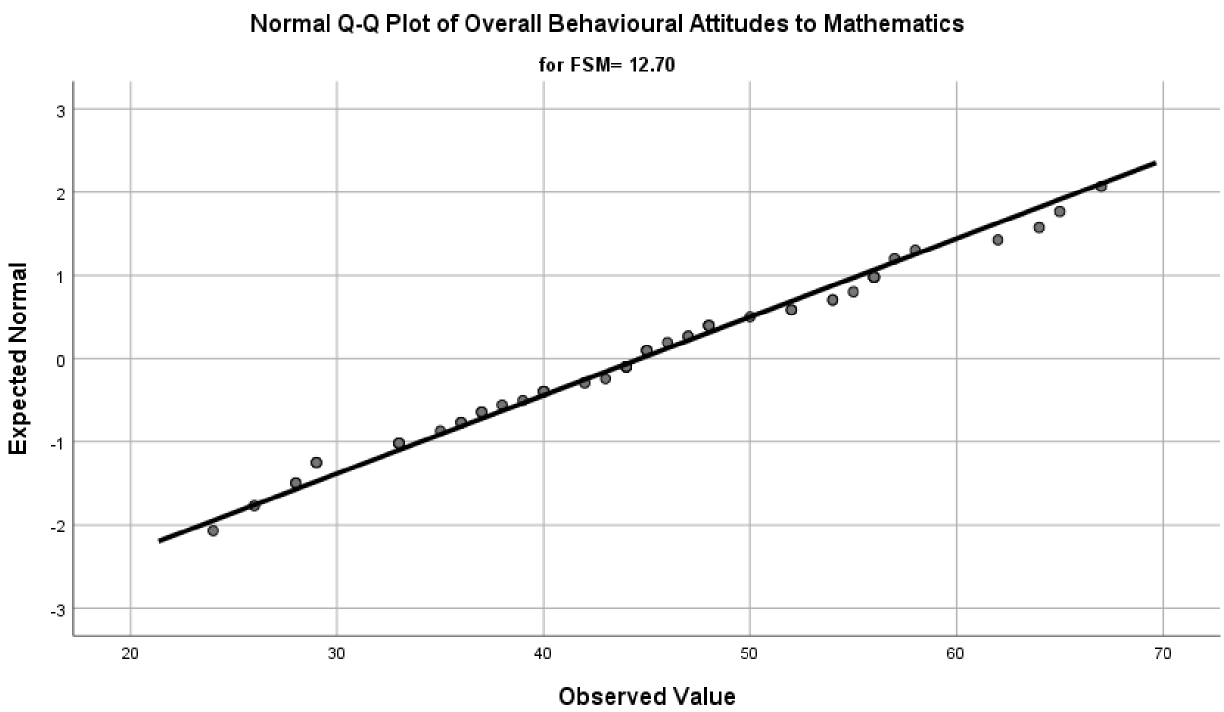
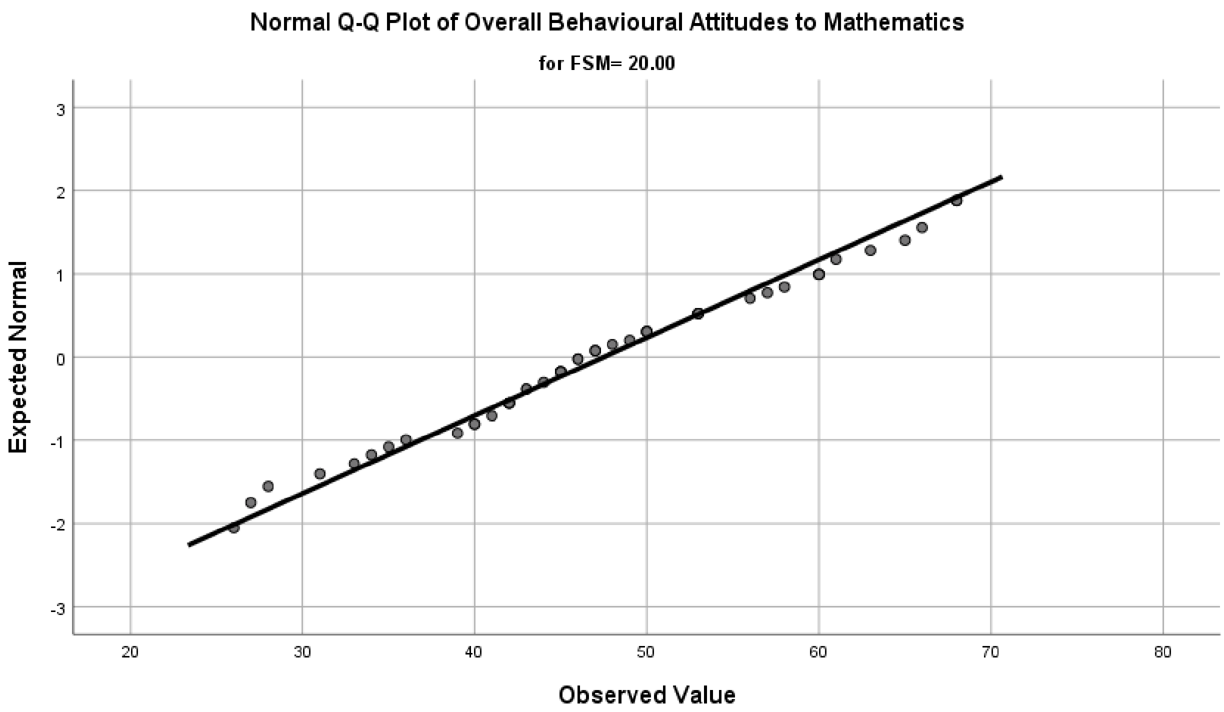
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 12.70
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 20.00
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
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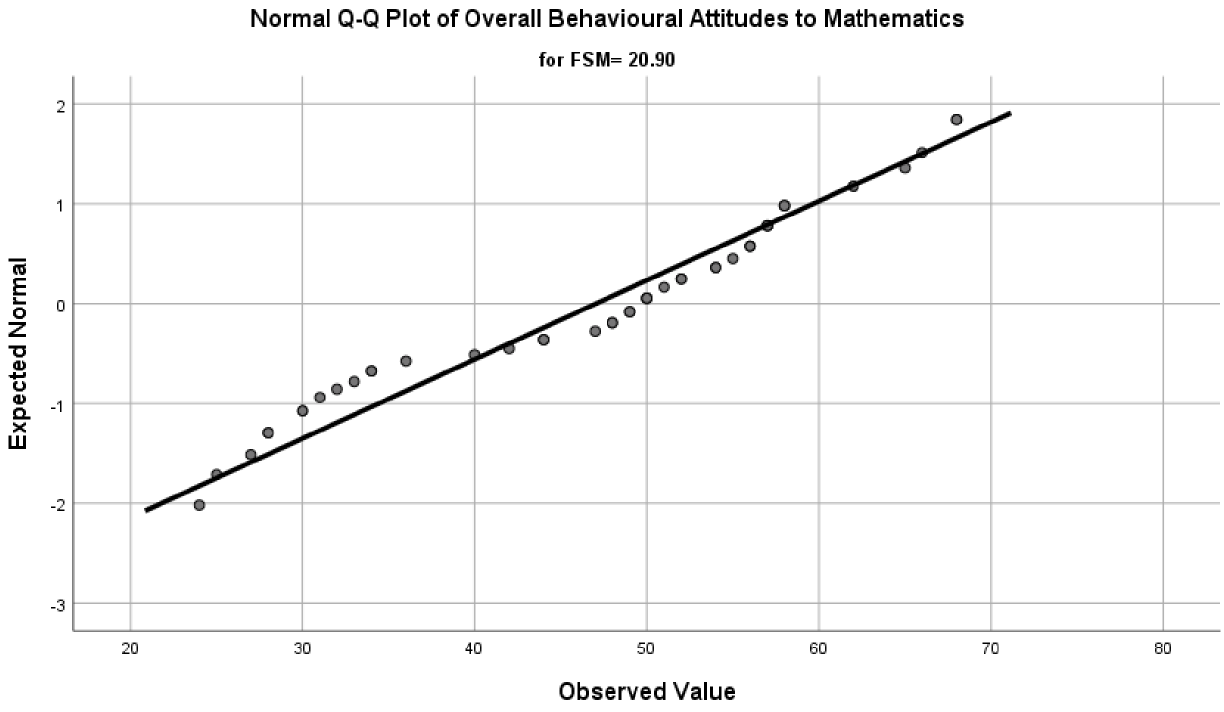
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 20.90
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
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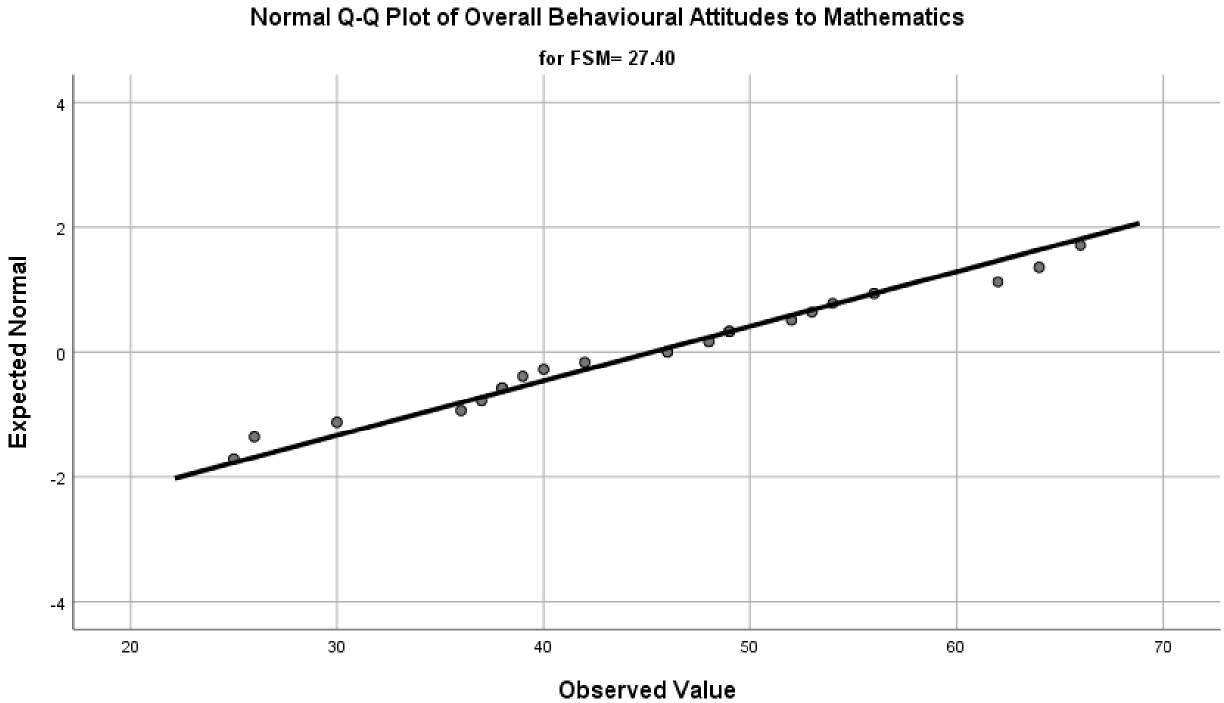
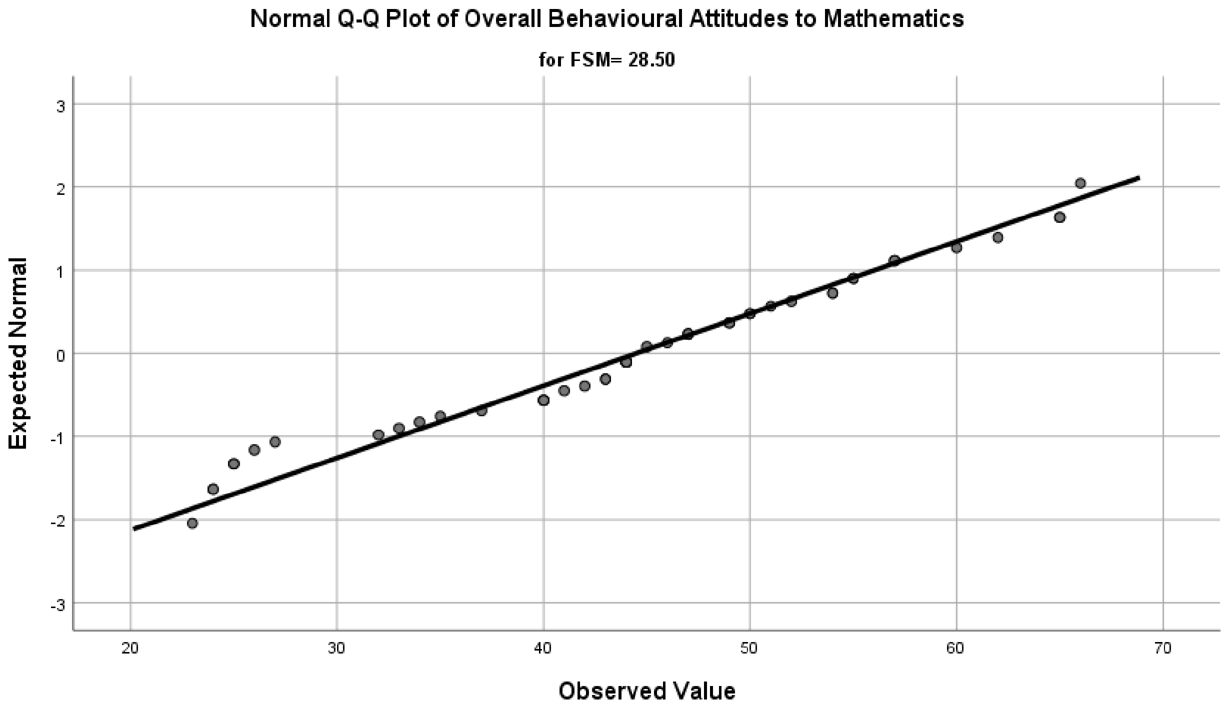
40
50
60
70
80



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 27.40
Expected Normal
Observed Value
4
2
0
-2
-4
20
30
40
50
60
70



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 28.50
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
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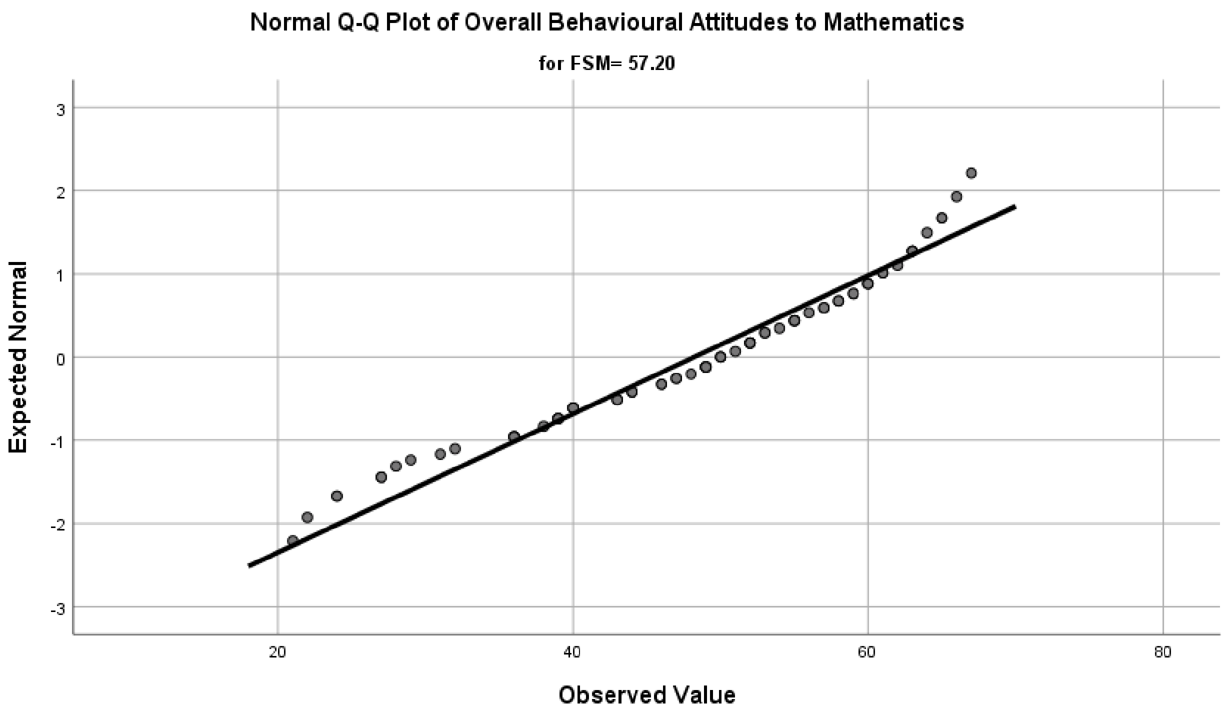
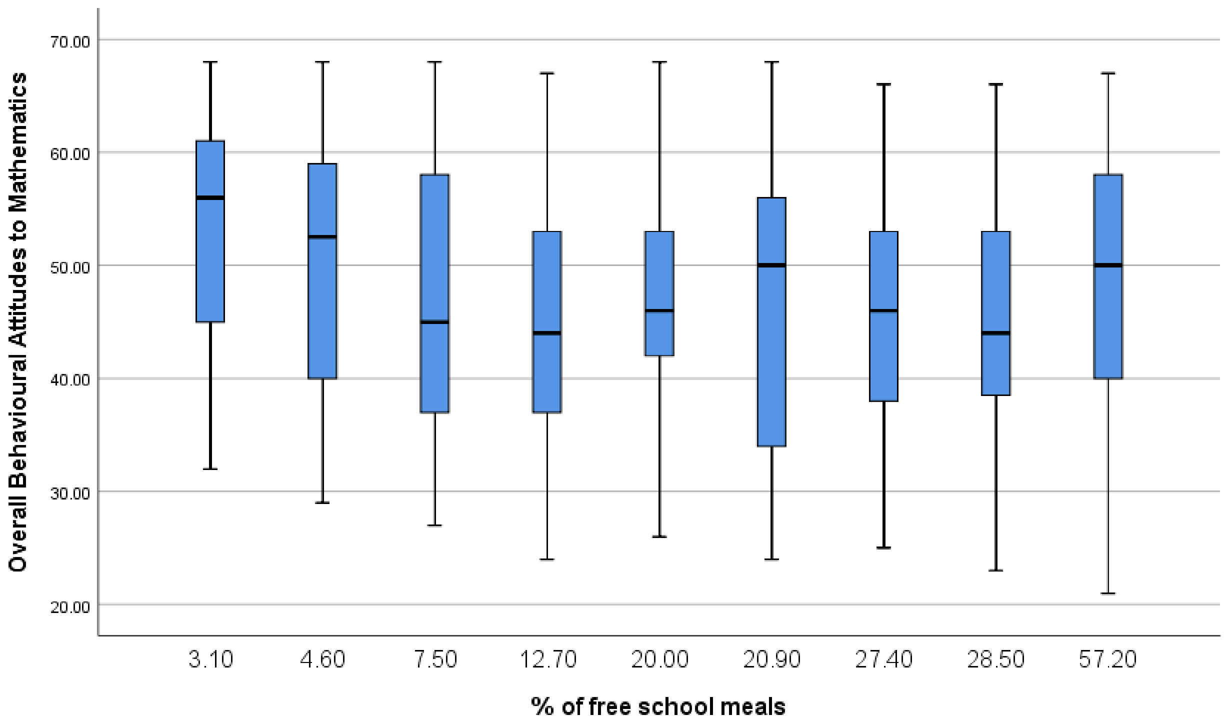
30
40
50
60
70



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for FSM= 57.20
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
40
60
80



Overall Behavioural Attitudes to Mathematics
% of free school meals
70.00
60.00
50.00
40.00
30.00
20.00
3.10
4.60
7.50
12.70
20.00
20.90
27.40
28.50
57.20

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
3.10	54	53.8333	10.07285	1.37074	51.0840	56.5827	32.00	68.00
4.60	44	49.9091	11.67549	1.76015	46.3594	53.4588	29.00	68.00
7.50	53	48.0566	12.41032	1.70469	44.6359	51.4773	27.00	68.00
12.70	51	44.6863	10.61977	1.48707	41.6994	47.6731	24.00	67.00
20.00	49	47.5102	10.67732	1.52533	44.4433	50.5771	26.00	68.00
20.90	45	47.0444	12.62025	1.88132	43.2529	50.8360	24.00	68.00
27.40	22	45.2727	11.43587	2.43814	40.2023	50.3431	25.00	66.00
28.50	48	44.5000	11.51872	1.66258	41.1553	47.8447	23.00	66.00
57.20	73	48.2192	12.01879	1.40669	45.4150	51.0234	21.00	67.00
Total	439	47.8952	11.71495	.55912	46.7963	48.9941	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	.952	8	430	.473
	Based on Median	.745	8	430	.652
	Based on Median and with adjusted df	.745	8	420.923	.652
	Based on trimmed mean	.944	8	430	.480

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3361.220	8	420.153	3.184	.002
Within Groups	56749.960	430	131.977		
Total	60111.180	438			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) % of free school meals	(J) % of free school meals	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
3.10	4.60	3.92424	2.33313	.944	-5.3143	13.1628
	7.50	5.77673	2.22129	.563	-3.0190	14.5725
	12.70	9.14706*	2.24317	.037	.2647	18.0294
	20.00	6.32313	2.26659	.457	-2.6520	15.2982
	20.90	6.78889	2.31880	.382	-2.3929	15.9707
	27.40	8.56061	2.90568	.372	-2.9451	20.0663
	28.50	9.33333*	2.27893	.035	.3094	18.3573
	57.20	5.61416	2.06202	.494	-2.5509	13.7792
4.60	3.10	-3.92424	2.33313	.944	-13.1628	5.3143
	7.50	1.85249	2.34299	1.000	-7.4251	11.1301
	12.70	5.22282	2.36374	.769	-4.1370	14.5826
	20.00	2.39889	2.38597	.998	-7.0489	11.8467

	20.90	2.86465	2.43563	.994	-6.7798	12.5091
	27.40	4.63636	2.99973	.966	-7.2418	16.5145
	28.50	5.40909	2.39770	.747	-4.0852	14.9034
	57.20	1.68991	2.19257	1.000	-6.9921	10.3719
7.50	3.10	-5.77673	2.22129	.563	-14.5725	3.0190
	4.60	-1.85249	2.34299	1.000	-11.1301	7.4251
	12.70	3.37033	2.25342	.972	-5.5526	12.2933
	20.00	.54640	2.27674	1.000	-8.4689	9.5617
	20.90	1.01216	2.32872	1.000	-8.2090	10.2333
	27.40	2.78388	2.91360	.999	-8.7532	14.3210
	28.50	3.55660	2.28903	.965	-5.5073	12.6205
	57.20	-.16257	2.07317	1.000	-8.3718	8.0466
12.70	3.10	-9.14706*	2.24317	.037	-18.0294	-.2647
	4.60	-5.22282	2.36374	.769	-14.5826	4.1370
	7.50	-3.37033	2.25342	.972	-12.2933	5.5526
	20.00	-2.82393	2.29808	.992	-11.9237	6.2759
	20.90	-2.35817	2.34959	.998	-11.6619	6.9456
	27.40	-.58645	2.93031	1.000	-12.1897	11.0168
	28.50	.18627	2.31026	1.000	-8.9617	9.3343
	57.20	-3.53290	2.09659	.943	-11.8348	4.7690
20.00	3.10	-6.32313	2.26659	.457	-15.2982	2.6520
	4.60	-2.39889	2.38597	.998	-11.8467	7.0489
	7.50	-.54640	2.27674	1.000	-9.5617	8.4689
	12.70	2.82393	2.29808	.992	-6.2759	11.9237
	20.90	.46576	2.37196	1.000	-8.9266	9.8581
	27.40	2.23748	2.94828	1.000	-9.4369	13.9119

	28.50	3.01020	2.33301	.989	-6.2279	12.2483
	57.20	-.70897	2.12163	1.000	-9.1101	7.6921
20.90	3.10	-6.78889	2.31880	.382	-15.9707	2.3929
	4.60	-2.86465	2.43563	.994	-12.5091	6.7798
	7.50	-1.01216	2.32872	1.000	-10.2333	8.2090
	12.70	2.35817	2.34959	.998	-6.9456	11.6619
	20.00	-.46576	2.37196	1.000	-9.8581	8.9266
	27.40	1.77172	2.98860	1.000	-10.0624	13.6058
	28.50	2.54444	2.38376	.997	-6.8946	11.9835
	57.20	-1.17473	2.17732	1.000	-9.7963	7.4469
27.40	3.10	-8.56061	2.90568	.372	-20.0663	2.9451
	4.60	-4.63636	2.99973	.966	-16.5145	7.2418
	7.50	-2.78388	2.91360	.999	-14.3210	8.7532
	12.70	.58645	2.93031	1.000	-11.0168	12.1897
	20.00	-2.23748	2.94828	1.000	-13.9119	9.4369
	20.90	-1.77172	2.98860	1.000	-13.6058	10.0624
	28.50	.77273	2.95778	1.000	-10.9393	12.4847
	57.20	-2.94645	2.79407	.997	-14.0102	8.1173
28.50	3.10	-9.33333*	2.27893	.035	-18.3573	-.3094
	4.60	-5.40909	2.39770	.747	-14.9034	4.0852
	7.50	-3.55660	2.28903	.965	-12.6205	5.5073
	12.70	-.18627	2.31026	1.000	-9.3343	8.9617
	20.00	-3.01020	2.33301	.989	-12.2483	6.2279
	20.90	-2.54444	2.38376	.997	-11.9835	6.8946
	27.40	-.77273	2.95778	1.000	-12.4847	10.9393
	57.20	-3.71918	2.13481	.931	-12.1725	4.7341

57.20	3.10	-5.61416	2.06202	.494	-13.7792	2.5509
	4.60	-1.68991	2.19257	1.000	-10.3719	6.9921
	7.50	.16257	2.07317	1.000	-8.0466	8.3718
	12.70	3.53290	2.09659	.943	-4.7690	11.8348
	20.00	.70897	2.12163	1.000	-7.6921	9.1101
	20.90	1.17473	2.17732	1.000	-7.4469	9.7963
	27.40	2.94645	2.79407	.997	-8.1173	14.0102
	28.50	3.71918	2.13481	.931	-4.7341	12.1725

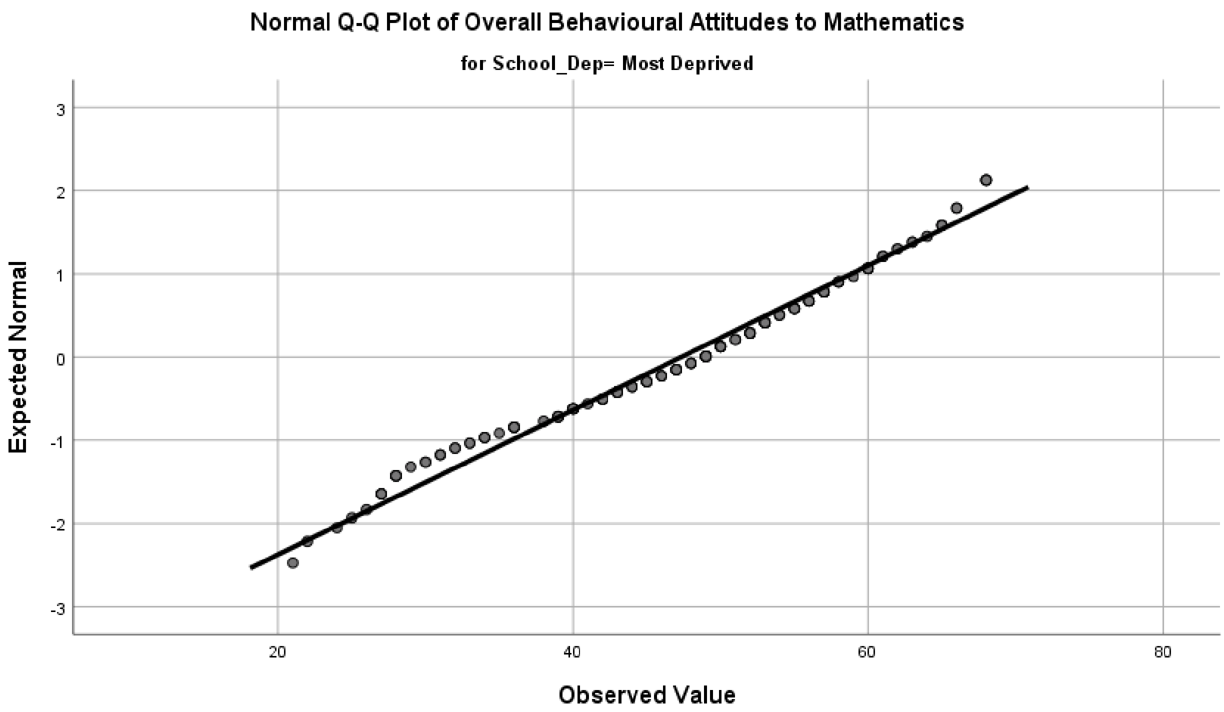
*. The mean difference is significant at the 0.05 level.

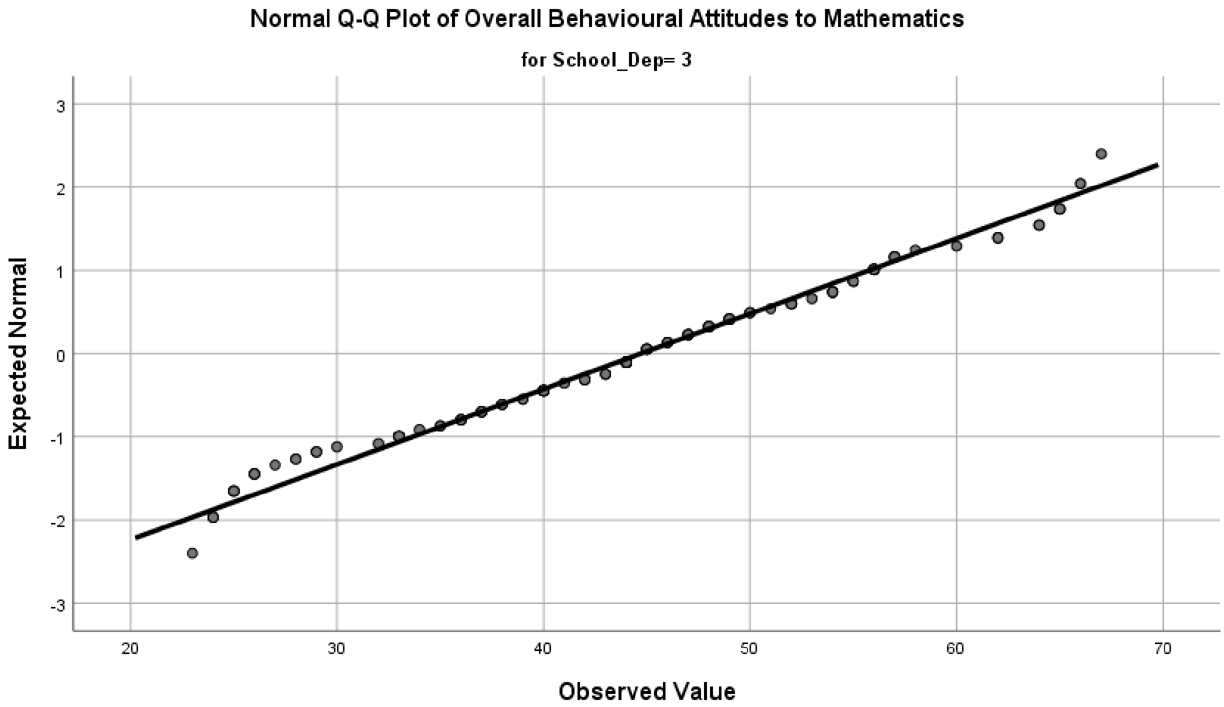
IMD and BAM

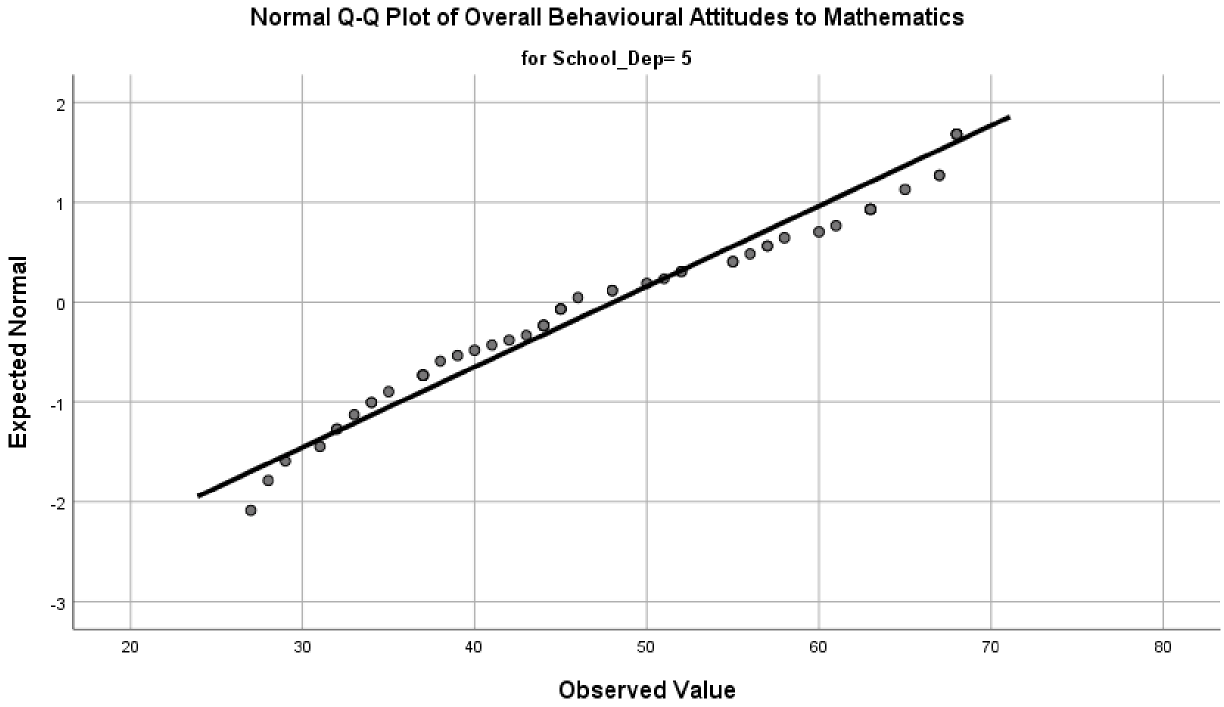
Descriptives

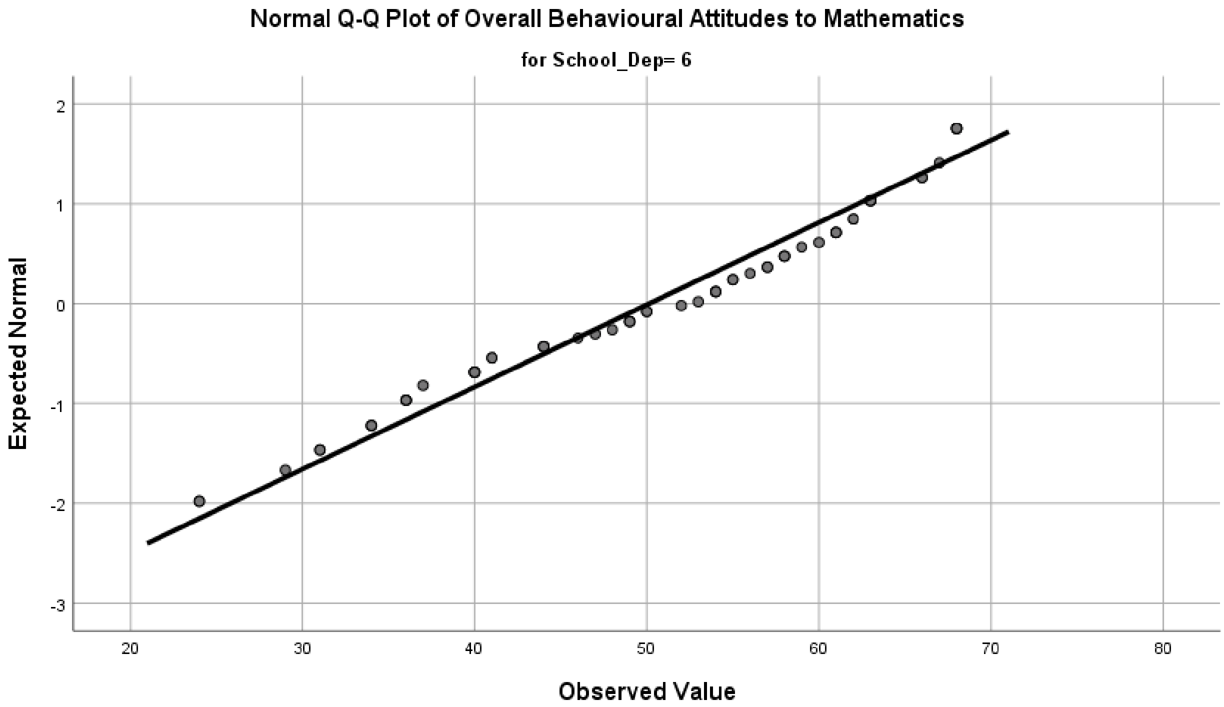
	School IMD Decile			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Most Deprived	Mean		47.3356	.94318
		95% Confidence Interval for Mean	Lower Bound	45.4717	
			Upper Bound	49.1994	
		5% Trimmed Mean		47.5063	
		Median		49.0000	
		Variance		132.549	
		Std. Deviation		11.51298	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		16.50	
		Skewness		-.304	.199
		Kurtosis		-.687	.395
	3	Mean		44.7190	1.00380
		95% Confidence Interval for Mean	Lower Bound	42.7316	
			Upper Bound	46.7065	
		5% Trimmed Mean		44.6974	
		Median		44.0000	
		Variance		121.920	
		Std. Deviation		11.04176	
		Minimum		23.00	
		Maximum		67.00	
		Range		44.00	
		Interquartile Range		16.50	
		Skewness		-.047	.220
		Kurtosis		-.575	.437
	5	Mean		48.0566	1.70469
		95% Confidence Interval for Mean	Lower Bound	44.6359	
			Upper Bound	51.4773	
		5% Trimmed Mean		48.0702	
		Median		45.0000	
		Variance		154.016	
		Std. Deviation		12.41032	
		Minimum		27.00	
		Maximum		68.00	
		Range		41.00	

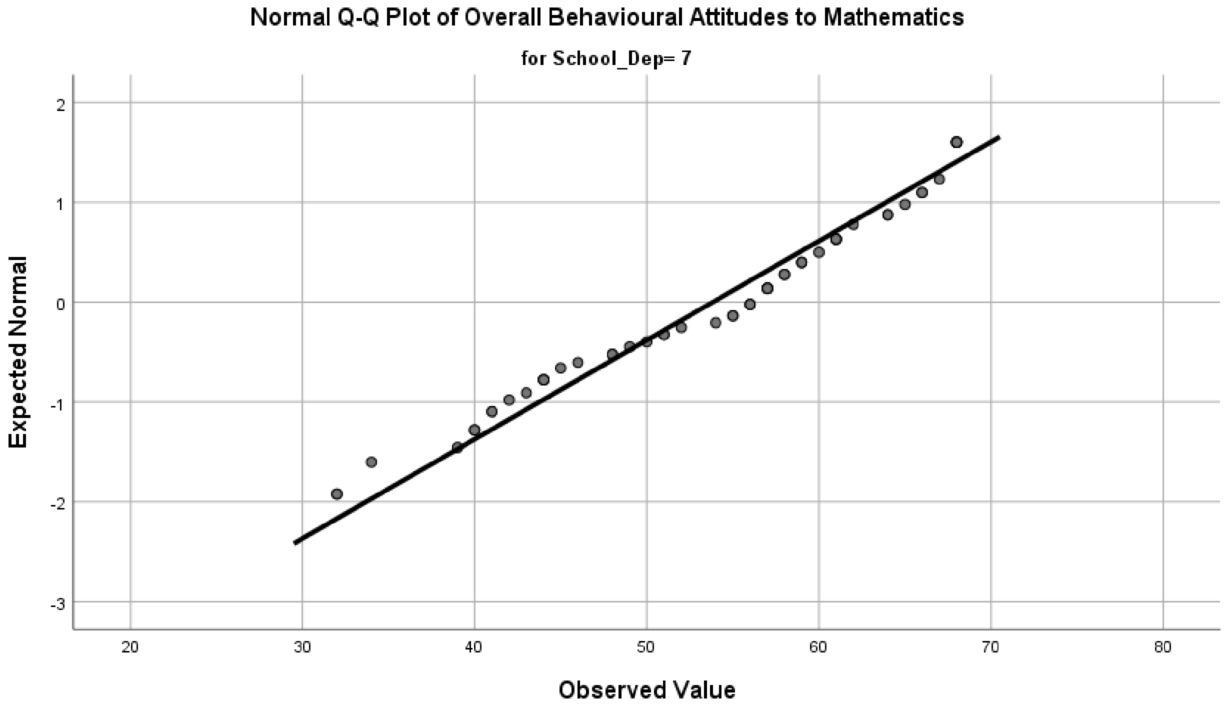
		Interquartile Range		22.00	
		Skewness		.143	.327
		Kurtosis		-1.174	.644
	6	Mean		50.1290	1.54219
		95% Confidence Interval for Mean	Lower Bound	47.0452	
			Upper Bound	53.2128	
		5% Trimmed Mean		50.4857	
		Median		52.5000	
		Variance		147.458	
		Std. Deviation		12.14325	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		21.00	
		Skewness		-.340	.304
		Kurtosis		-.912	.599
	7	Mean		53.8333	1.37074
		95% Confidence Interval for Mean	Lower Bound	51.0840	
			Upper Bound	56.5827	
		5% Trimmed Mean		54.2305	
		Median		56.0000	
		Variance		101.462	
		Std. Deviation		10.07285	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.25	
		Skewness		-.430	.325
		Kurtosis		-.732	.639

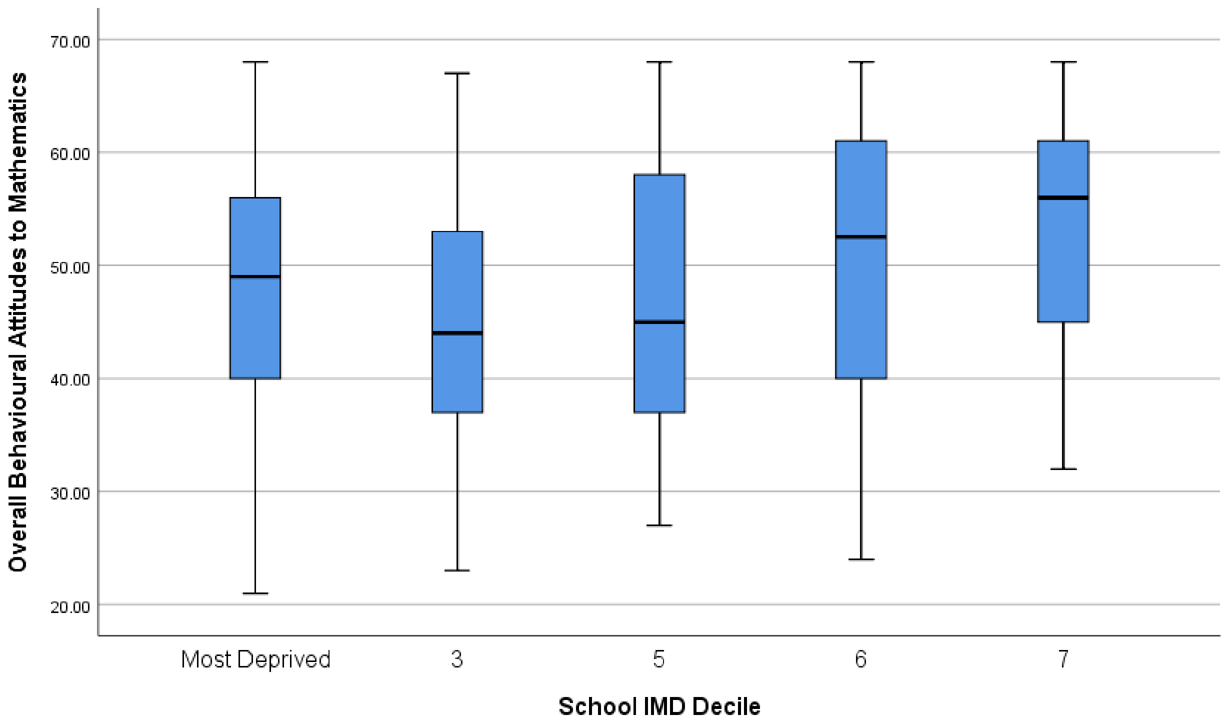

Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for School_Dep= Most Deprived
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for School_Dep= 3
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for School_Dep= 5
Expected Normal
2
1
0
-1
-2
-3
20
30
40
50
60
70
80
Observed Value


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for School_Dep= 6
Expected Normal
2
1
0
-1
-2
-3
20
30
40
50
60
70
80
Observed Value


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for School_Dep= 7
Expected Normal
2
1
0
-1
-2
-3
20
30
40
50
60
70
80
Observed Value


Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Most Deprived
3
5
6
7
School IMD Decile

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Most Deprived	149	47.3356	11.51298	.94318	45.4717	49.1994	21.00	68.00
3	121	44.7190	11.04176	1.00380	42.7316	46.7065	23.00	67.00
5	53	48.0566	12.41032	1.70469	44.6359	51.4773	27.00	68.00
6	62	50.1290	12.14325	1.54219	47.0452	53.2128	24.00	68.00
7	54	53.8333	10.07285	1.37074	51.0840	56.5827	32.00	68.00
Total	439	47.8952	11.71495	.55912	46.7963	48.9941	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	1.385	4	434	.238
	Based on Median	1.245	4	434	.291
	Based on Median and with adjusted df	1.245	4	431.294	.291
	Based on trimmed mean	1.409	4	434	.230

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.

Between Groups	3482.214	4	870.554	6.672	.000
Within Groups	56628.966	434	130.481		
Total	60111.180	438			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) School IMD Decile	(J) School IMD Decile	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Most Deprived	3	2.61656	1.39788	.478	-1.7078	6.9410
	5	-.72103	1.82692	.997	-6.3727	4.9306
	6	-2.79346	1.72634	.624	-8.1340	2.5470
	7	-6.49776*	1.81440	.013	-12.1107	-.8849
3	Most Deprived	-2.61656	1.39788	.478	-6.9410	1.7078
	5	-3.33760	1.88156	.534	-9.1583	2.4831
	6	-5.41002	1.78407	.058	-10.9291	.1091
	7	-9.11433*	1.86941	.000	-14.8974	-3.3312
5	Most Deprived	.72103	1.82692	.997	-4.9306	6.3727
	3	3.33760	1.88156	.534	-2.4831	9.1583
	6	-2.07243	2.13693	.919	-8.6831	4.5382
	7	-5.77673	2.20867	.147	-12.6093	1.0559
6	Most Deprived	2.79346	1.72634	.624	-2.5470	8.1340
	3	5.41002	1.78407	.058	-.1091	10.9291
	5	2.07243	2.13693	.919	-4.5382	8.6831
	7	-3.70430	2.12623	.553	-10.2819	2.8733

7	Most Deprived	6.49776*	1.81440	.013	.8849	12.1107
	3	9.11433*	1.86941	.000	3.3312	14.8974
	5	5.77673	2.20867	.147	-1.0559	12.6093
	6	3.70430	2.12623	.553	-2.8733	10.2819

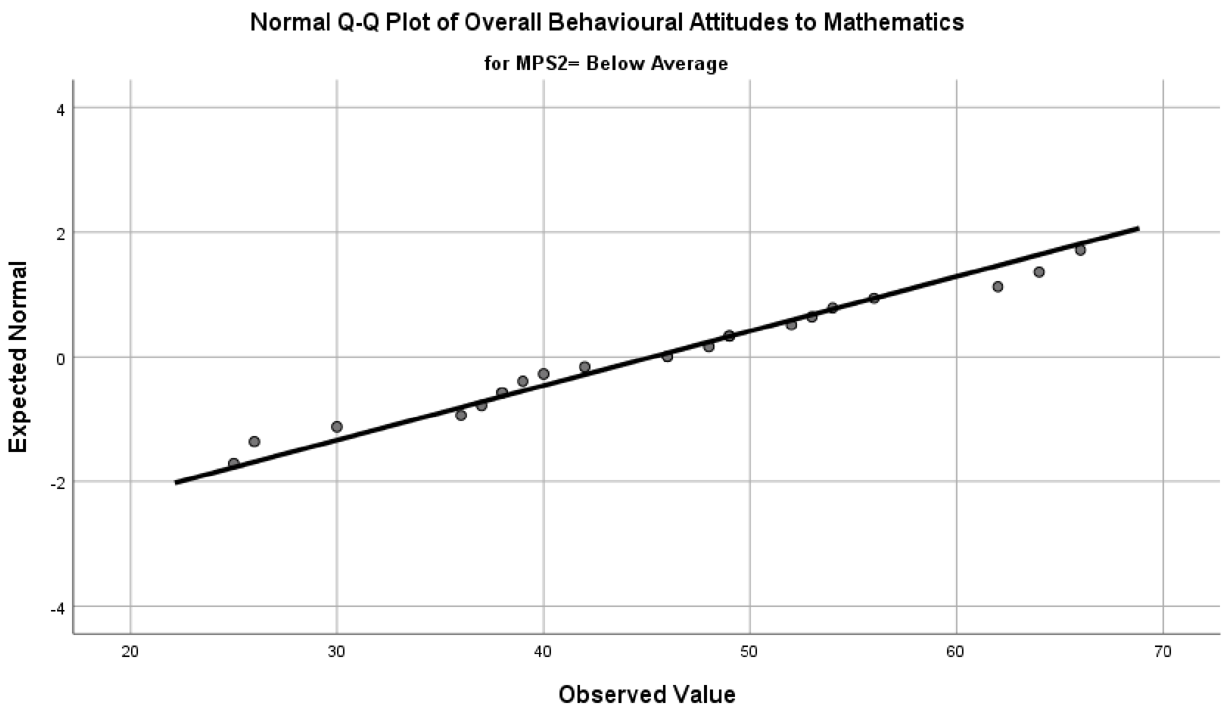
*. The mean difference is significant at the 0.05 level.

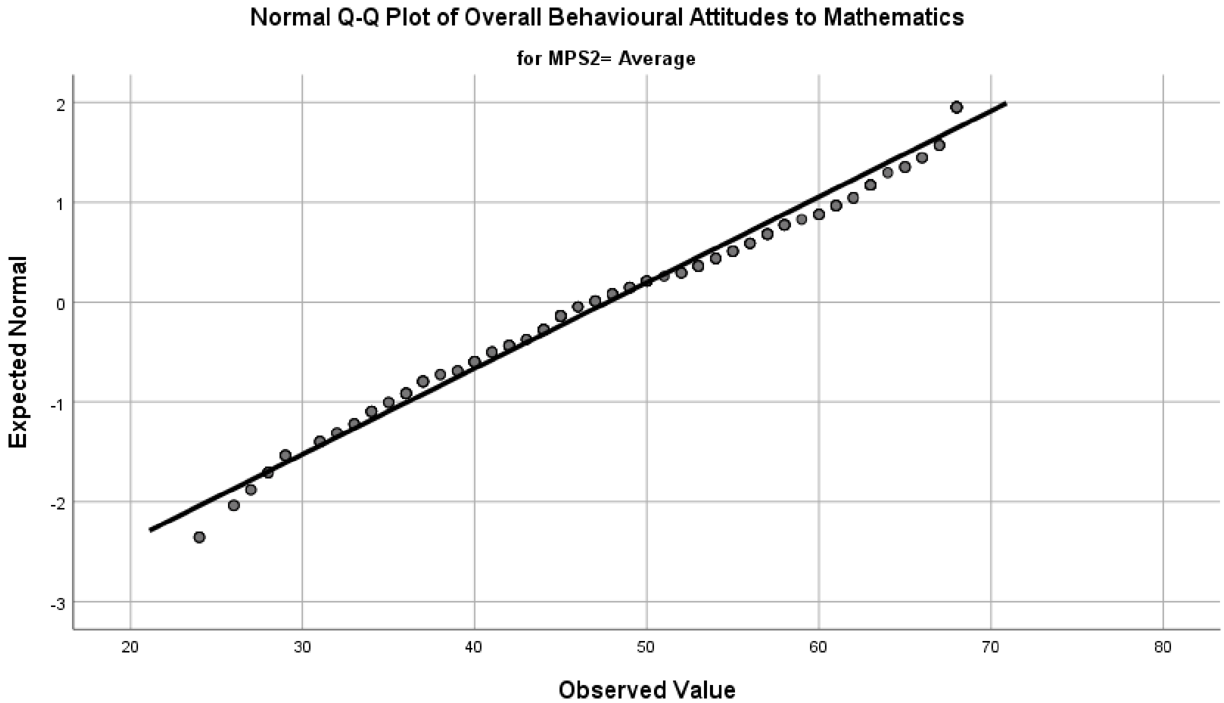
MPS2 and BAM

Descriptives

	Maths Progress Score 2 (Average)			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Below Average	Mean		45.2727	2.43814
		95% Confidence Interval for Mean	Lower Bound	40.2023	
			Upper Bound	50.3431	
		5% Trimmed Mean		45.2525	
		Median		46.0000	
		Variance		130.779	
		Std. Deviation		11.43587	
		Minimum		25.00	
		Maximum		66.00	
		Range		41.00	
		Interquartile Range		15.50	
		Skewness		.047	.491
		Kurtosis		-.544	.953
	Average	Mean		47.7302	.79326
		95% Confidence Interval for Mean	Lower Bound	46.1666	
			Upper Bound	49.2938	
		5% Trimmed Mean		47.7972	
		Median		47.0000	
		Variance		135.291	
		Std. Deviation		11.63148	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	
		Interquartile Range		18.00	
		Skewness		.004	.166
		Kurtosis		-.909	.330
	Above Average	Mean		46.3581	.97364
		95% Confidence Interval for Mean	Lower Bound	44.4340	
			Upper Bound	48.2822	
		5% Trimmed Mean		46.5390	
		Median		48.5000	
		Variance		140.299	
		Std. Deviation		11.84481	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		16.75	

		Skewness		-.330	.199
		Kurtosis		-.754	.396
	Well Above Average	Mean		53.8333	1.37074
		95% Confidence Interval for Mean	Lower Bound	51.0840	
			Upper Bound	56.5827	
		5% Trimmed Mean		54.2305	
		Median		56.0000	
		Variance		101.462	
		Std. Deviation		10.07285	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.25	
		Skewness		-.430	.325
		Kurtosis		-.732	.639




Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for MPS2= Average
Expected Normal
Observed Value
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1
0
-1
-2
-3
20
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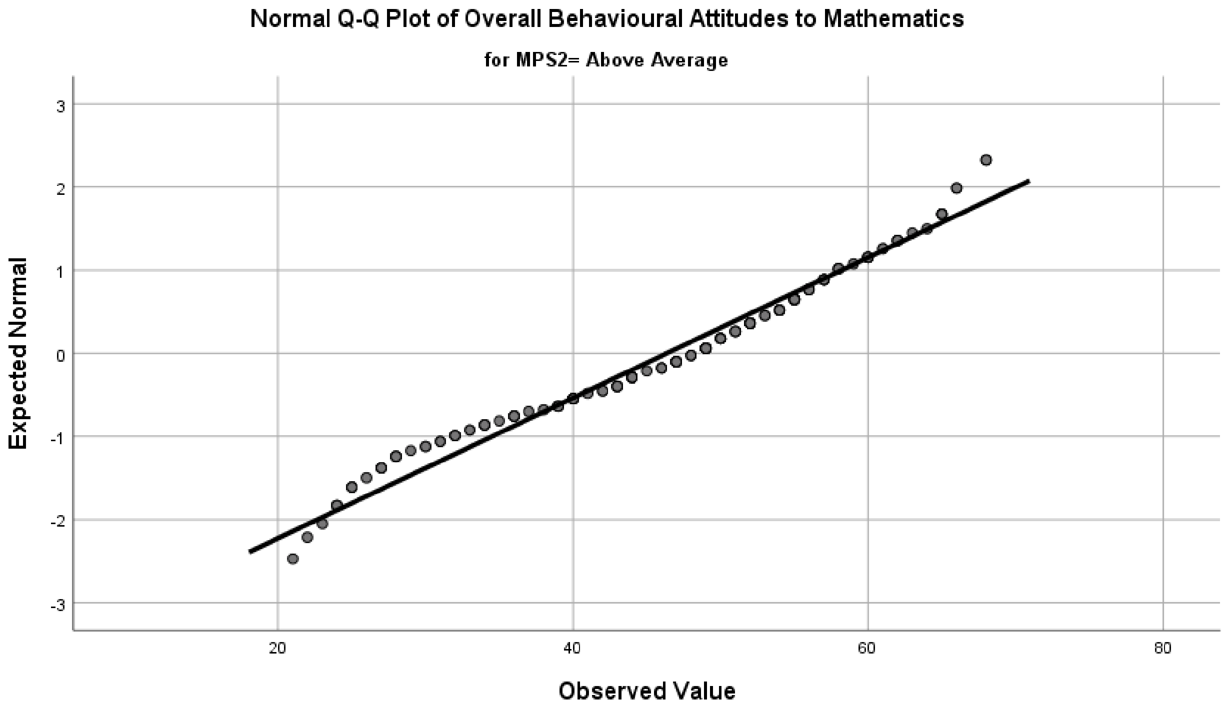
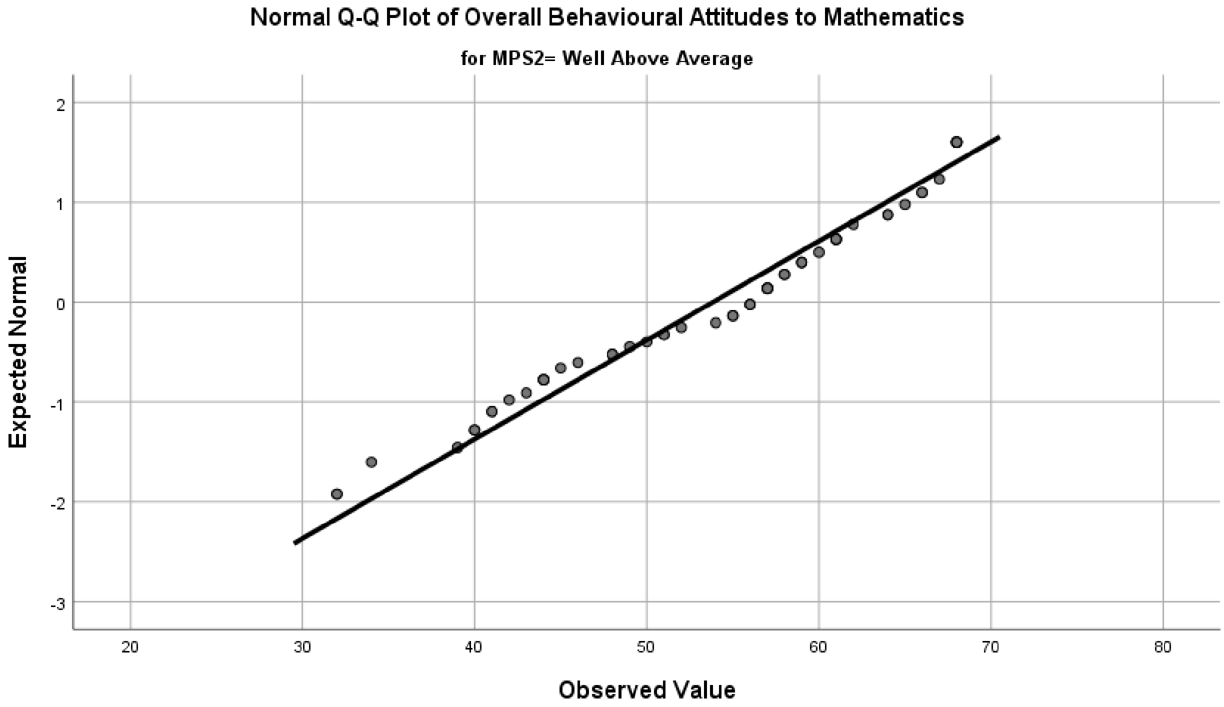
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for MPS2= Above Average
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
40
60
80



Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for MPS2= Well Above Average
Expected Normal
2
1
0
-1
-2
-3
20
30
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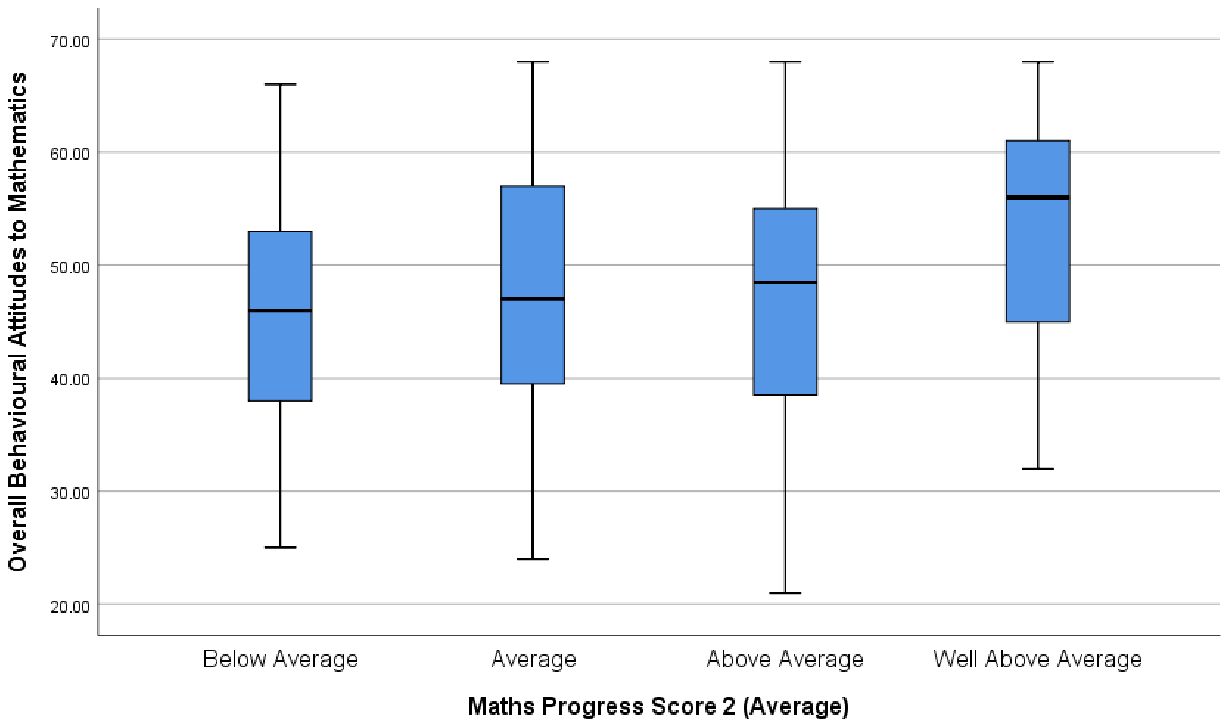
50
60
70
80
Observed Value



Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
Below Average
Average
Above Average
Well Above Average
Maths Progress Score 2 (Average)

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Below Average	22	45.2727	11.43587	2.43814	40.2023	50.3431	25.00	66.00
Average	215	47.7302	11.63148	.79326	46.1666	49.2938	24.00	68.00
Above Average	148	46.3581	11.84481	.97364	44.4340	48.2822	21.00	68.00
Well Above Average	54	53.8333	10.07285	1.37074	51.0840	56.5827	32.00	68.00
Total	439	47.8952	11.71495	.55912	46.7963	48.9941	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	.710	3	435	.547
	Based on Median	.839	3	435	.473
	Based on Median and with adjusted df	.839	3	429.008	.473
	Based on trimmed mean	.763	3	435	.515

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2410.943	3	803.648	6.059	.000
Within Groups	57700.237	435	132.644		

Total	60111.180	438			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

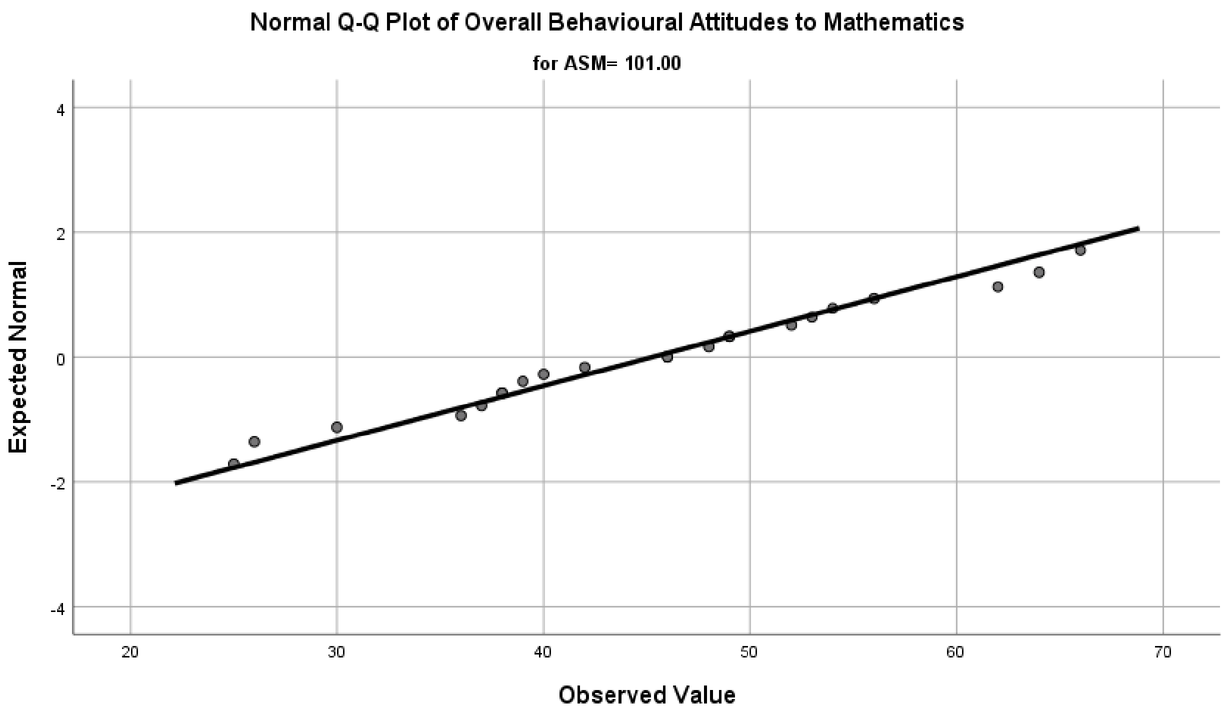
(I) Maths Progress Score 2 (Average)	(J) Maths Progress Score 2 (Average)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Below Average	Average	-2.45751	2.57803	.823	-9.6926	4.7776
	Above Average	-1.08538	2.63164	.982	-8.4710	6.3002
	Well Above Average	-8.56061*	2.91302	.036	-16.7359	-.3853
Average	Below Average	2.45751	2.57803	.823	-4.7776	9.6926
	Above Average	1.37212	1.23012	.743	-2.0802	4.8244
	Well Above Average	-6.10310*	1.75309	.007	-11.0231	-1.1831
Above Average	Below Average	1.08538	2.63164	.982	-6.3002	8.4710
	Average	-1.37212	1.23012	.743	-4.8244	2.0802
	Well Above Average	-7.47523*	1.83102	.001	-12.6139	-2.3365
Well Above Average	Below Average	8.56061*	2.91302	.036	.3853	16.7359
	Average	6.10310*	1.75309	.007	1.1831	11.0231
	Above Average	7.47523*	1.83102	.001	2.3365	12.6139

*. The mean difference is significant at the 0.05 level.

Descriptives

	Average Score in Maths			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	101.00	Mean		45.2727	2.43814
		95% Confidence Interval for Mean	Lower Bound	40.2023	
			Upper Bound	50.3431	
		5% Trimmed Mean		45.2525	
		Median		46.0000	
		Variance		130.779	
		Std. Deviation		11.43587	
		Minimum		25.00	
		Maximum		66.00	
		Range		41.00	
		Interquartile Range		15.50	
		Skewness		.047	.491
		Kurtosis		-.544	.953
	104.00	Mean		46.8186	.82407
		95% Confidence Interval for Mean	Lower Bound	45.1938	
			Upper Bound	48.4435	
		5% Trimmed Mean		46.8813	
		Median		48.0000	
		Variance		138.533	
		Std. Deviation		11.77002	
		Minimum		21.00	
		Maximum		68.00	
		Range		47.00	
		Interquartile Range		19.00	
		Skewness		-.120	.170
		Kurtosis		-.870	.339
	105.00	Mean		48.9730	1.09555
		95% Confidence Interval for Mean	Lower Bound	46.8018	
			Upper Bound	51.1441	
		5% Trimmed Mean		49.1857	
		Median		49.0000	
		Variance		133.227	
		Std. Deviation		11.54238	
		Minimum		24.00	
		Maximum		68.00	
		Range		44.00	

		Interquartile Range		18.00	
		Skewness		-.160	.229
		Kurtosis		-.832	.455
	106.00	Mean		44.5000	1.66258
		95% Confidence Interval for Mean	Lower Bound	41.1553	
			Upper Bound	47.8447	
		5% Trimmed Mean		44.5000	
		Median		44.0000	
		Variance		132.681	
		Std. Deviation		11.51872	
		Minimum		23.00	
		Maximum		66.00	
		Range		43.00	
		Interquartile Range		15.75	
		Skewness		-.194	.343
		Kurtosis		-.508	.674
	109.00	Mean		53.8333	1.37074
		95% Confidence Interval for Mean	Lower Bound	51.0840	
			Upper Bound	56.5827	
		5% Trimmed Mean		54.2305	
		Median		56.0000	
		Variance		101.462	
		Std. Deviation		10.07285	
		Minimum		32.00	
		Maximum		68.00	
		Range		36.00	
		Interquartile Range		16.25	
		Skewness		-.430	.325
		Kurtosis		-.732	.639


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for ASM= 101.00
Expected Normal
Observed Value
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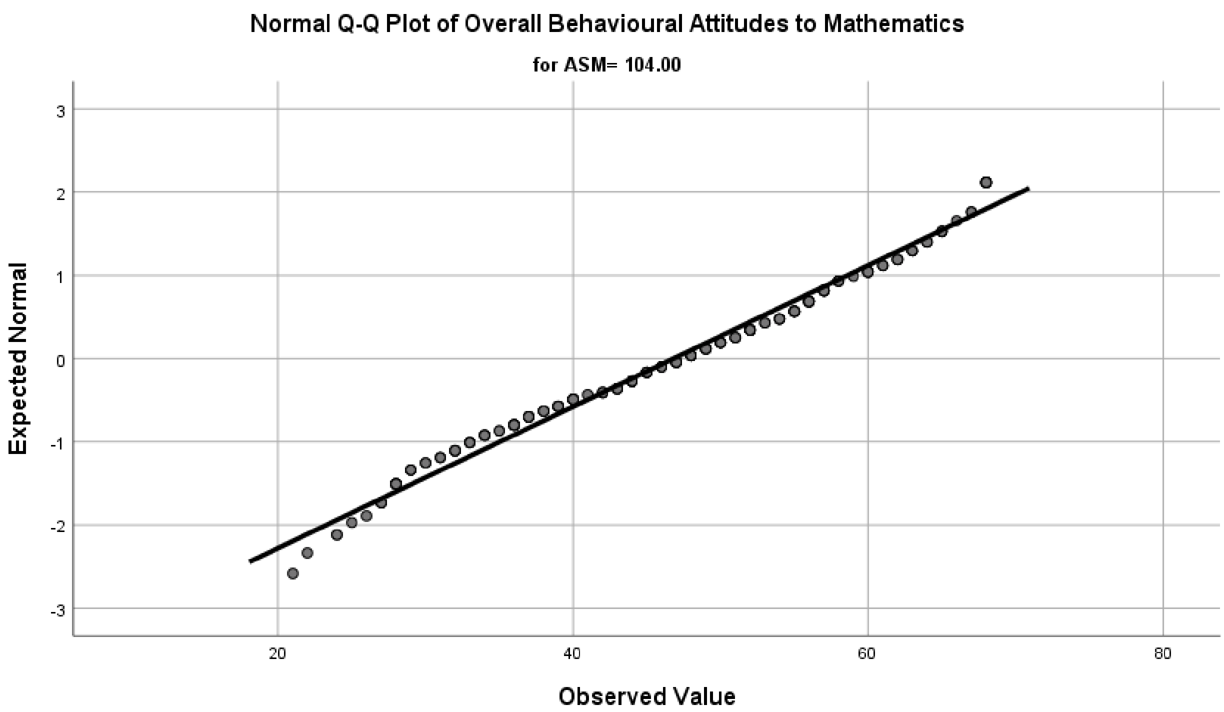
2
0
-2
-4
20
30
40
50
60
70


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for ASM= 104.00
Expected Normal
Observed Value
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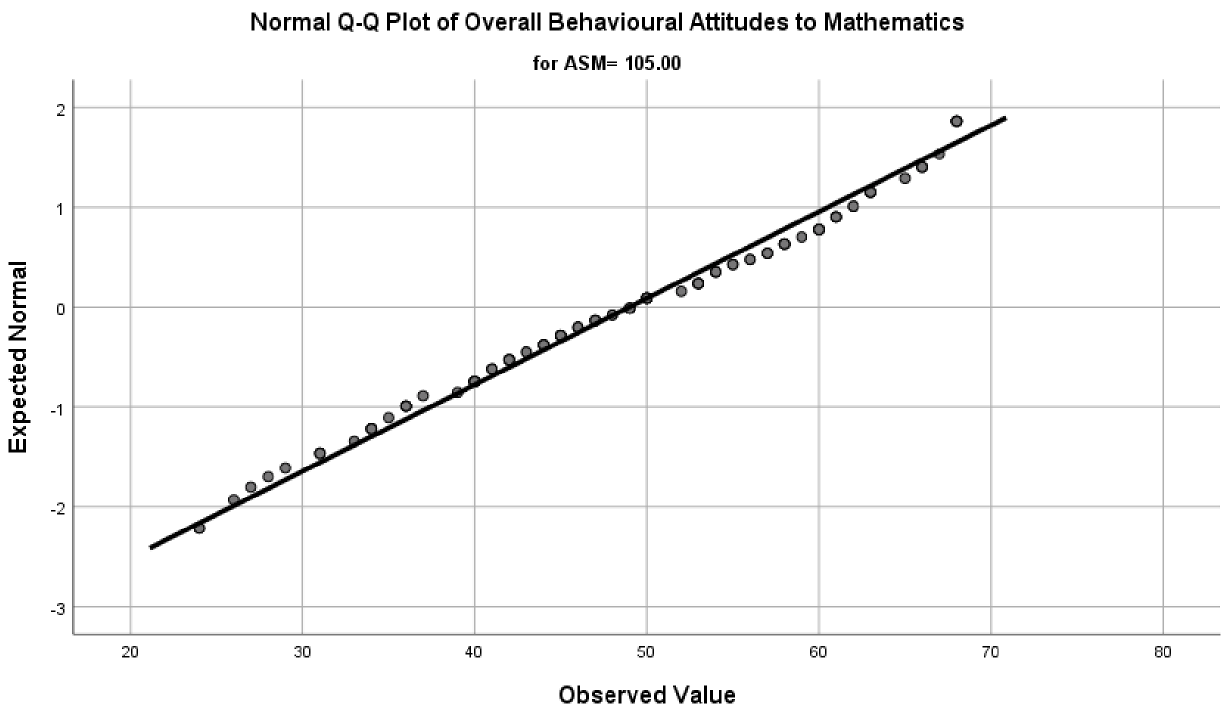
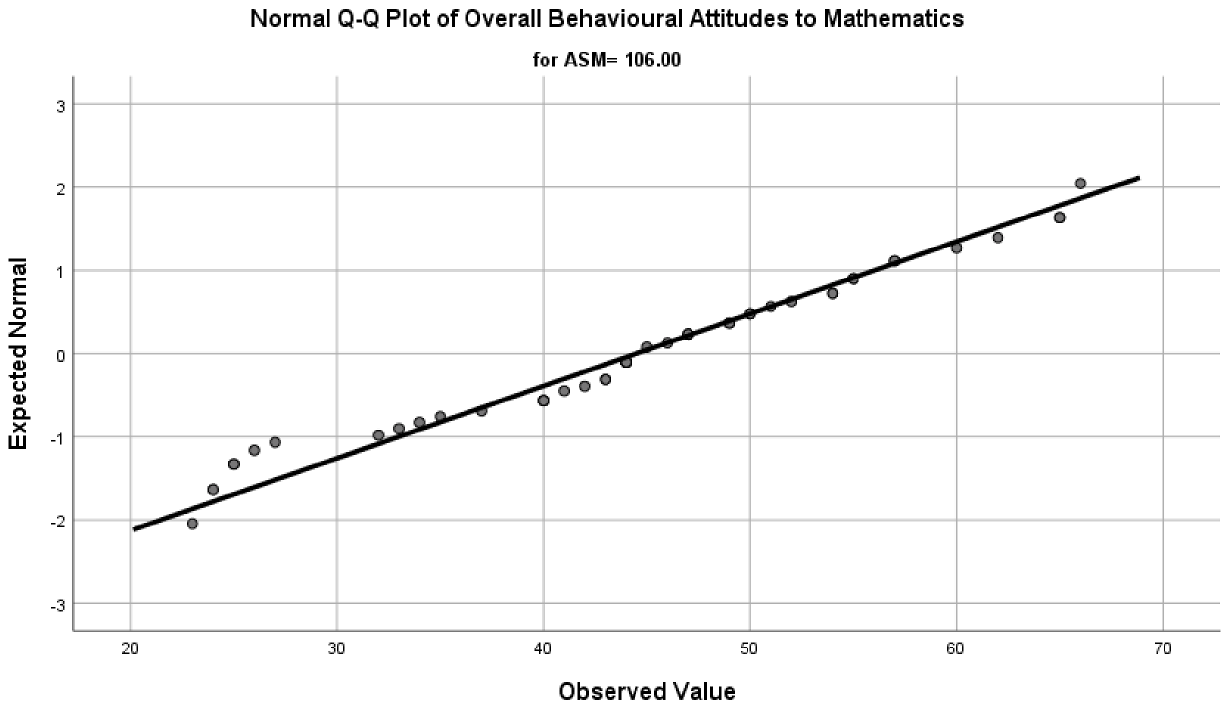
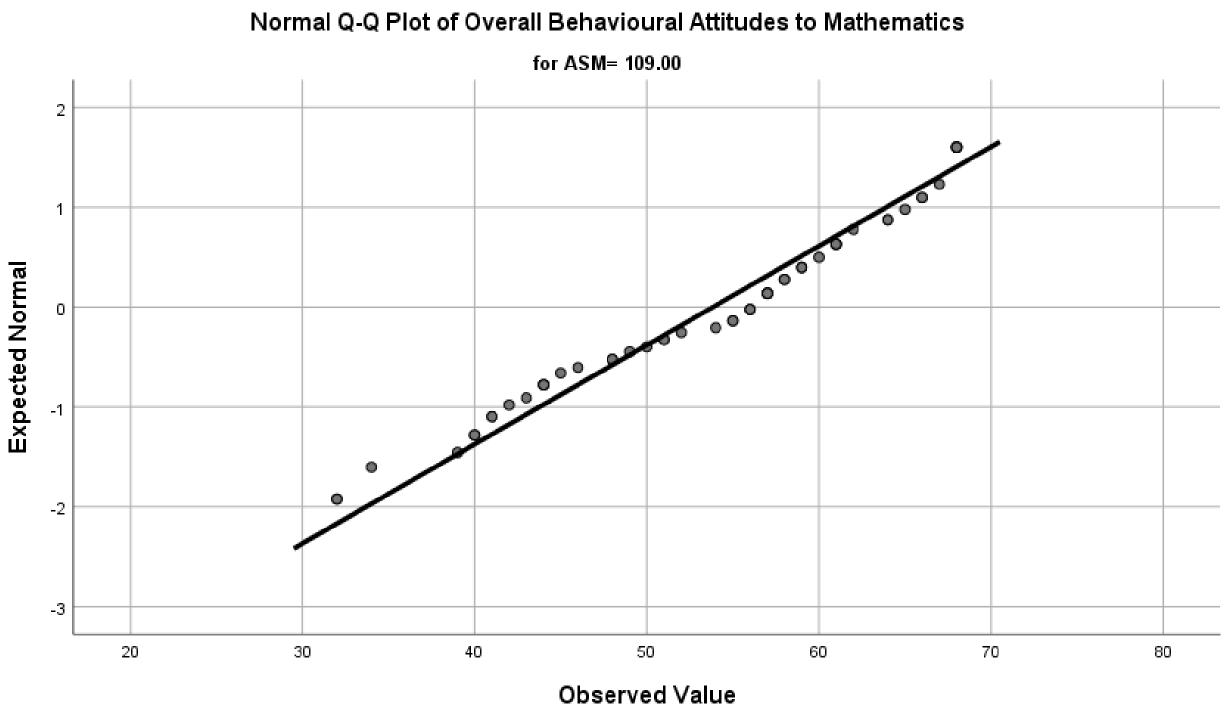
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for ASM= 105.00
Expected Normal
2
1
0
-1
-2
-3
20
30
40
50
60
70
80
Observed Value


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for ASM= 106.00
Expected Normal
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
Observed Value


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for ASM= 109.00
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
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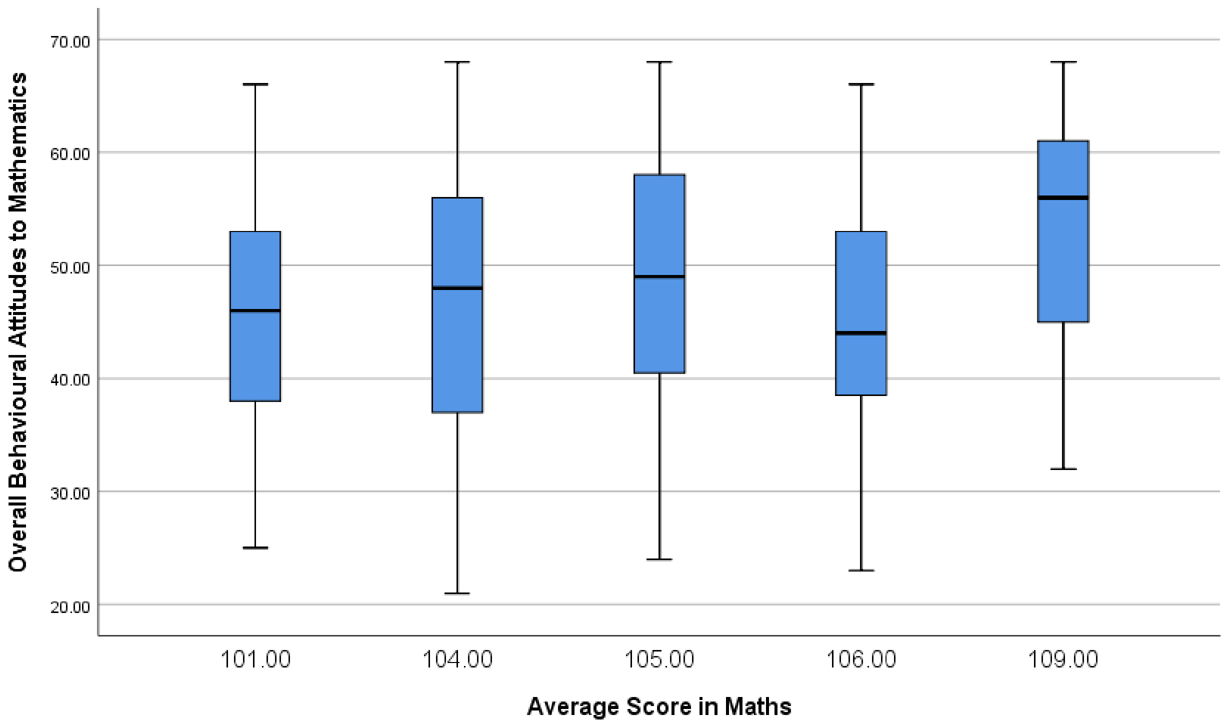
40
50
60
70
80


Overall Behavioural Attitudes to Mathematics
70.00
60.00
50.00
40.00
30.00
20.00
101.00
104.00
105.00
106.00
109.00
Average Score in Maths

Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
101.00	22	45.2727	11.43587	2.43814	40.2023	50.3431	25.00	66.00
104.00	204	46.8186	11.77002	.82407	45.1938	48.4435	21.00	68.00
105.00	111	48.9730	11.54238	1.09555	46.8018	51.1441	24.00	68.00
106.00	48	44.5000	11.51872	1.66258	41.1553	47.8447	23.00	66.00
109.00	54	53.8333	10.07285	1.37074	51.0840	56.5827	32.00	68.00
Total	439	47.8952	11.71495	.55912	46.7963	48.9941	21.00	68.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	.634	4	434	.638
	Based on Median	.781	4	434	.538
	Based on Median and with adjusted df	.781	4	430.290	.538
	Based on trimmed mean	.676	4	434	.609

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2974.108	4	743.527	5.648	.000

Within Groups	57137.072	434	131.652		
Total	60111.180	438			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) Average Score in Maths	(J) Average Score in Maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
101.00	104.00	-1.54590	2.57479	.986	-9.5111	6.4193
	105.00	-3.70025	2.67773	.752	-11.9839	4.5834
	106.00	.77273	2.95414	.999	-8.3660	9.9115
	109.00	-8.56061	2.90210	.071	-17.5384	.4172
104.00	101.00	1.54590	2.57479	.986	-6.4193	9.5111
	105.00	-2.15435	1.35330	.639	-6.3408	2.0321
	106.00	2.31863	1.84068	.811	-3.3756	8.0128
	109.00	-7.01471*	1.75595	.003	-12.4468	-1.5826
105.00	101.00	3.70025	2.67773	.752	-4.5834	11.9839
	104.00	2.15435	1.35330	.639	-2.0321	6.3408
	106.00	4.47297	1.98212	.280	-1.6588	10.6047
	109.00	-4.86036	1.90370	.166	-10.7495	1.0288
106.00	101.00	-.77273	2.95414	.999	-9.9115	8.3660
	104.00	-2.31863	1.84068	.811	-8.0128	3.3756
	105.00	-4.47297	1.98212	.280	-10.6047	1.6588
	109.00	-9.33333*	2.27613	.002	-16.3746	-2.2920
109.00	101.00	8.56061	2.90210	.071	-.4172	17.5384

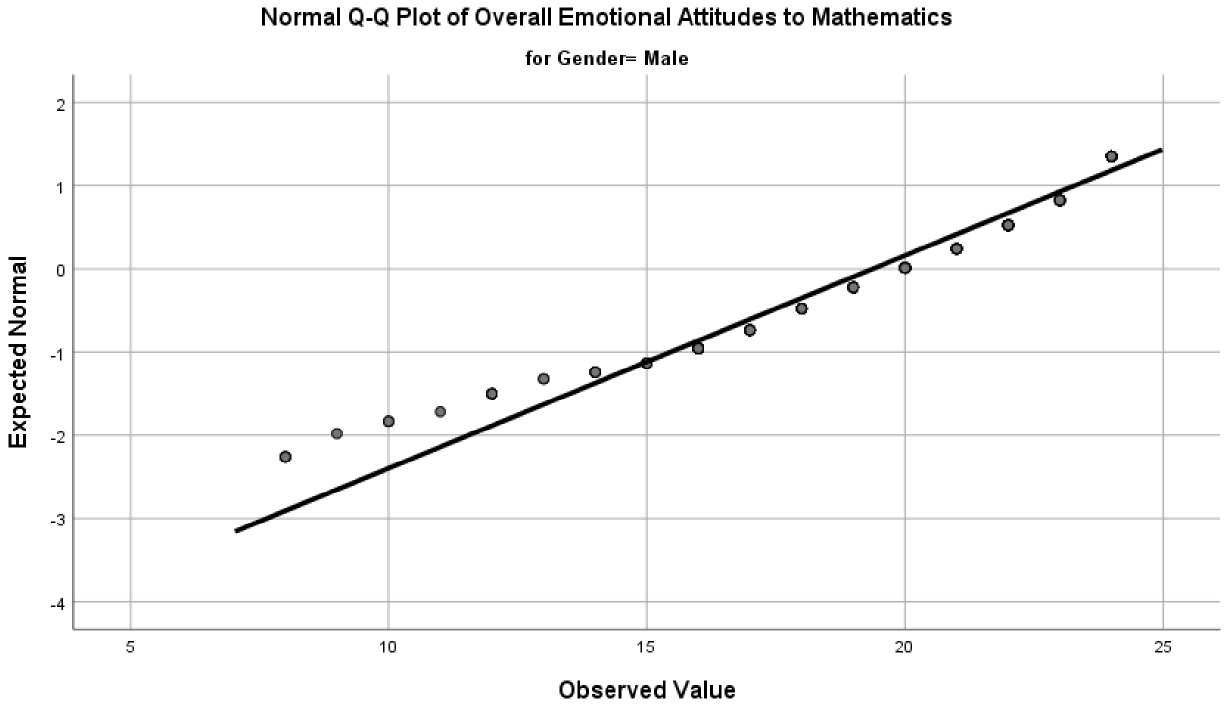
	104.00	7.01471*	1.75595	.003	1.5826	12.4468
	105.00	4.86036	1.90370	.166	-1.0288	10.7495
	106.00	9.33333*	2.27613	.002	2.2920	16.3746

*. The mean difference is significant at the 0.05 level.

Appendix E: Bivariate Analysis for All Independent Variables and EAM

Descriptives

	Pupil Gender			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Male	Mean		19.3732	.27050
		95% Confidence Interval for Mean	Lower Bound	18.8399	
			Upper Bound	19.9065	
		5% Trimmed Mean		19.6640	
		Median		20.0000	
		Variance		15.293	
		Std. Deviation		3.91059	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	
		Skewness		-.907	.168
		Kurtosis		.424	.335
	Female	Mean		18.0216	.28584
		95% Confidence Interval for Mean	Lower Bound	17.4584	
			Upper Bound	18.5848	
		5% Trimmed Mean		18.1785	
		Median		19.0000	
		Variance		18.873	
		Std. Deviation		4.34436	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.397	.160
		Kurtosis		-.729	.319


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Gender= Male
Expected Normal
Observed Value
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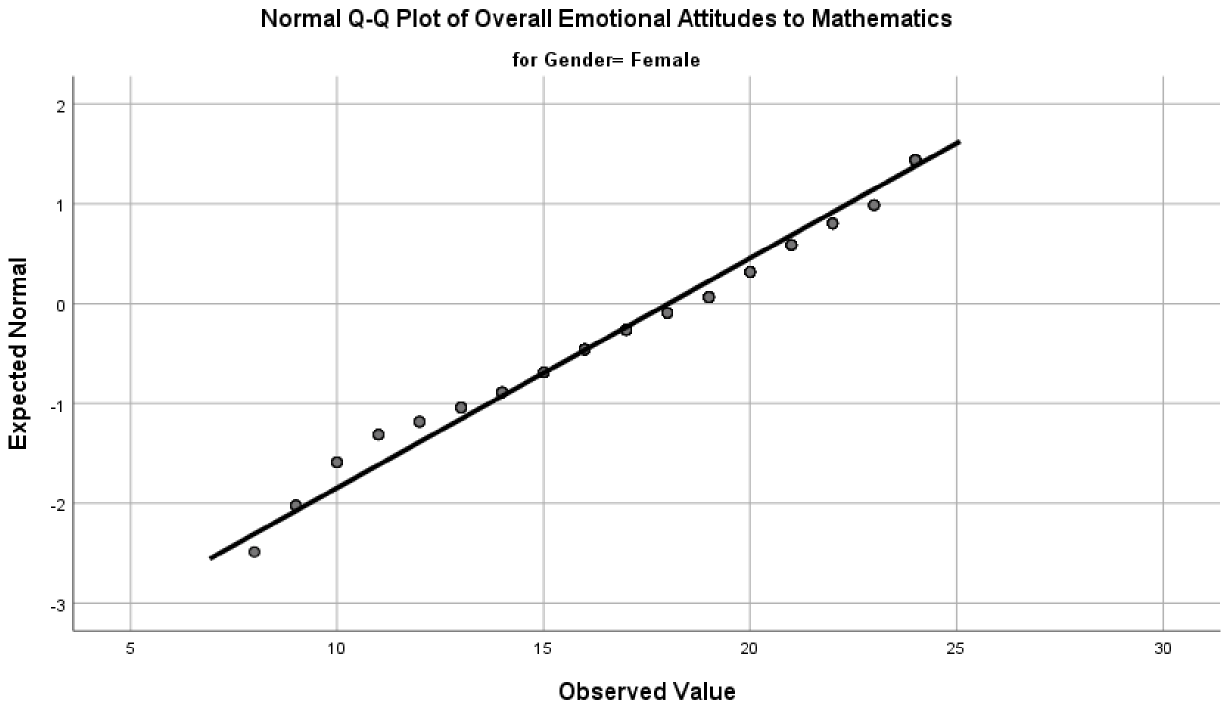
-1
-2
-3
-4
5
10
15
20
25


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Gender= Female
Expected Normal
Observed Value
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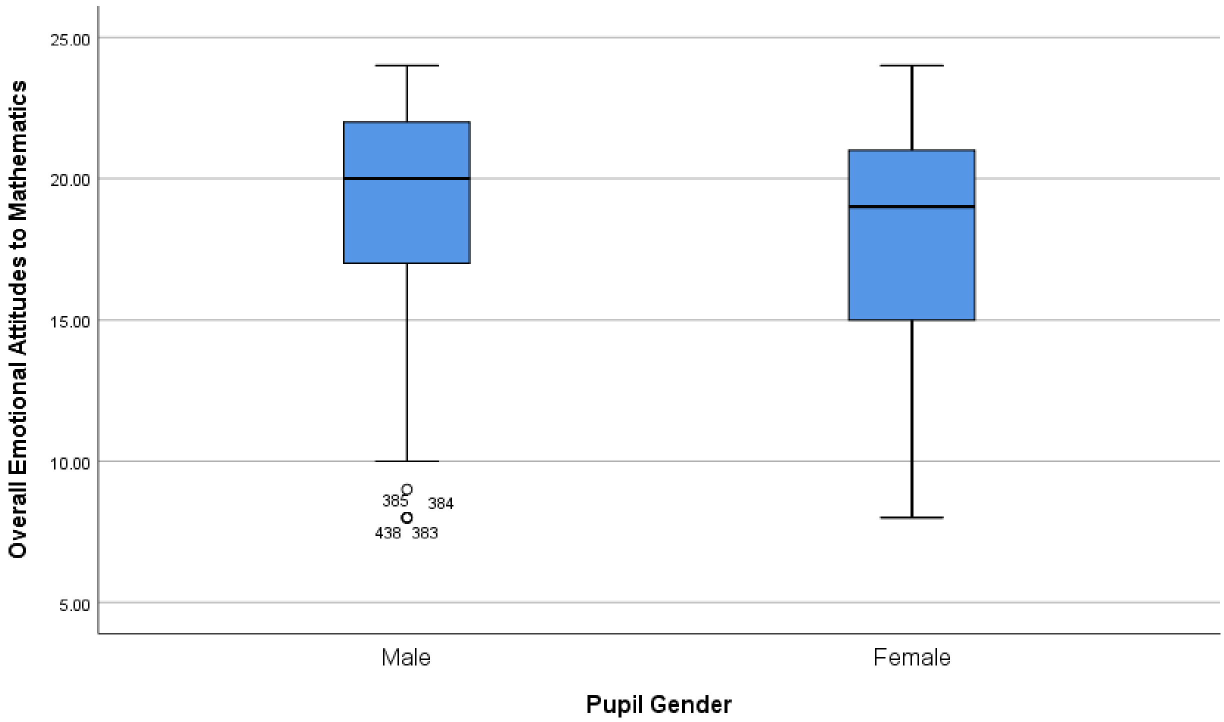
1
0
-1
-2
-3
5
10
15
20
25
30



Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	5.051	1	438	.025
	Based on Median	5.138	1	438	.024
	Based on Median and with adjusted df	5.138	1	437.486	.024
	Based on trimmed mean	5.413	1	438	.020

Ranks

	Pupil Gender	N	Mean Rank	Sum of Ranks
Overall Emotional Attitudes to Mathematics	Male	209	241.73	50521.00
	Female	231	201.29	46499.00
	Total	440		

Test Statistics[a]

	Overall Emotional Attitudes to Mathematics
Mann-Whitney U	19703.000
Wilcoxon W	46499.000
Z	-3.346
Asymp. Sig. (2-tailed)	.001

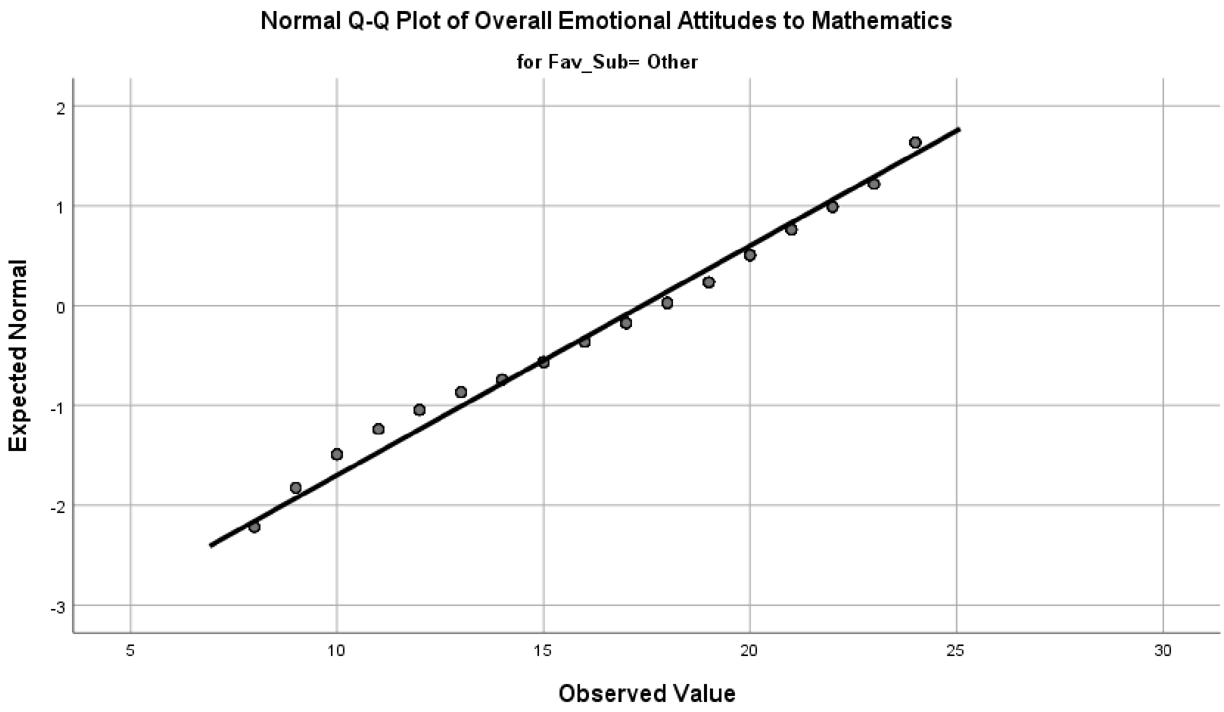
a. Grouping Variable: Pupil Gender

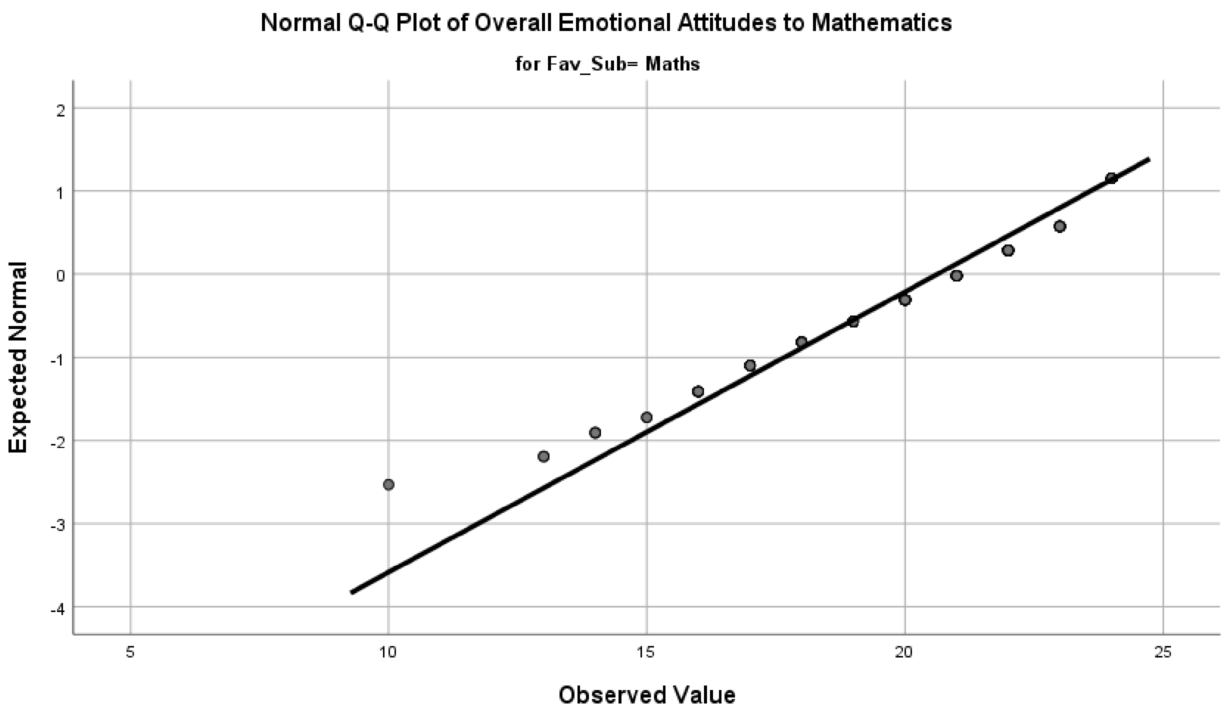
Fav Sub and EA

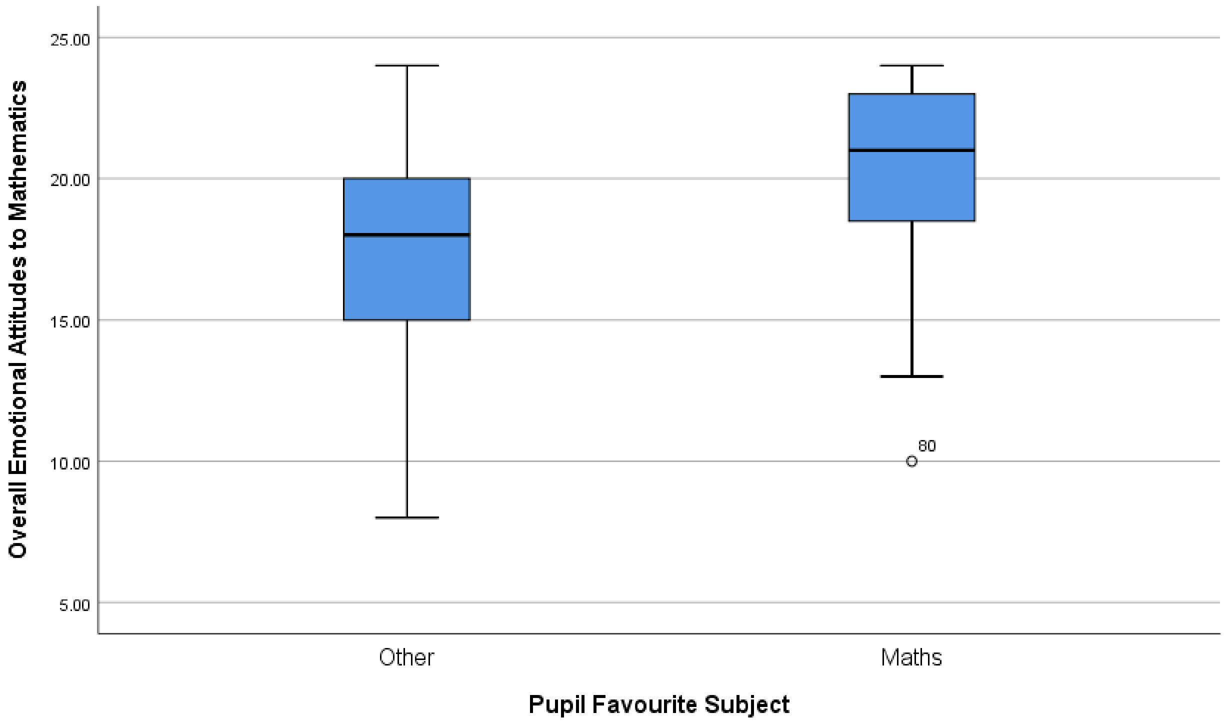
Descriptives

	Pupil Favourite Subject			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Other	Mean		17.3878	.26814
		95% Confidence Interval for Mean	Lower Bound	16.8598	
			Upper Bound	17.9158	
		5% Trimmed Mean		17.5027	
		Median		18.0000	
		Variance		18.910	
		Std. Deviation		4.34857	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	
		Skewness		-.330	.150
		Kurtosis		-.755	.299
	Maths	Mean		20.6307	.22353
		95% Confidence Interval for Mean	Lower Bound	20.1895	
			Upper Bound	21.0719	
		5% Trimmed Mean		20.8270	
		Median		21.0000	
		Variance		8.794	
		Std. Deviation		2.96551	
		Minimum		10.00	
		Maximum		24.00	

	Range	14.00	
	Interquartile Range	4.75	
	Skewness	-.734	.183
	Kurtosis	.073	.364







Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	30.482	1	437	.000
	Based on Median	27.926	1	437	.000
	Based on Median and with adjusted df	27.926	1	396.178	.000
	Based on trimmed mean	30.772	1	437	.000

Ranks

	Pupil Favourite Subject	N	Mean Rank	Sum of Ranks
Overall Emotional Attitudes to Mathematics	Other	263	181.24	47666.50
	Maths	176	277.92	48913.50
	Total	439		

Test Statistics[a]

	Overall Emotional Attitudes to Mathematics
Mann-Whitney U	12950.500
Wilcoxon W	47666.500
Z	-7.860
Asymp. Sig. (2-tailed)	.000

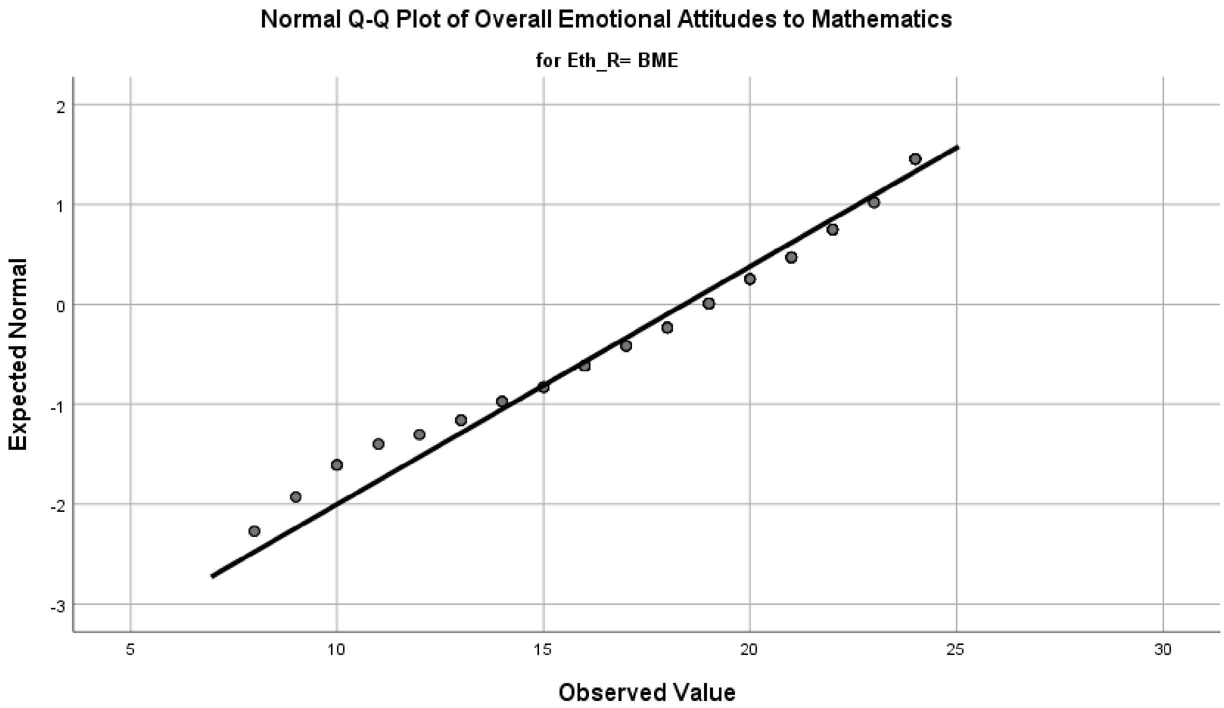
a. Grouping Variable: Pupil Favourite Subject

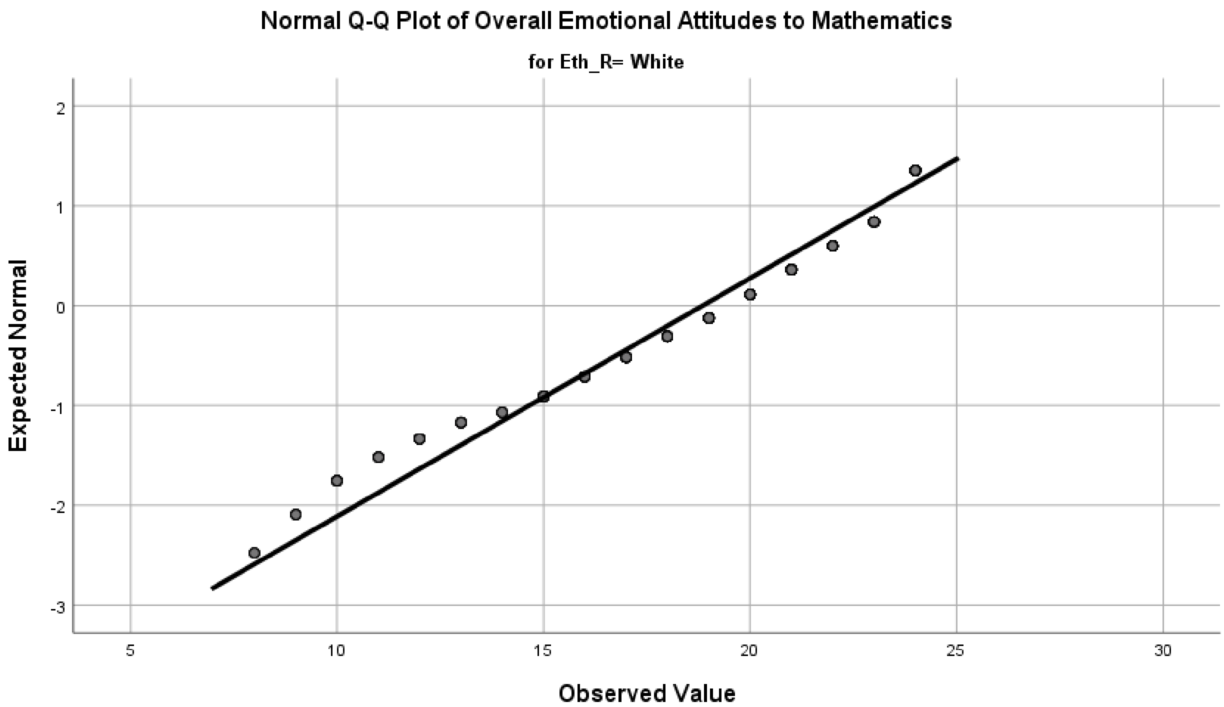
Ethnicity and EA

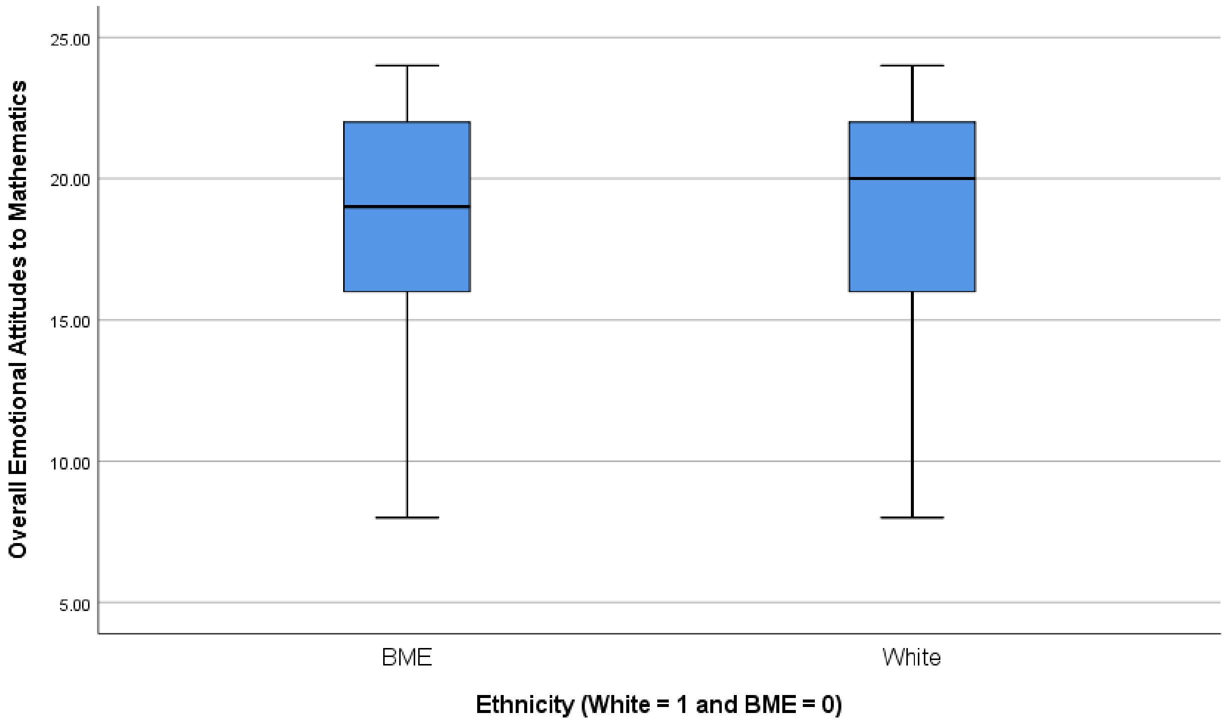
Descriptives

	Ethnicity (White = 1 and BME = 0)			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	BME	Mean		18.4109	.36990
		95% Confidence Interval for Mean	Lower Bound	17.6789	
			Upper Bound	19.1428	
		5% Trimmed Mean		18.6193	
		Median		19.0000	
		Variance		17.650	
		Std. Deviation		4.20121	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.593	.213
		Kurtosis		-.360	.423
	White	Mean		18.8505	.24159
		95% Confidence Interval for Mean	Lower Bound	18.3751	
			Upper Bound	19.3259	
		5% Trimmed Mean		19.0930	
		Median		20.0000	
		Variance		17.568	
		Std. Deviation		4.19137	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	

	Interquartile Range	6.00	
	Skewness	-.654	.140
	Kurtosis	-.368	.280







25.00
20.00
15.00
10.00
5.00
Overall Emotional Attitudes to Mathematics
BME
White
Ethnicity (White = 1 and BME = 0)

Group Statistics

	Ethnicity (White = 1 and BME = 0)	N	Mean	Std. Deviation	Std. Error Mean
Overall Emotional Attitudes to Mathematics	BME	129	18.4109	4.20121	.36990
	White	301	18.8505	4.19137	.24159

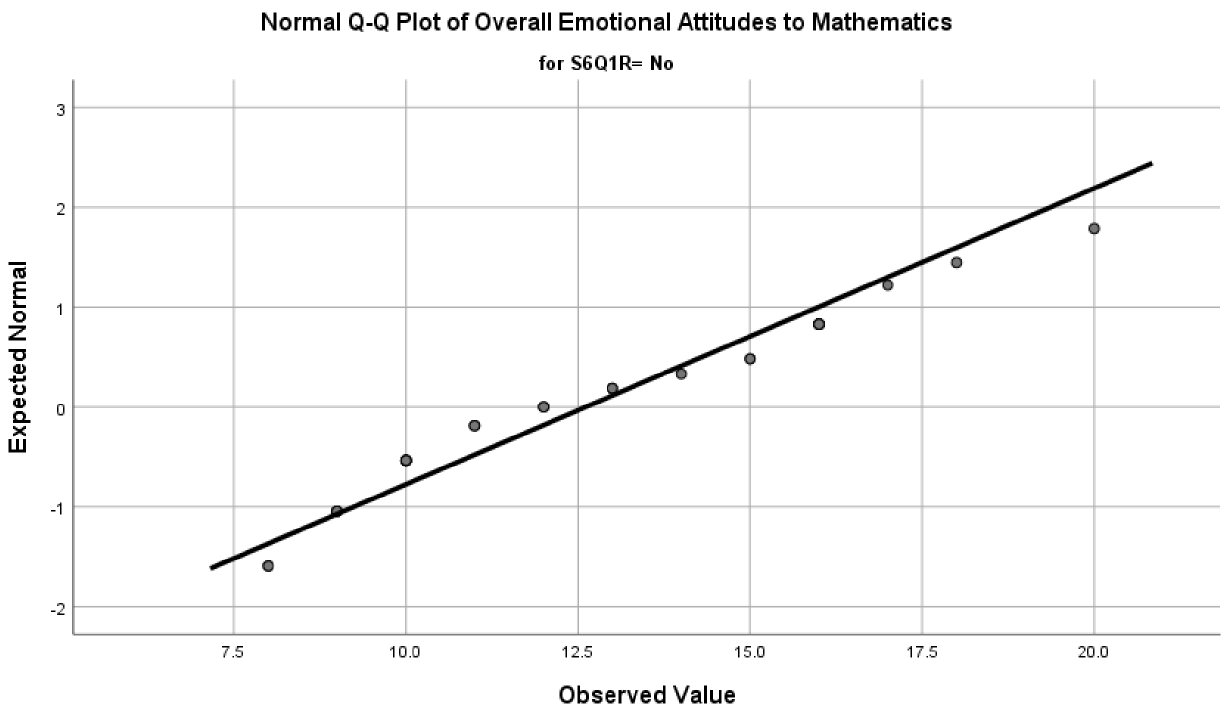
Independent Samples Test

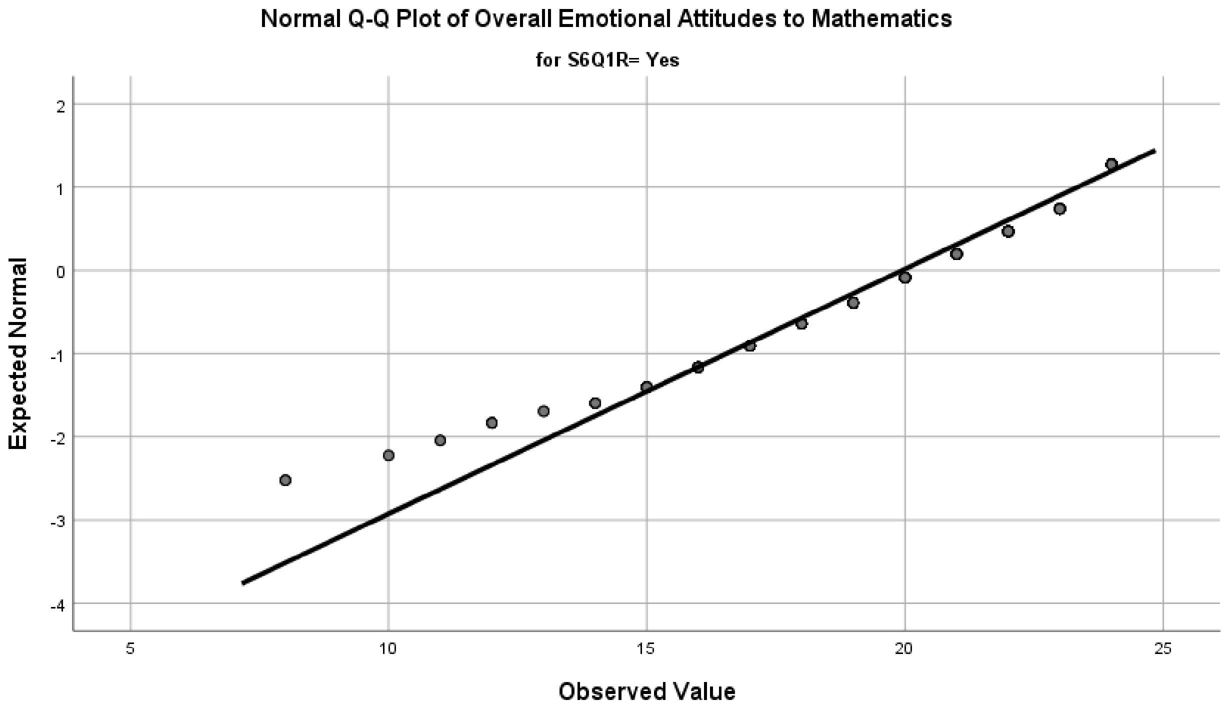
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Emotional Attitudes to Mathematics	Equal variances assumed	.008	.928	-.996	428	.320	-.43965	.44138	-1.30720	.42791
	Equal variances not assumed			-.995	241.725	.321	-.43965	.44180	-1.30991	.43062

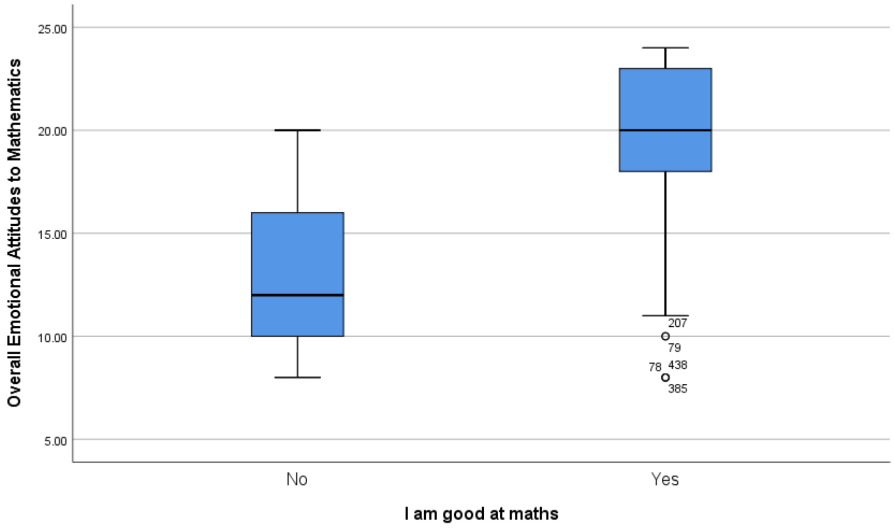
Good at maths and EAM

Descriptives

	I am good at maths			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	No	Mean		12.6154	.66118
		95% Confidence Interval for Mean	Lower Bound	11.2537	
			Upper Bound	13.9771	
		5% Trimmed Mean		12.4872	
		Median		12.0000	
		Variance		11.366	
		Std. Deviation		3.37137	
		Minimum		8.00	
		Maximum		20.00	
		Range		12.00	
		Interquartile Range		6.00	
		Skewness		.443	.456
		Kurtosis		-.859	.887
	Yes	Mean		19.9446	.18350
		95% Confidence Interval for Mean	Lower Bound	19.5837	
			Upper Bound	20.3055	
		5% Trimmed Mean		20.2083	
		Median		20.0000	
		Variance		11.550	
		Std. Deviation		3.39846	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	
		Skewness		-.881	.132
		Kurtosis		.750	.263


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for S6Q1R= No
Expected Normal
3
2
1
0
-1
-2
7.5
10.0
12.5
15.0
17.5
20.0
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for S6Q1R= Yes
Expected Normal
2
1
0
-1
-2
-3
-4
5
10
15
20
25
Observed Value



Group Statistics

	I am good at maths	N	Mean	Std. Deviation	Std. Error Mean
Overall Emotional Attitudes to Mathematics	No	26	12.6154	3.37137	.66118
	Yes	343	19.9446	3.39846	.18350

Independent Samples Test

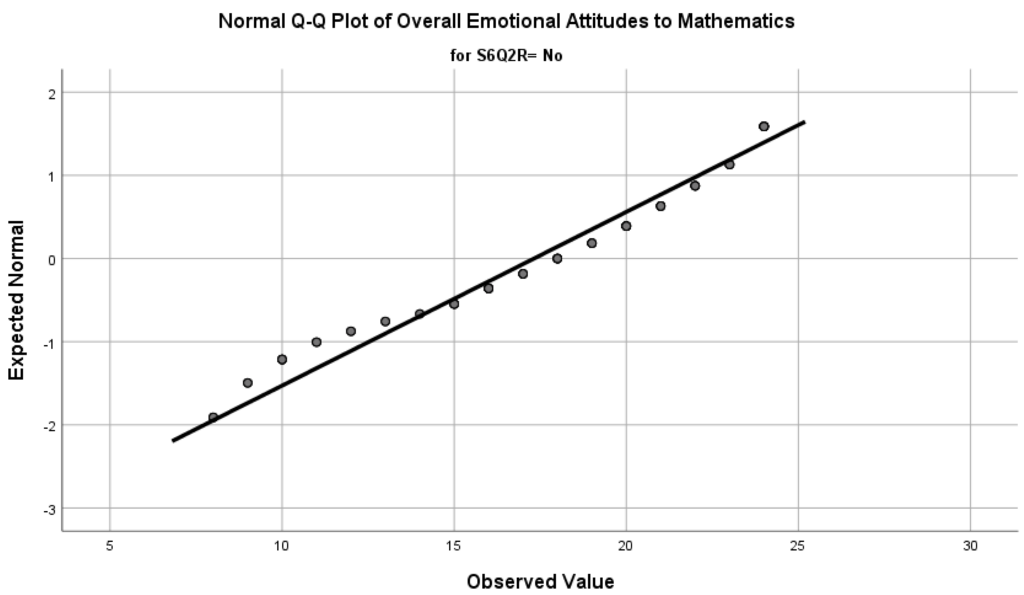
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Emotional Attitudes to Mathematics	Equal variances assumed	.274	.601	-10.608	367	.000	-7.32922	.69092	-8.68788	-5.97057
	Equal variances not assumed			-10.681	28.987	.000	-7.32922	.68617	-8.73263	-5.92582

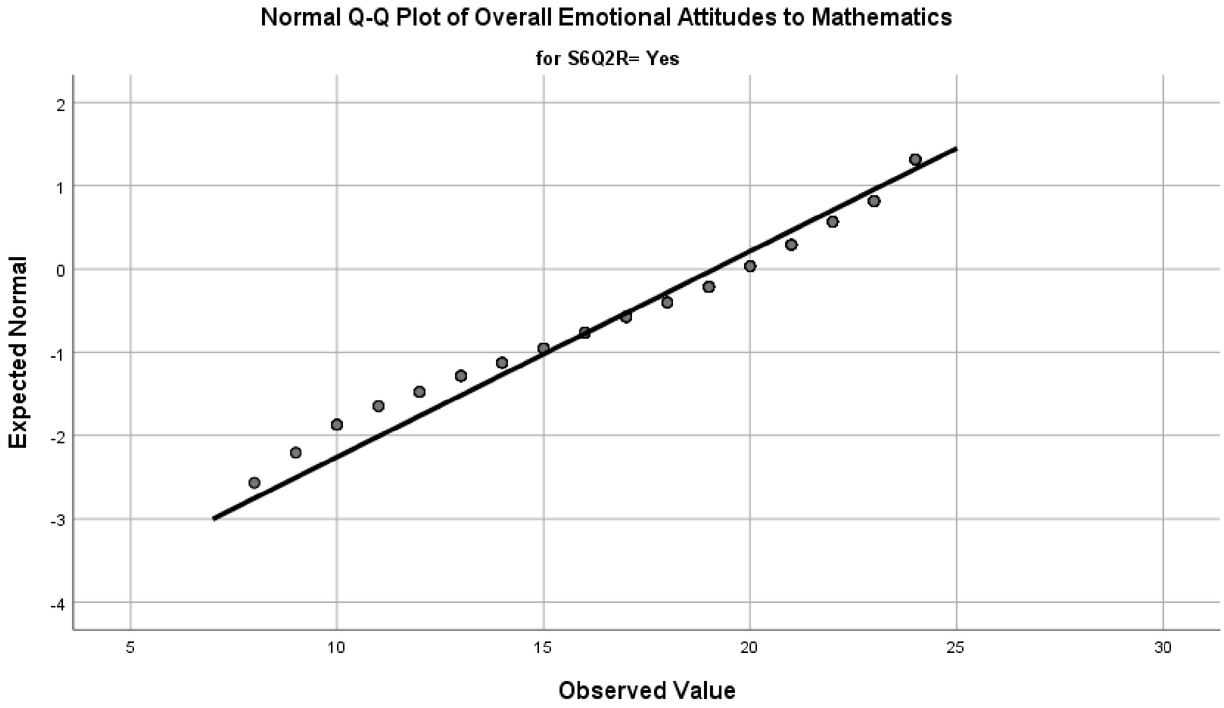
Maths at home and EA

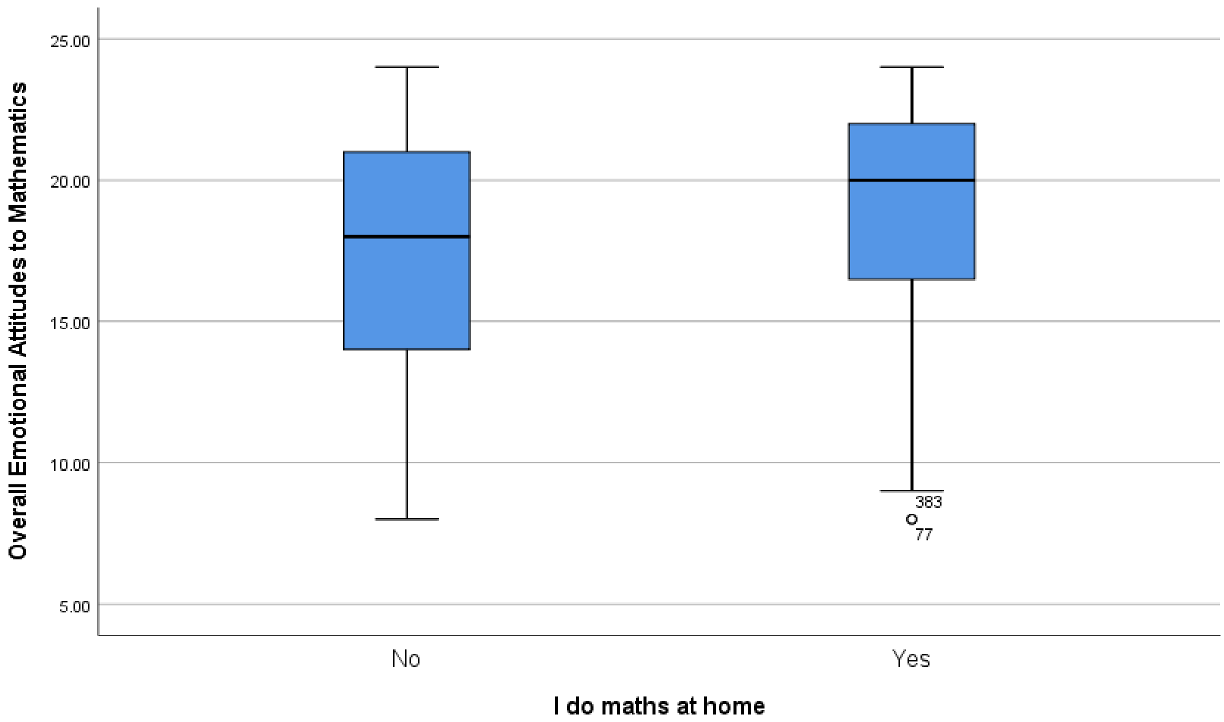
Descriptives

	I do maths at home		Statistic	Std. Error
	No	Mean	17.3182	.51023

Overall Emotional Attitudes to Mathematics		95% Confidence Interval for Mean	Lower Bound	16.3041	
			Upper Bound	18.3323	
		5% Trimmed Mean		17.4596	
		Median		18.0000	
		Variance		22.909	
		Std. Deviation		4.78634	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.00	
		Skewness		-.417	.257
		Kurtosis		-.887	.508
	Yes	Mean		19.1375	.23716
		95% Confidence Interval for Mean	Lower Bound	18.6707	
			Upper Bound	19.6042	
		5% Trimmed Mean		19.3919	
		Median		20.0000	
		Variance		16.367	
		Std. Deviation		4.04565	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.705	.143
		Kurtosis		-.269	.285




Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for S6Q2R= Yes
Expected Normal
Observed Value
2
1
0
-1
-2
-3
-4
5
10
15
20
25
30


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
383
77
No
Yes
I do maths at home

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	5.581	1	377	.019
	Based on Median	4.857	1	377	.028
	Based on Median and with adjusted df	4.857	1	375.384	.028
	Based on trimmed mean	5.564	1	377	.019

Ranks

	I do maths at home	N	Mean Rank	Sum of Ranks
Overall Emotional Attitudes to Mathematics	No	88	158.18	13920.00
	Yes	291	199.62	58090.00
	Total	379		

Test Statistics[a]

	Overall Emotional Attitudes to Mathematics
Mann-Whitney U	10004.000
Wilcoxon W	13920.000
Z	-3.124
Asymp. Sig. (2-tailed)	.002

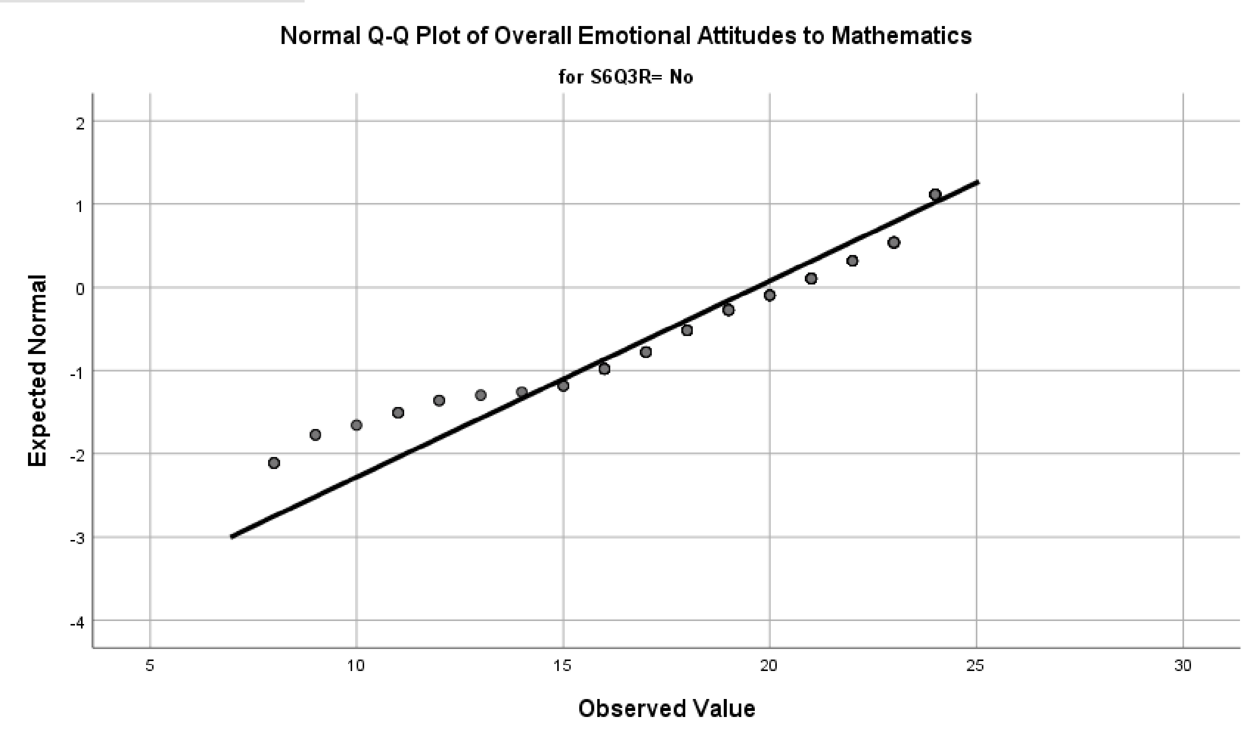
a. Grouping Variable: I do maths at home

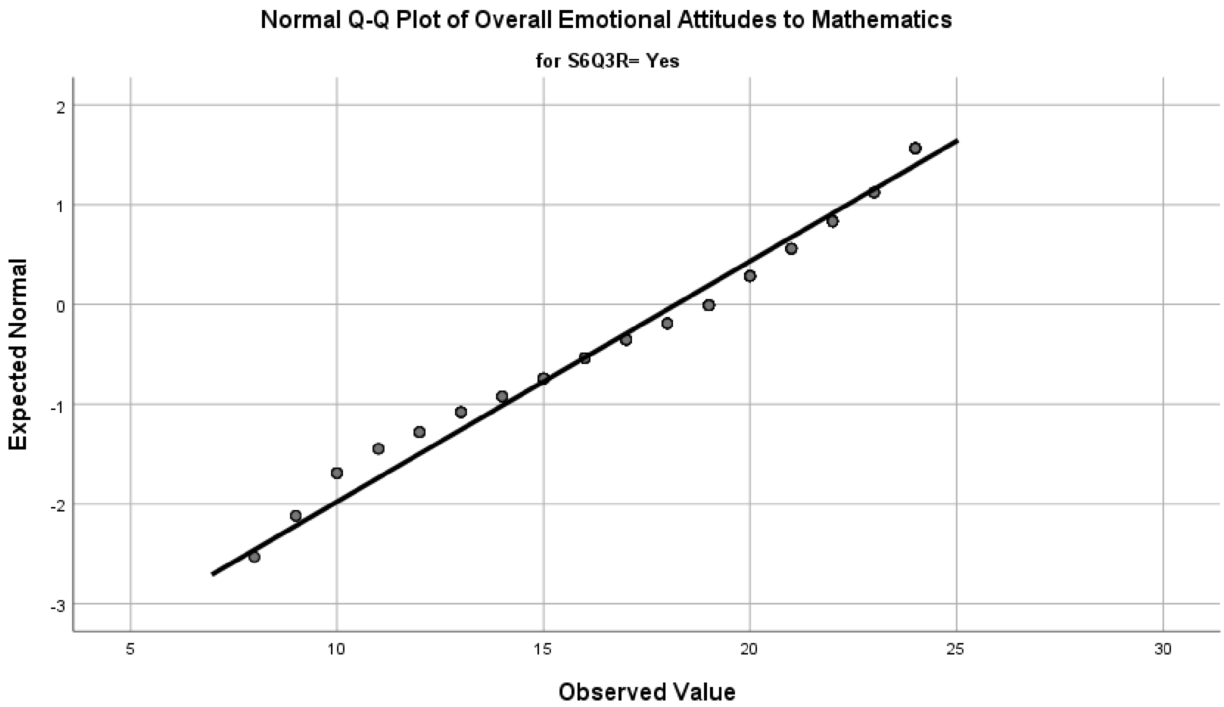
Parents and EA

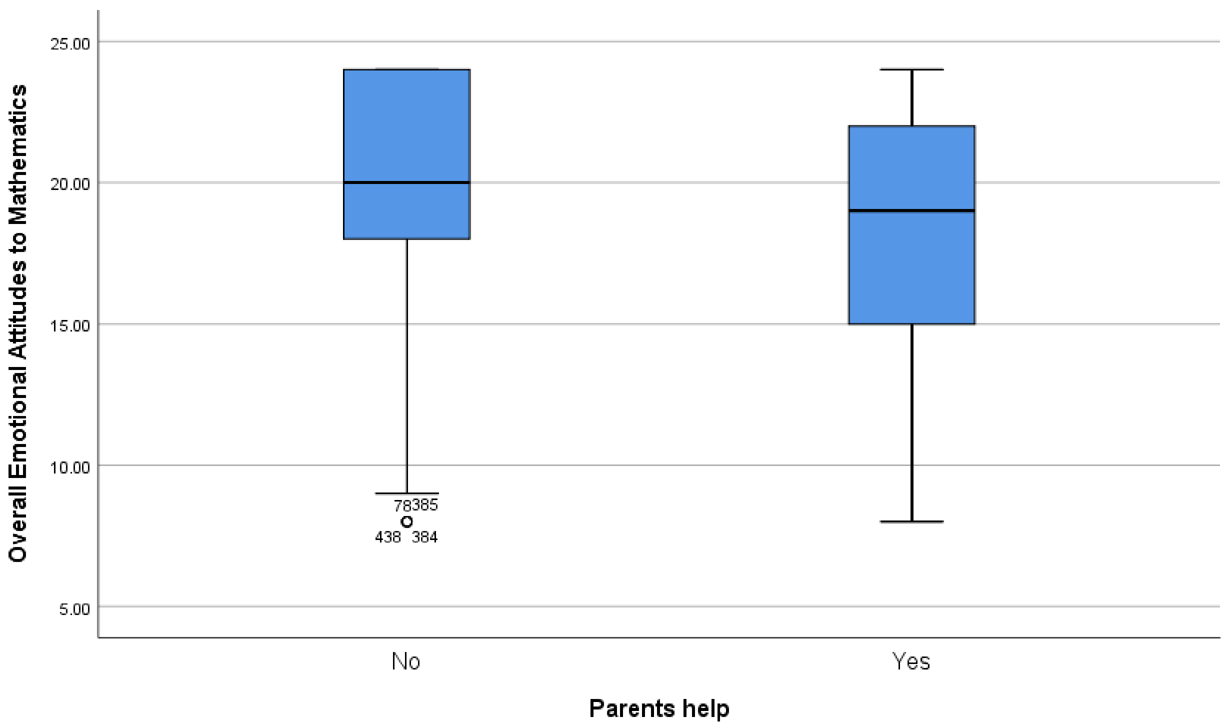
Descriptives

	Parents help			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	No	Mean		19.6713	.35462
		95% Confidence Interval for Mean	Lower Bound	18.9703	
			Upper Bound	20.3723	

		5% Trimmed Mean		20.0447	
		Median		20.0000	
		Variance		17.983	
		Std. Deviation		4.24061	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-1.042	.203
		Kurtosis		.566	.403
	Yes	Mean		18.2091	.25582
		95% Confidence Interval for Mean	Lower Bound	17.7054	
			Upper Bound	18.7129	
		5% Trimmed Mean		18.3773	
		Median		19.0000	
		Variance		17.212	
		Std. Deviation		4.14871	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.00	
		Skewness		-.505	.150
		Kurtosis		-.598	.299




Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for S6Q3R= Yes
Expected Normal
2
1
0
-1
-2
-3
5
10
15
20
25
30
Observed Value


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
78385
438 384
No
Yes
Parents help

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Emotional Attitudes to Mathematics	Equal variances assumed	.065	.799	3.366	404	.001	1.46220	.43443	.60817	2.31623
	Equal variances not assumed			3.344	286.240	.001	1.46220	.43726	.60155	2.32286

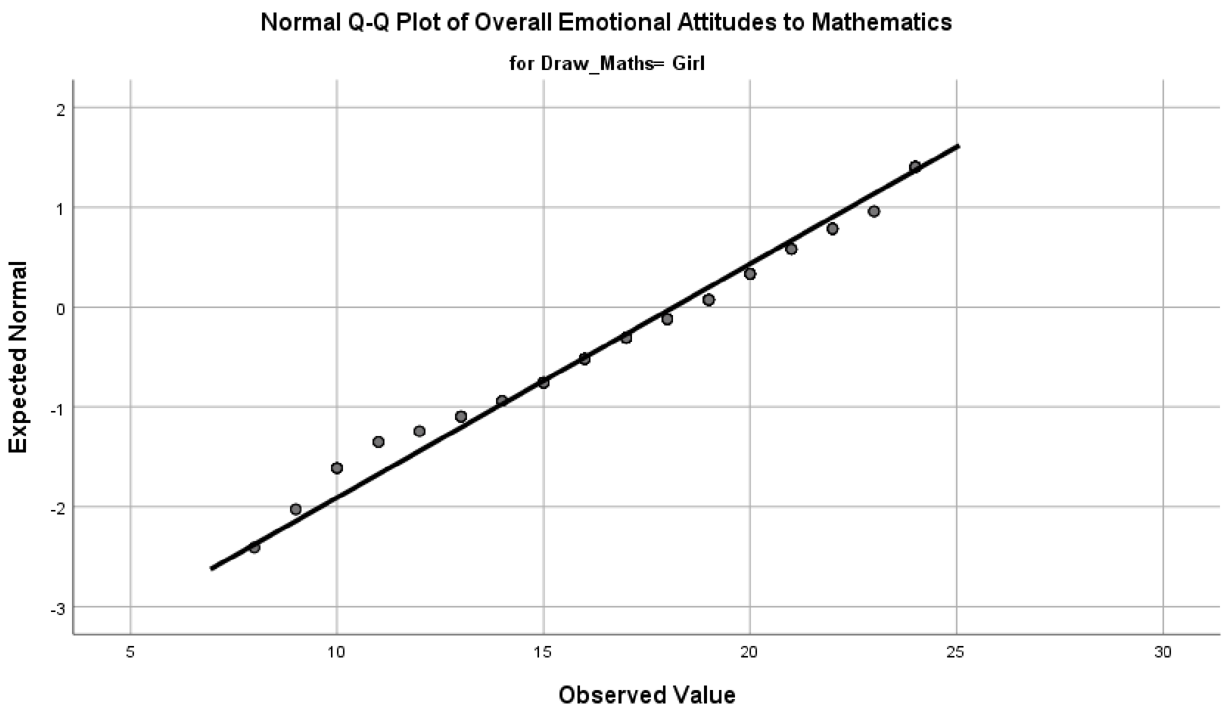
Group Statistics

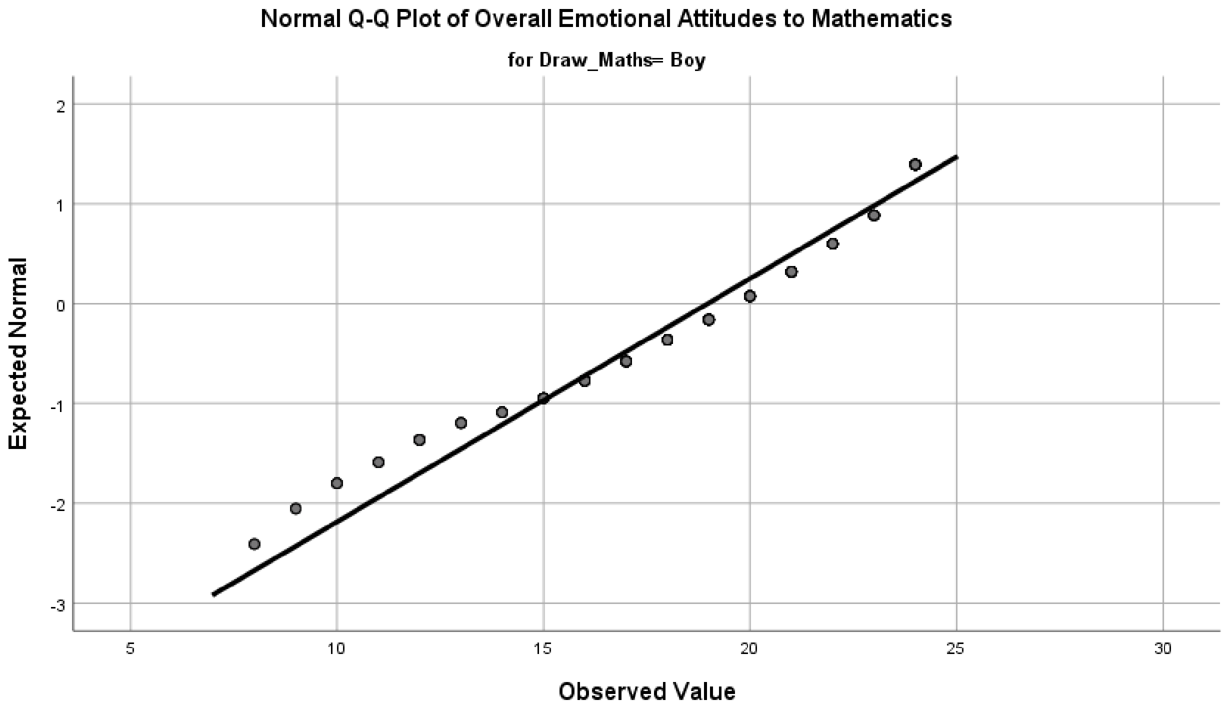
	Parents help	N	Mean	Std. Deviation	Std. Error Mean
Overall Emotional Attitudes to Mathematics	No	143	19.6713	4.24061	.35462
	Yes	263	18.2091	4.14871	.25582

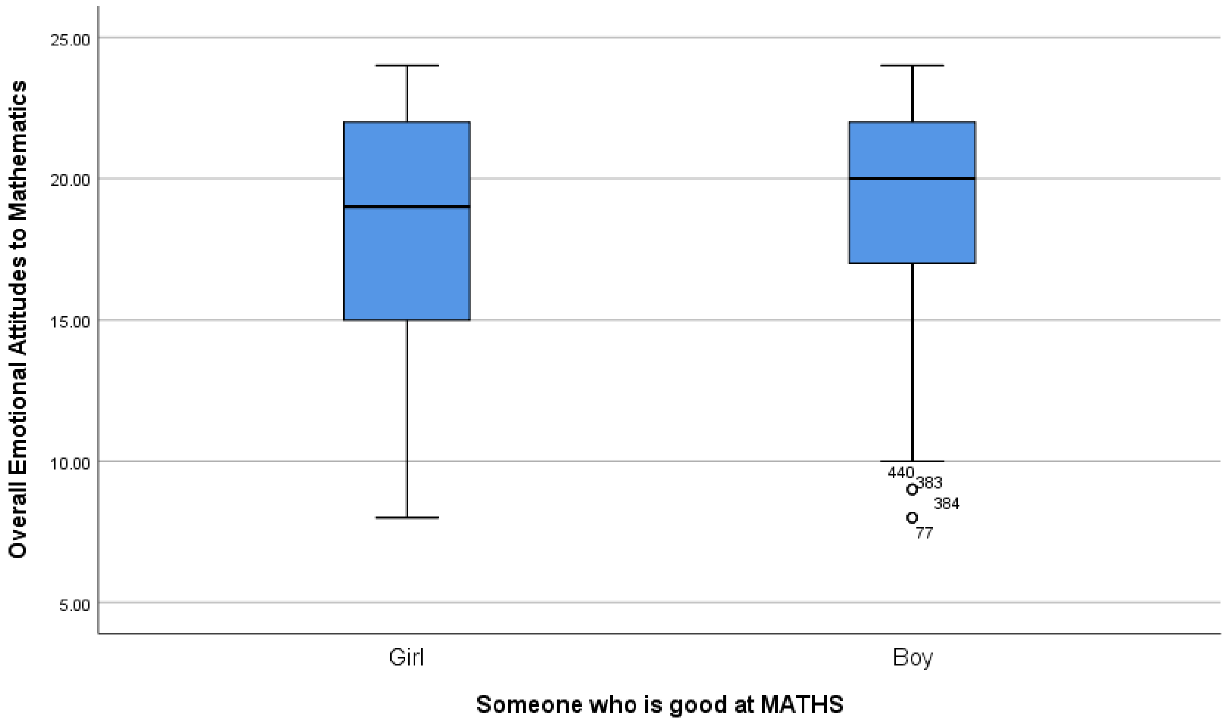
Good at maths and EA

Descriptives

	Someone who is good at MATHS			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Girl	Mean		18.1505	.31312
		95% Confidence Interval for Mean	Lower Bound	17.5328	
			Upper Bound	18.7683	
		5% Trimmed Mean		18.3202	
		Median		19.0000	
		Variance		18.237	
		Std. Deviation		4.27044	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.00	
		Skewness		-.427	.178
		Kurtosis		-.599	.355
	Boy	Mean		18.9719	.26014
		95% Confidence Interval for Mean	Lower Bound	18.4595	
			Upper Bound	19.4842	
		5% Trimmed Mean		19.2247	
		Median		20.0000	
		Variance		16.850	
		Std. Deviation		4.10488	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	
		Skewness		-.734	.154
		Kurtosis		-.195	.307


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Draw_Maths= Girl
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Draw_Maths= Boy
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30



Group Statistics

	Someone who is good at MATHS	N	Mean	Std. Deviation	Std. Error Mean
Overall Emotional Attitudes to Mathematics	Girl	186	18.1505	4.27044	.31312
	Boy	249	18.9719	4.10488	.26014

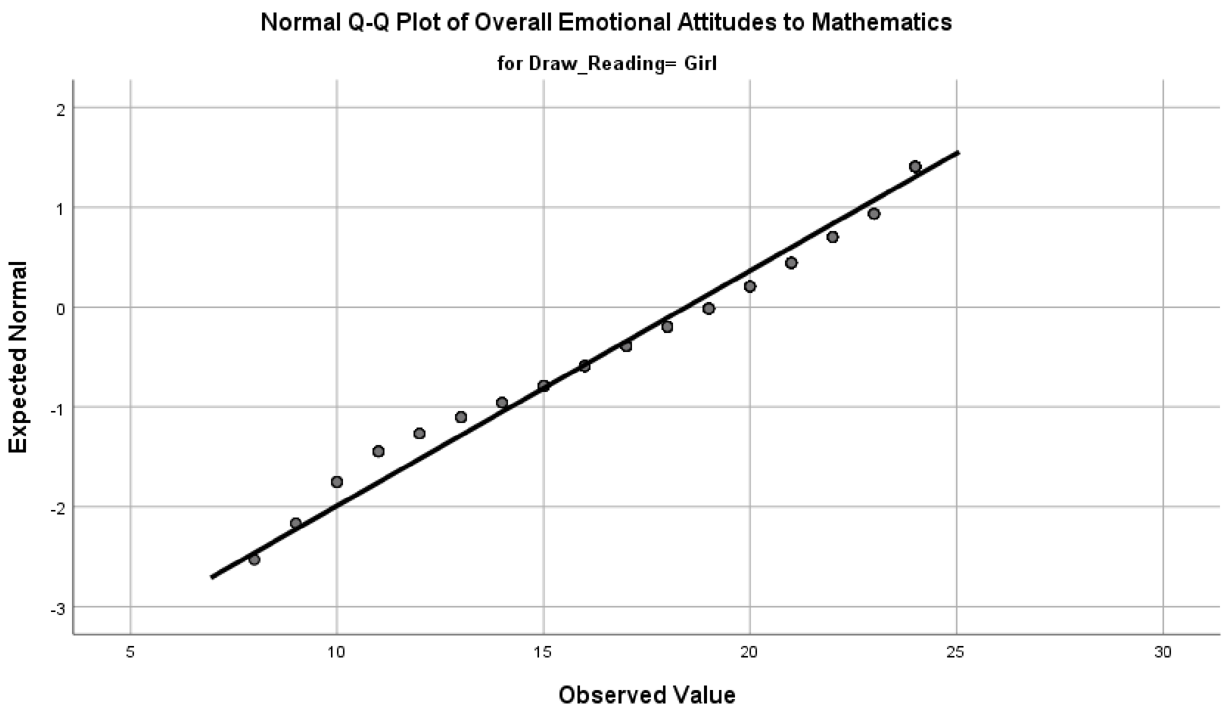
Independent Samples Test

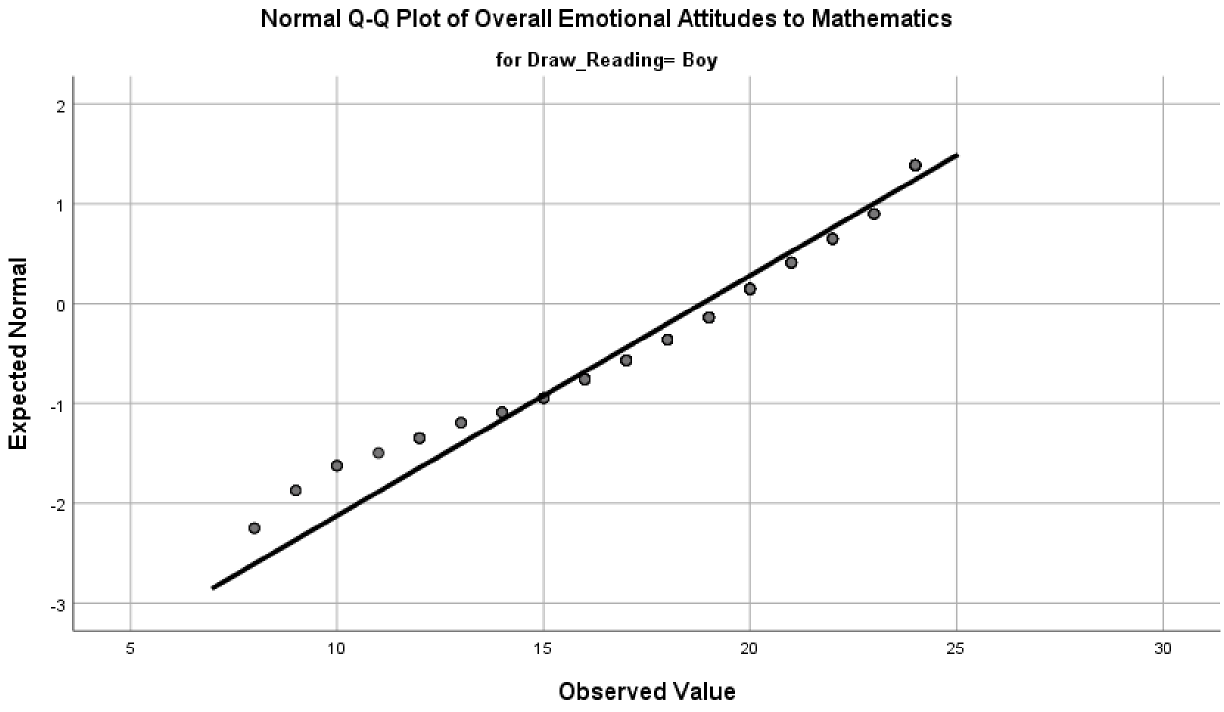
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Emotional Attitudes to Mathematics	Equal variances assumed	.637	.425	-2.029	433	.043	-.82135	.40476	-1.61688	-.02582
	Equal variances not assumed			-2.018	389.934	.044	-.82135	.40708	-1.62170	-.02100

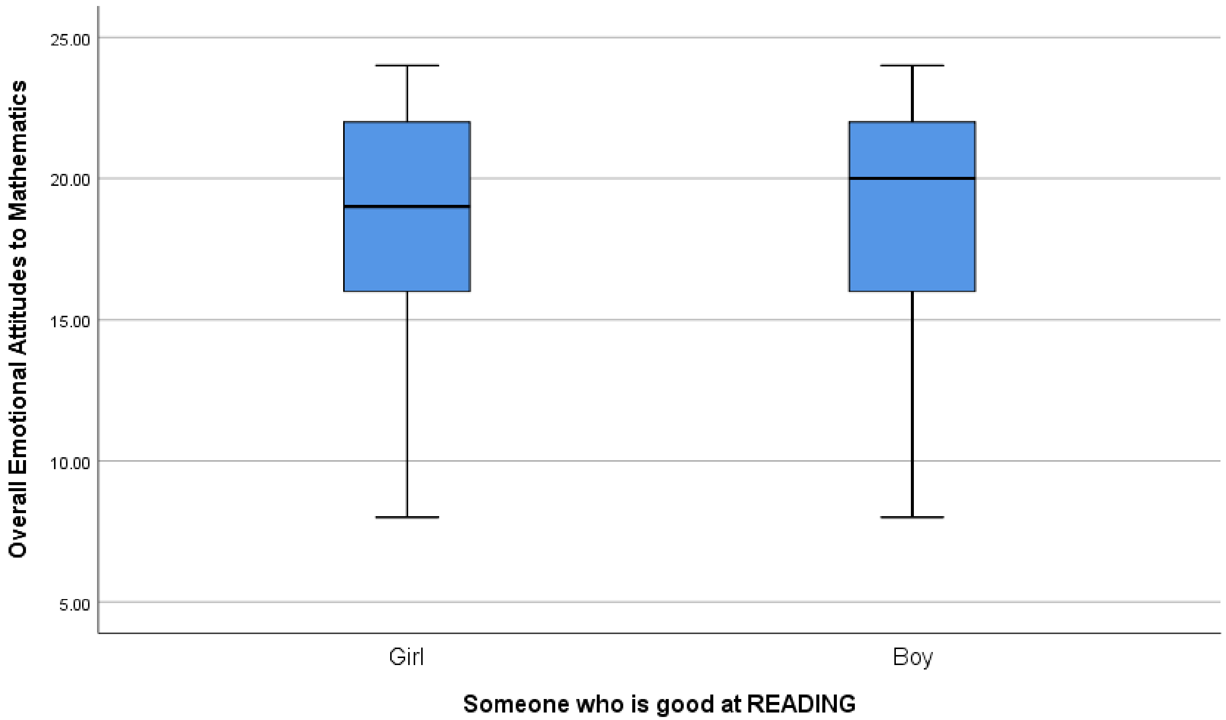
Reading and EAM

Descriptives

	Someone who is good at READING			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Girl	Mean		18.4542	.26236
		95% Confidence Interval for Mean	Lower Bound	17.9376	
			Upper Bound	18.9708	
		5% Trimmed Mean		18.6455	
		Median		19.0000	
		Variance		18.034	
		Std. Deviation		4.24668	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.501	.150
		Kurtosis		-.642	.300
	Boy	Mean		18.8333	.32662
		95% Confidence Interval for Mean	Lower Bound	18.1883	
			Upper Bound	19.4784	
		5% Trimmed Mean		19.0988	
		Median		20.0000	
		Variance		17.283	
		Std. Deviation		4.15724	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.769	.191
		Kurtosis		-.011	.379


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Draw_Reading= Girl
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Draw_Reading= Boy
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
Girl
Boy
Someone who is good at READING

Group Statistics

	Someone who is good at READING	N	Mean	Std. Deviation	Std. Error Mean
Overall Emotional Attitudes to Mathematics	Girl	262	18.4542	4.24668	.26236
	Boy	162	18.8333	4.15724	.32662

Independent Samples Test

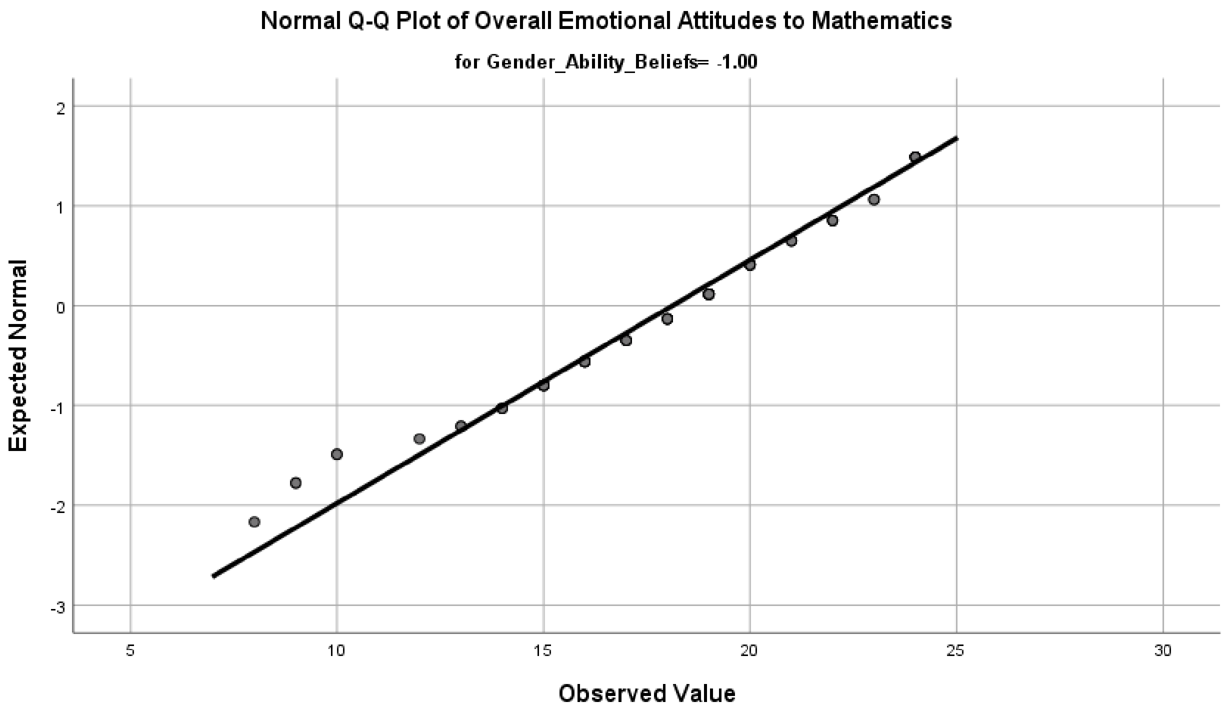
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Overall Emotional Attitudes to Mathematics	Equal variances assumed	.898	.344	-.900	422	.368	-.37913	.42106	-1.20677	.44850
	Equal variances not assumed			-.905	346.741	.366	-.37913	.41895	-1.20313	.44486

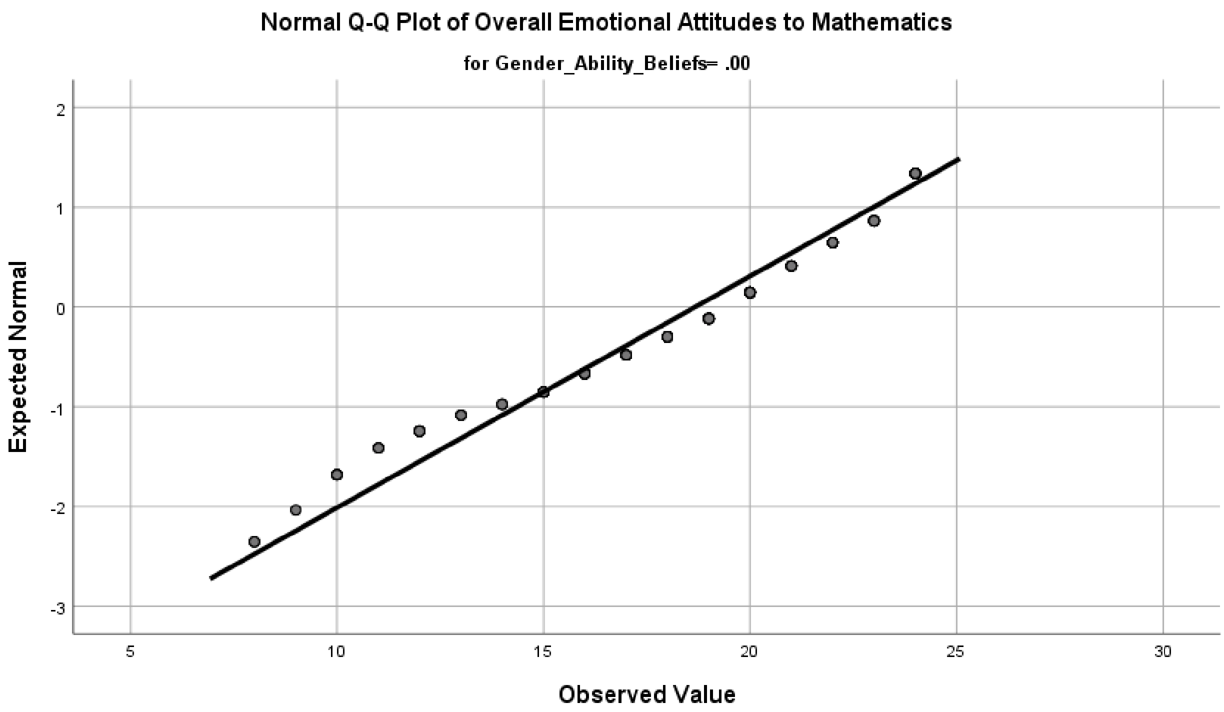
GAB and EAM

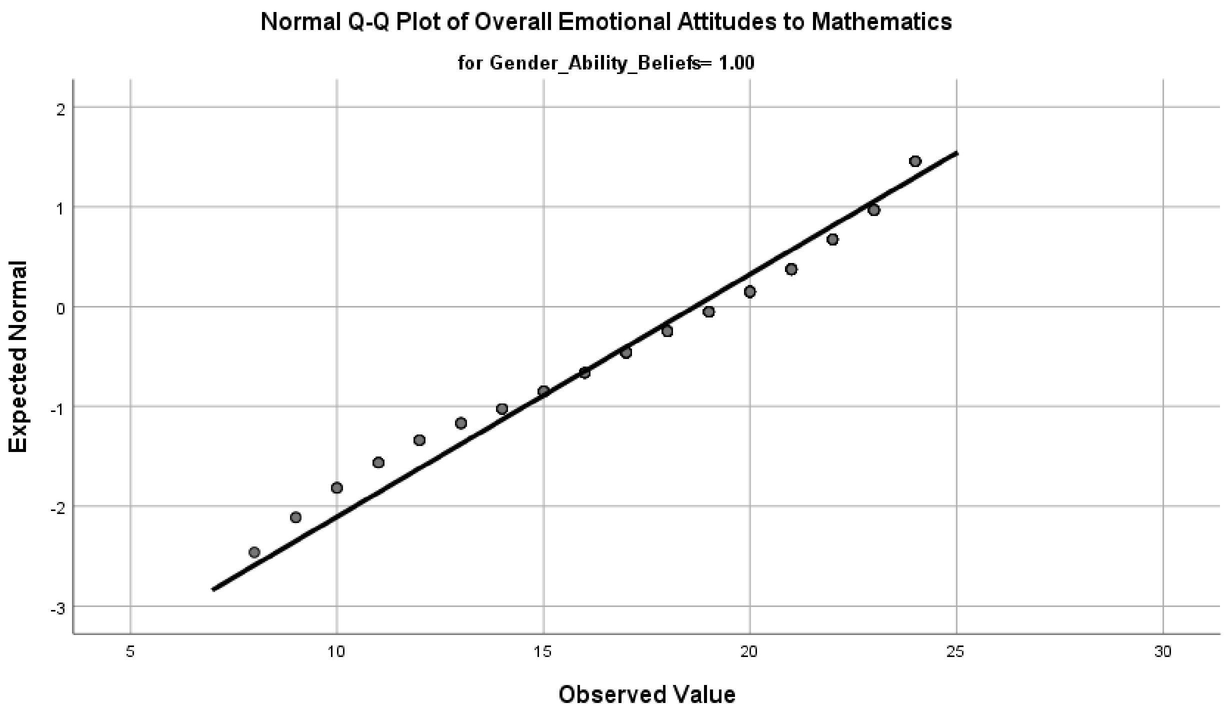
Descriptives

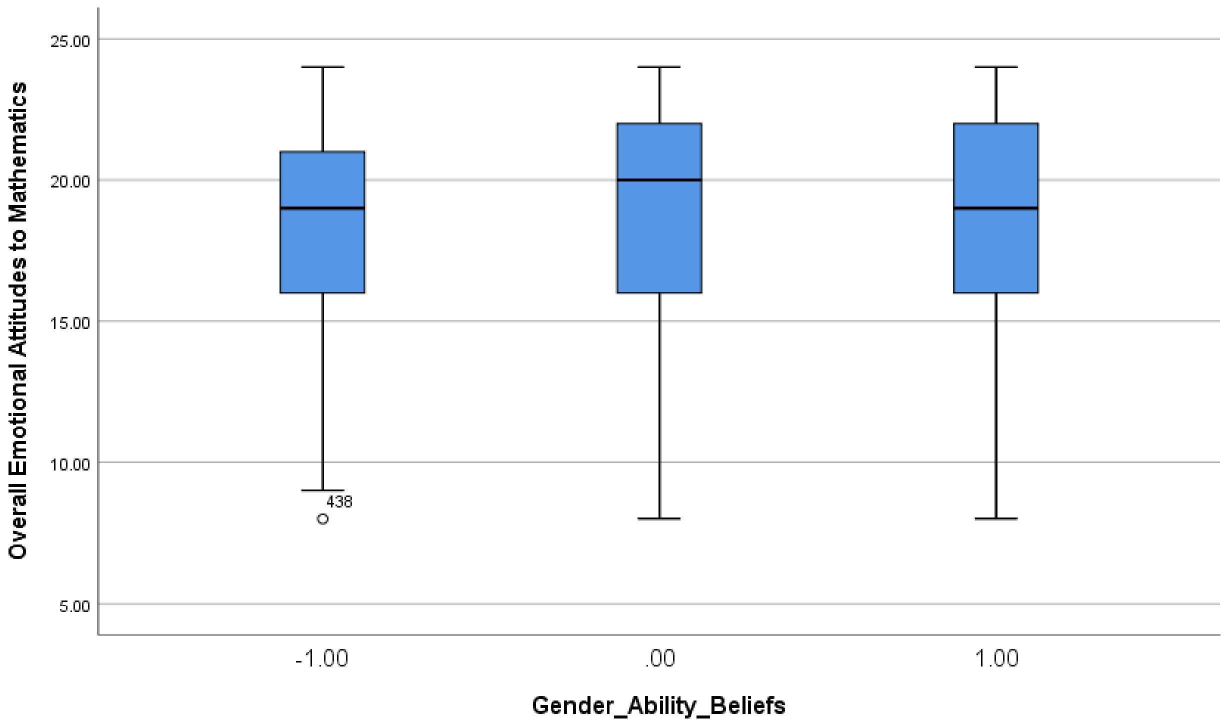
	Gender_Ability_Beliefs			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	-1.00	Mean		18.1231	.50882
		95% Confidence Interval for Mean	Lower Bound	17.1066	
			Upper Bound	19.1396	
		5% Trimmed Mean		18.3162	
		Median		19.0000	
		Variance		16.828	
		Std. Deviation		4.10224	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.50	
		Skewness		-.530	.297
		Kurtosis		-.152	.586
	.00	Mean		18.6744	.29394
		95% Confidence Interval for Mean	Lower Bound	18.0950	
			Upper Bound	19.2538	
		5% Trimmed Mean		18.9018	
		Median		20.0000	
		Variance		18.576	
		Std. Deviation		4.30996	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.640	.166
		Kurtosis		-.444	.330
	1.00	Mean		18.6643	.34421
		95% Confidence Interval for Mean	Lower Bound	17.9839	
			Upper Bound	19.3448	
		5% Trimmed Mean		18.8714	
		Median		19.0000	
		Variance		16.943	
		Std. Deviation		4.11617	
		Minimum		8.00	
		Maximum		24.00	

	Range	16.00	
	Interquartile Range	6.00	
	Skewness	-.579	.203
	Kurtosis	-.490	.403






Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Gender_Ability_Beliefs= 1.00
Expected Normal
2
1
0
-1
-2
-3
5
10
15
20
25
30
Observed Value


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
438
-1.00
.00
1.00
Gender_Ability_Beliefs

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
-1.00	65	18.1231	4.10224	.50882	17.1066	19.1396	8.00	24.00
.00	215	18.6744	4.30996	.29394	18.0950	19.2538	8.00	24.00
1.00	143	18.6643	4.11617	.34421	17.9839	19.3448	8.00	24.00
Total	423	18.5863	4.20860	.20463	18.1841	18.9885	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	.349	2	420	.706
	Based on Median	.161	2	420	.851
	Based on Median and with adjusted df	.161	2	407.984	.851
	Based on trimmed mean	.259	2	420	.772

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.488	2	8.244	.464	.629
Within Groups	7458.113	420	17.757		
Total	7474.600	422			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

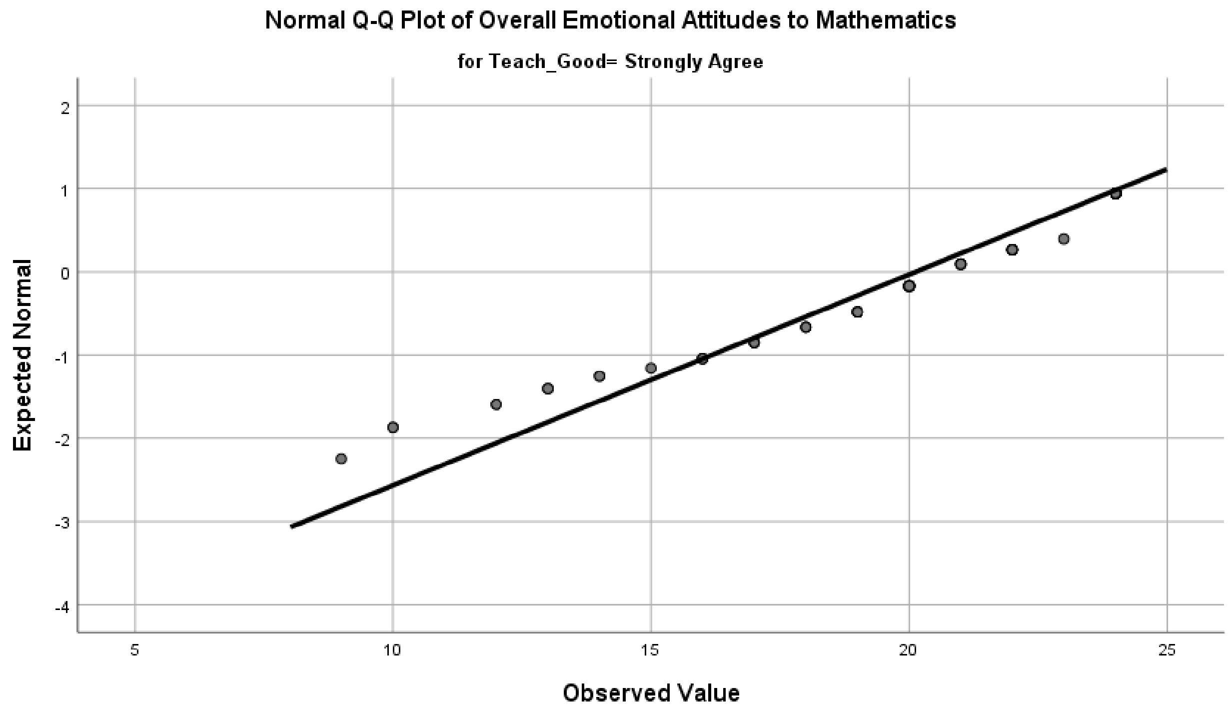
(I) Gender_Ability_Beliefs	(J) Gender_Ability_Beliefs	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
-1.00	.00	-.55134	.59648	.653	-2.0166	.9139
	1.00	-.54126	.63037	.692	-2.0898	1.0073
.00	-1.00	.55134	.59648	.653	-.9139	2.0166
	1.00	.01008	.45472	1.000	-1.1069	1.1271
1.00	-1.00	.54126	.63037	.692	-1.0073	2.0898
	.00	-.01008	.45472	1.000	-1.1271	1.1069

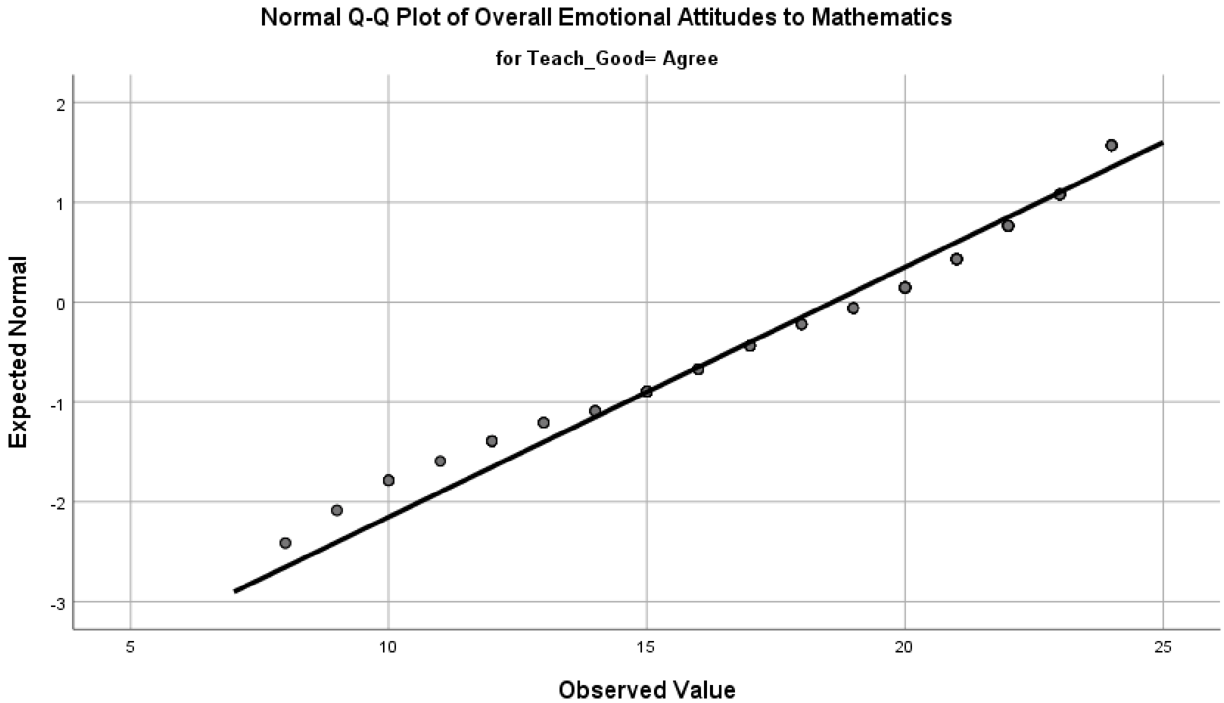
Teacher good maths and EA

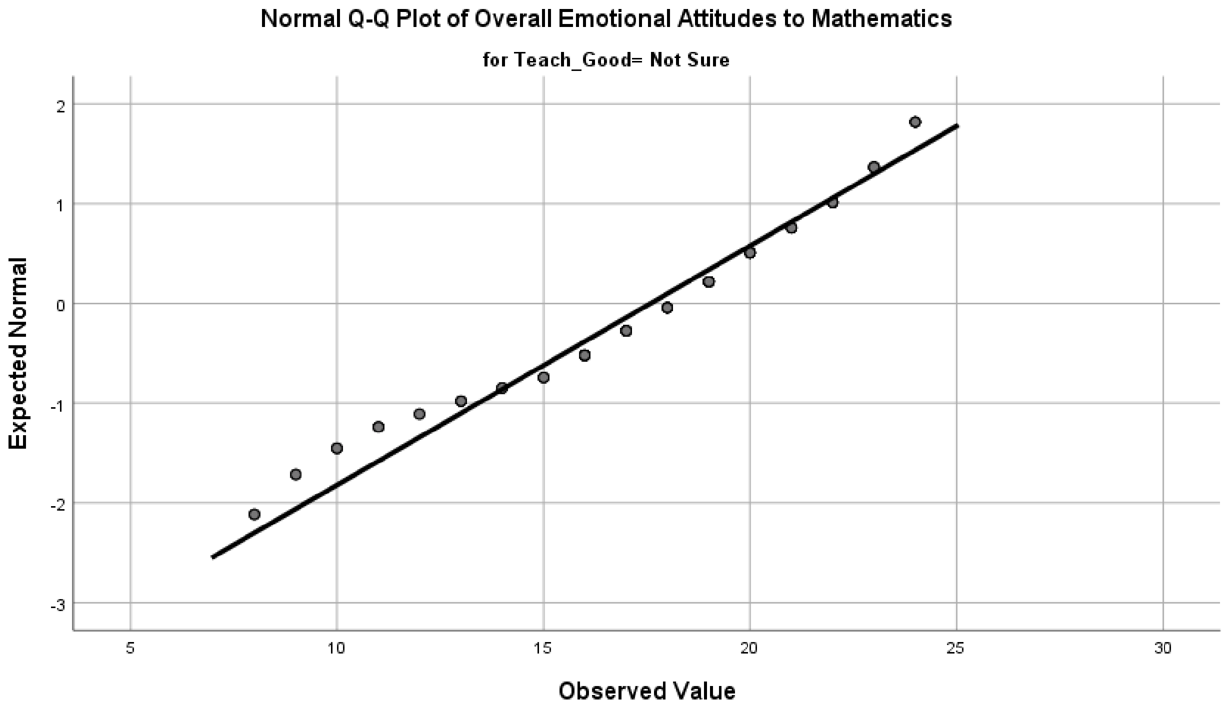
Descriptives

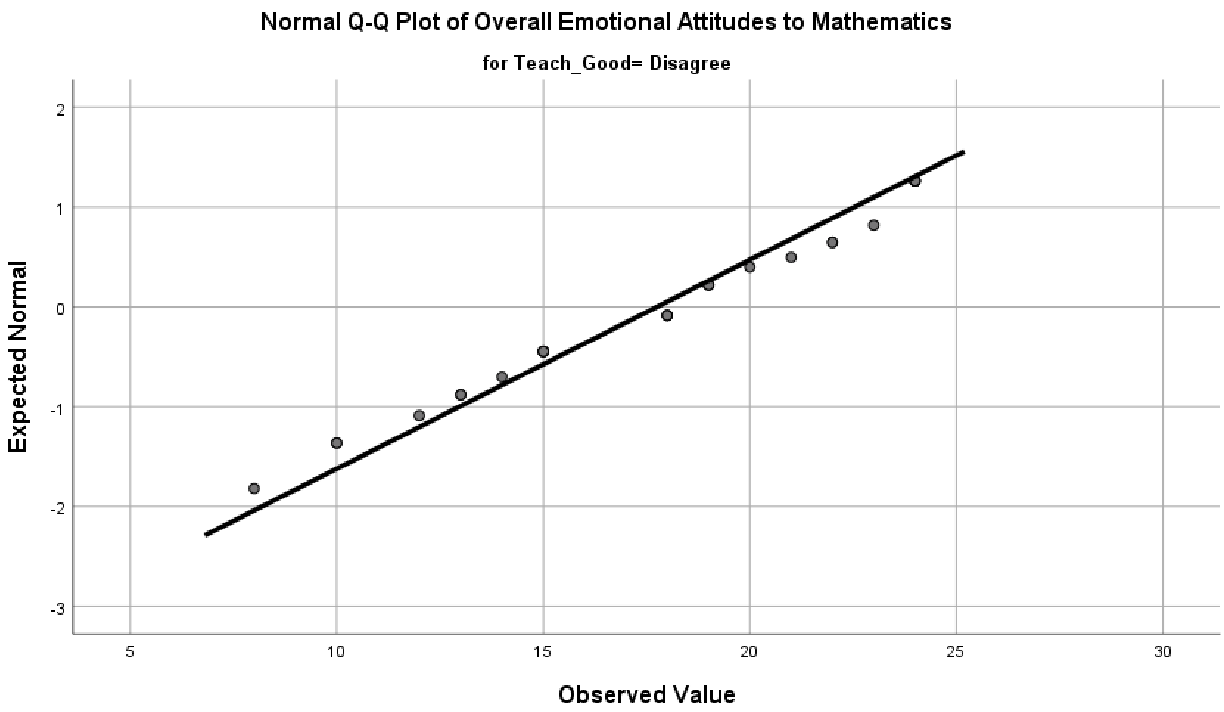
	Teacher I am good at maths			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Strongly Agree	Mean		20.1250	.44129
		95% Confidence Interval for Mean	Lower Bound	19.2466	
			Upper Bound	21.0034	
		5% Trimmed Mean		20.4583	
		Median		20.0000	
		Variance		15.579	
		Std. Deviation		3.94704	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		6.00	
		Skewness		-.973	.269
		Kurtosis		.337	.532
	Agree	Mean		18.6011	.29139
		95% Confidence Interval for Mean	Lower Bound	18.0262	
			Upper Bound	19.1759	
		5% Trimmed Mean		18.8121	
		Median		19.0000	
		Variance		15.963	
		Std. Deviation		3.99537	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.616	.177
		Kurtosis		-.325	.353
	Not Sure	Mean		17.5913	.38880
		95% Confidence Interval for Mean	Lower Bound	16.8211	
			Upper Bound	18.3615	
		5% Trimmed Mean		17.7415	
		Median		18.0000	
		Variance		17.384	
		Std. Deviation		4.16943	
		Minimum		8.00	
		Maximum		24.00	

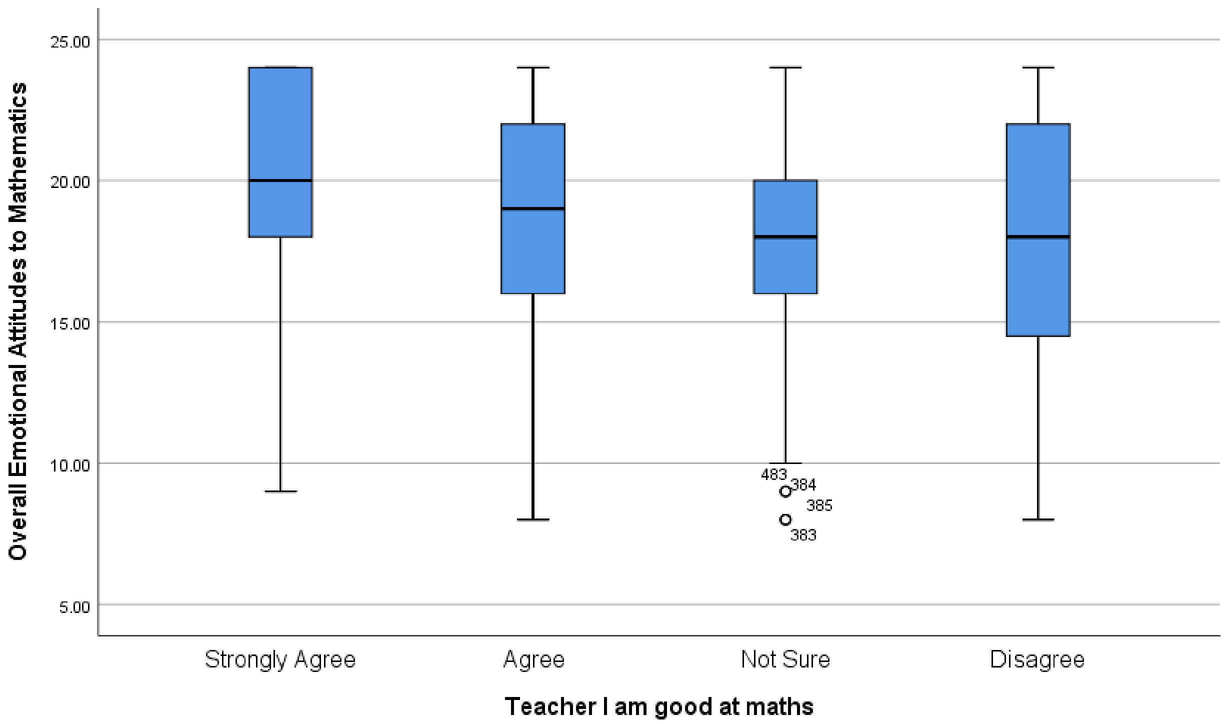
		Range		16.00	
		Interquartile Range		4.00	
		Skewness		-.559	.226
		Kurtosis		-.360	.447
	Disagree	Mean		17.7500	.90359
		95% Confidence Interval for Mean	Lower Bound	15.8960	
			Upper Bound	19.6040	
		5% Trimmed Mean		17.9127	
		Median		18.0000	
		Variance		22.861	
		Std. Deviation		4.78133	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.75	
		Skewness		-.302	.441
		Kurtosis		-.888	.858




Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Teach_Good= Agree
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Teach_Good= Not Sure
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Teach_Good= Disagree
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
483
384
385
383
Strongly Agree
Agree
Not Sure
Disagree
Teacher I am good at maths

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	20.1250	3.94704	.44129	19.2466	21.0034	9.00	24.00
Agree	188	18.6011	3.99537	.29139	18.0262	19.1759	8.00	24.00
Not Sure	115	17.5913	4.16943	.38880	16.8211	18.3615	8.00	24.00
Disagree	28	17.7500	4.78133	.90359	15.8960	19.6040	8.00	24.00
Total	411	18.5572	4.17233	.20581	18.1526	18.9617	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	.887	3	407	.448
	Based on Median	.734	3	407	.532
	Based on Median and with adjusted df	.734	3	402.172	.532
	Based on trimmed mean	.777	3	407	.507

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	322.535	3	107.512	6.421	.000
Within Groups	6814.871	407	16.744		
Total	7137.406	410			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) Teacher I am good at maths	(J) Teacher I am good at maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strongly Agree	Agree	1.52394	.54623	.052	-.0095	3.0573
	Not Sure	2.53370*	.59574	.001	.8613	4.2061
	Disagree	2.37500	.89850	.074	-.1473	4.8973
Agree	Strongly Agree	-1.52394	.54623	.052	-3.0573	.0095
	Not Sure	1.00976	.48442	.228	-.3501	2.3696
	Disagree	.85106	.82890	.788	-1.4758	3.1780
Not Sure	Strongly Agree	-2.53370*	.59574	.001	-4.2061	-.8613
	Agree	-1.00976	.48442	.228	-2.3696	.3501
	Disagree	-.15870	.86233	.998	-2.5794	2.2620
Disagree	Strongly Agree	-2.37500	.89850	.074	-4.8973	.1473
	Agree	-.85106	.82890	.788	-3.1780	1.4758
	Not Sure	.15870	.86233	.998	-2.2620	2.5794

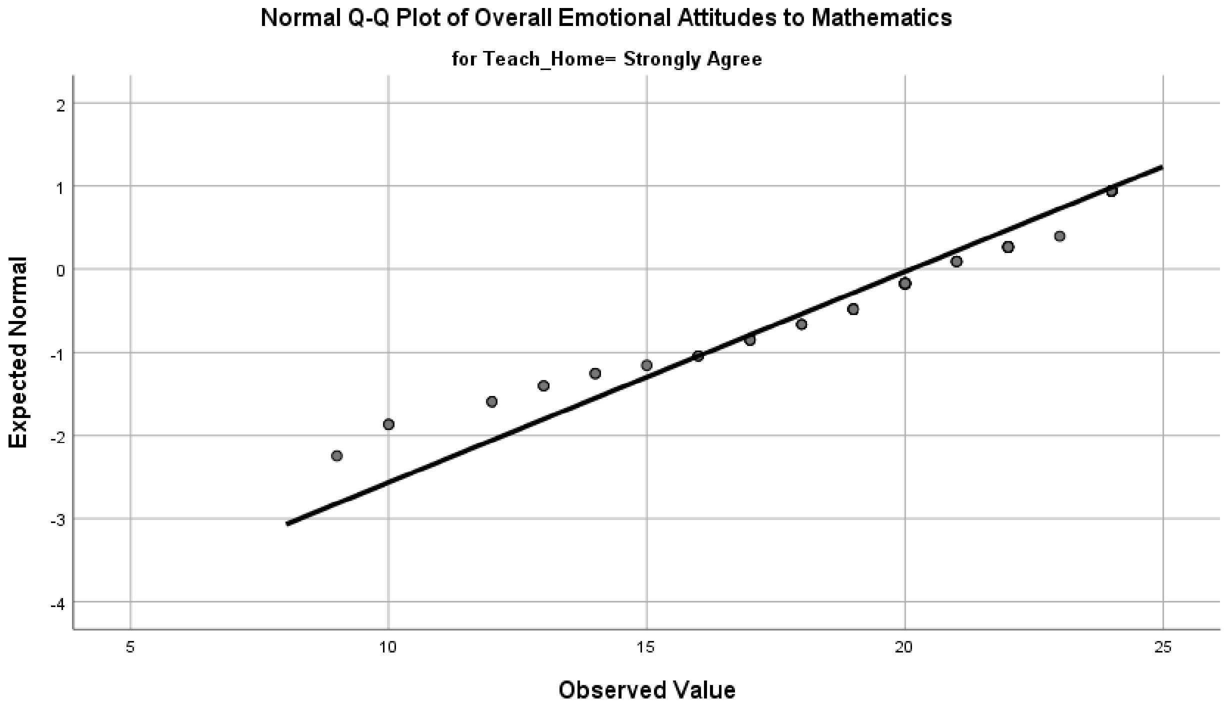
*. The mean difference is significant at the 0.05 level.

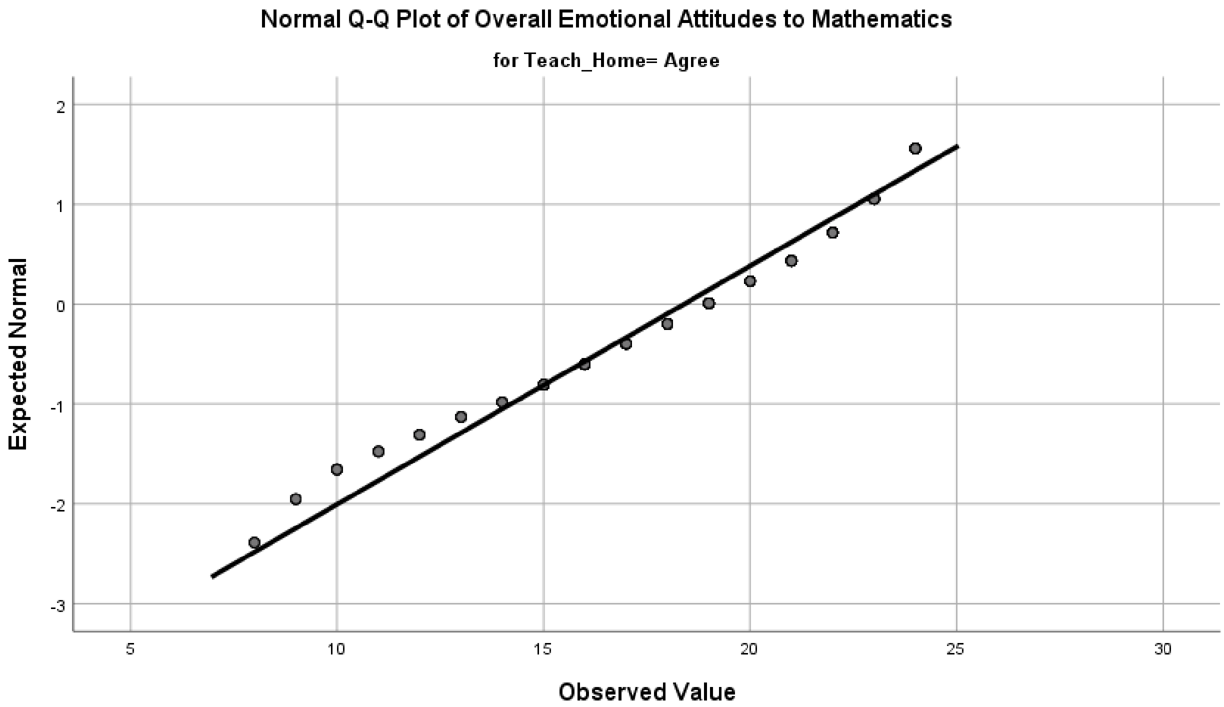
Teacher maths at home and EA

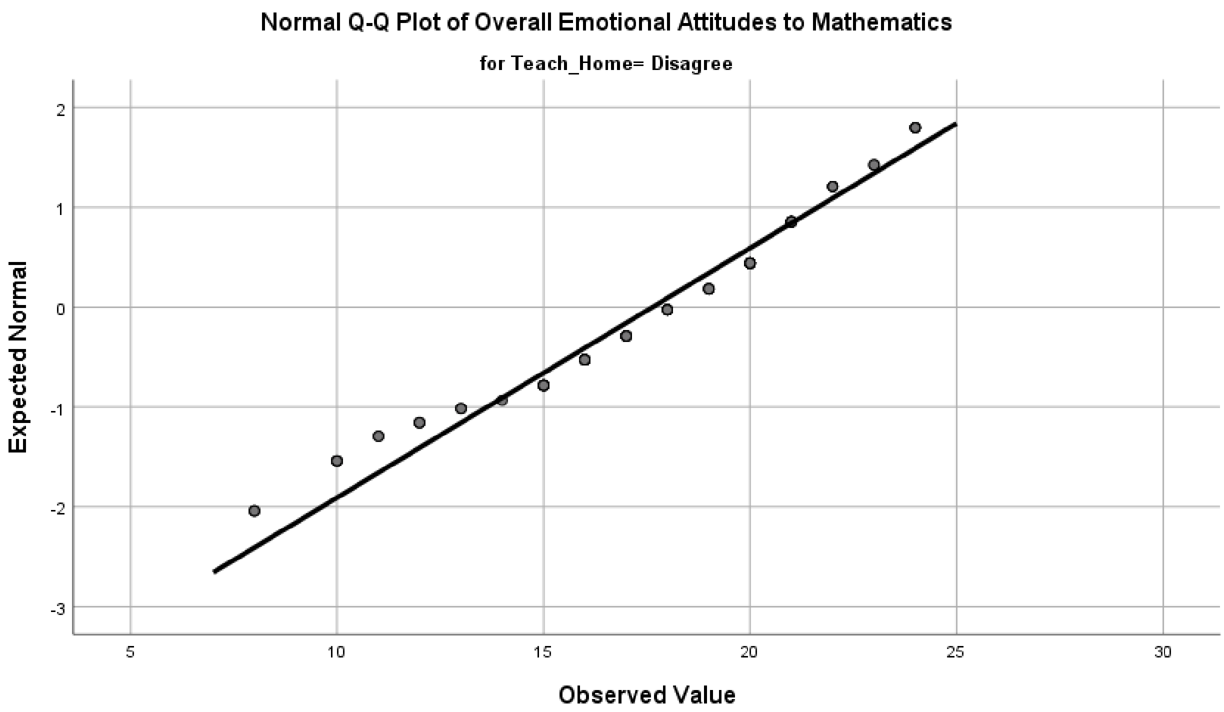
Descriptives

	Teacher: I do maths at home			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Strongly Agree	Mean		20.1250	.44129
		95% Confidence Interval for Mean	Lower Bound	19.2466	
			Upper Bound	21.0034	
		5% Trimmed Mean		20.4583	
		Median		20.0000	
		Variance		15.579	
		Std. Deviation		3.94704	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		6.00	
		Skewness		-.973	.269
		Kurtosis		.337	.532
	Agree	Mean		18.4000	.27313
		95% Confidence Interval for Mean	Lower Bound	17.8619	
			Upper Bound	18.9381	
		5% Trimmed Mean		18.6076	
		Median		19.0000	
		Variance		17.532	
		Std. Deviation		4.18708	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.572	.159
		Kurtosis		-.468	.316
	Disagree	Mean		17.6354	.40828
		95% Confidence Interval for Mean	Lower Bound	16.8249	
			Upper Bound	18.4460	
		5% Trimmed Mean		17.7755	
		Median		18.0000	
		Variance		16.003	
		Std. Deviation		4.00032	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.50	

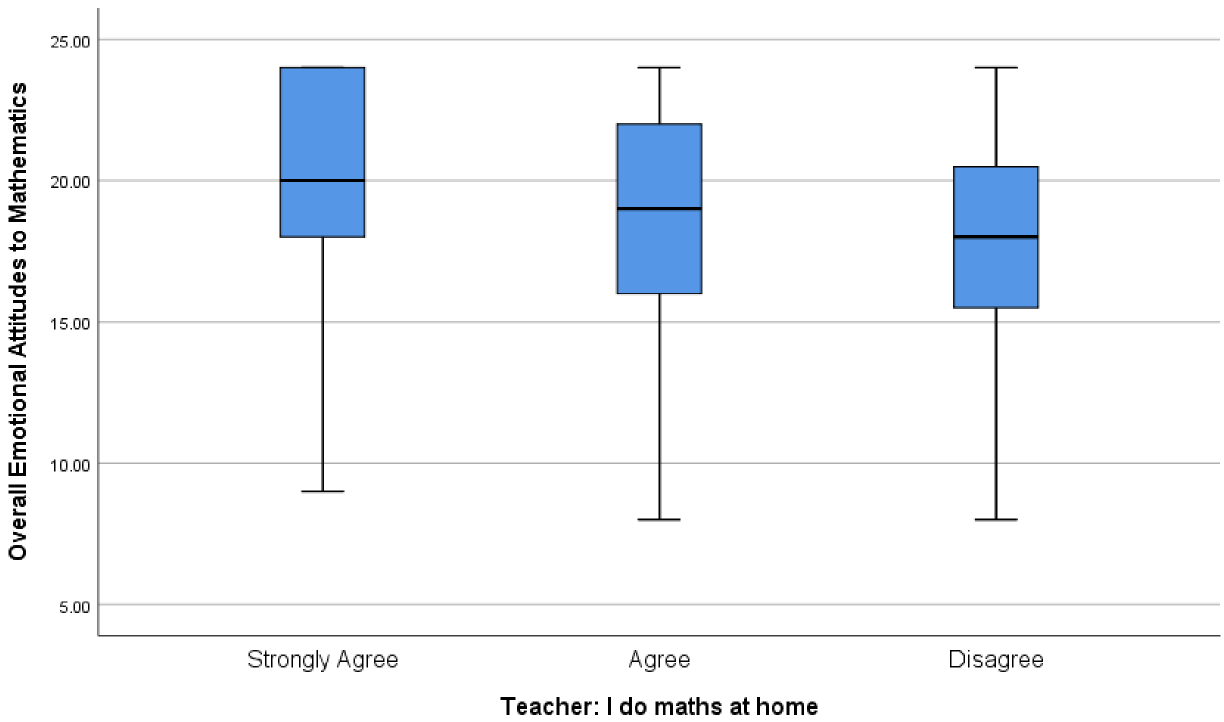
	Skewness	-.613	.246
	Kurtosis	-.167	.488







Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Teach_Home= Disagree
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30



Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
Strongly Agree
Agree
Disagree
Teacher: I do maths at home

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	20.1250	3.94704	.44129	19.2466	21.0034	9.00	24.00
Agree	235	18.4000	4.18708	.27313	17.8619	18.9381	8.00	24.00
Disagree	96	17.6354	4.00032	.40828	16.8249	18.4460	8.00	24.00
Total	411	18.5572	4.17233	.20581	18.1526	18.9617	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	.872	2	408	.419
	Based on Median	.689	2	408	.503
	Based on Median and with adjusted df	.689	2	407.786	.503
	Based on trimmed mean	.786	2	408	.457

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	284.017	2	142.008	8.454	.000
Within Groups	6853.390	408	16.798		
Total	7137.406	410			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) Teacher: I do maths at home	(J) Teacher: I do maths at home	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strongly Agree	Agree	1.72500*	.53052	.005	.4216	3.0284
	Disagree	2.48958*	.62044	.000	.9653	4.0139
Agree	Strongly Agree	-1.72500*	.53052	.005	-3.0284	-.4216
	Disagree	.76458	.49644	.306	-.4551	1.9842
Disagree	Strongly Agree	-2.48958*	.62044	.000	-4.0139	-.9653
	Agree	-.76458	.49644	.306	-1.9842	.4551

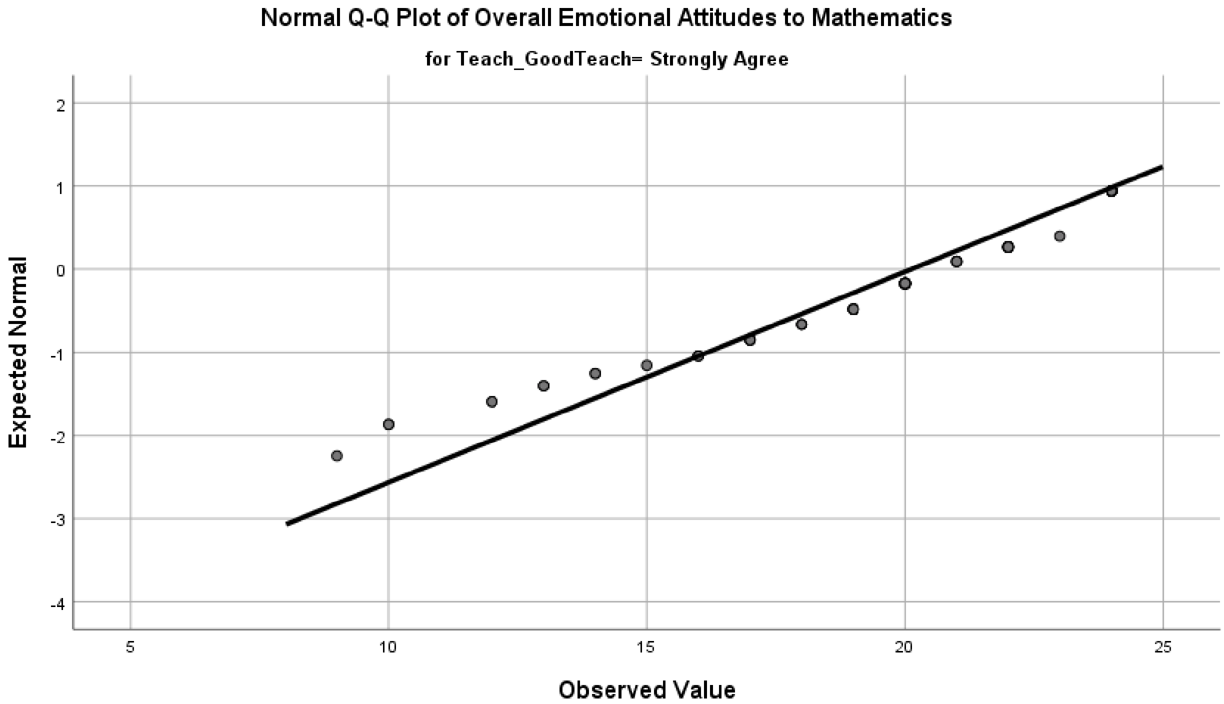
*. The mean difference is significant at the 0.05 level.

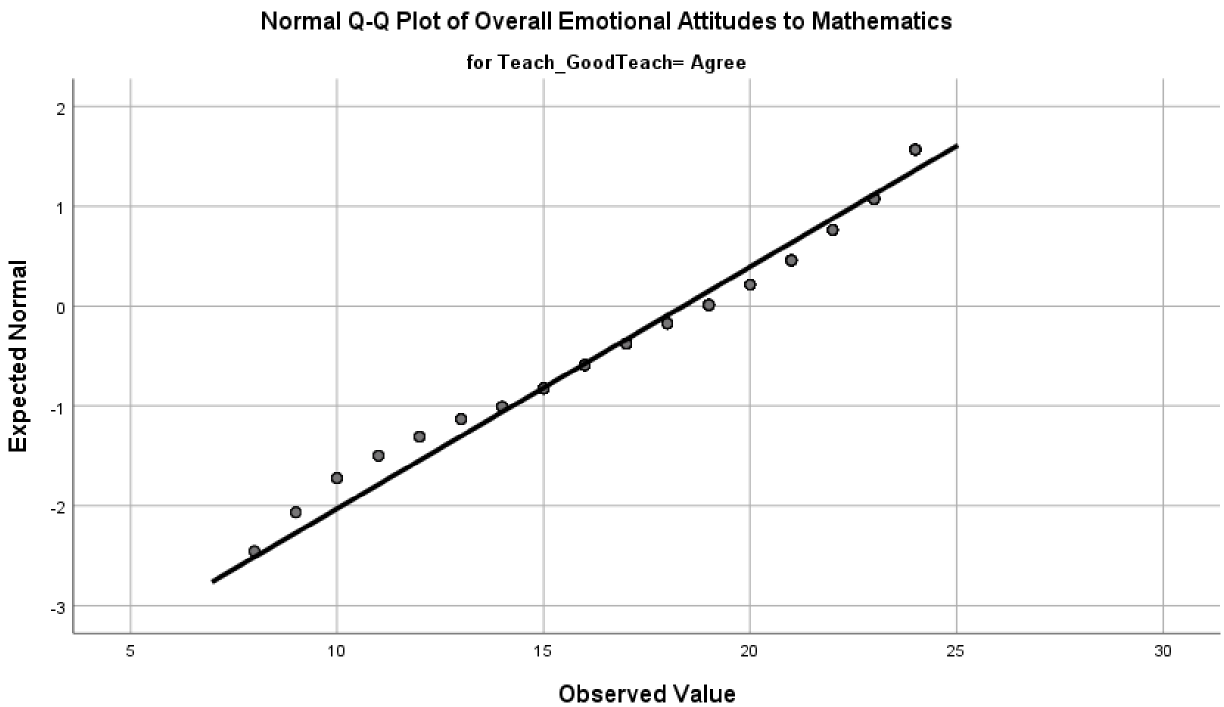
Believe good teaching maths and EAM

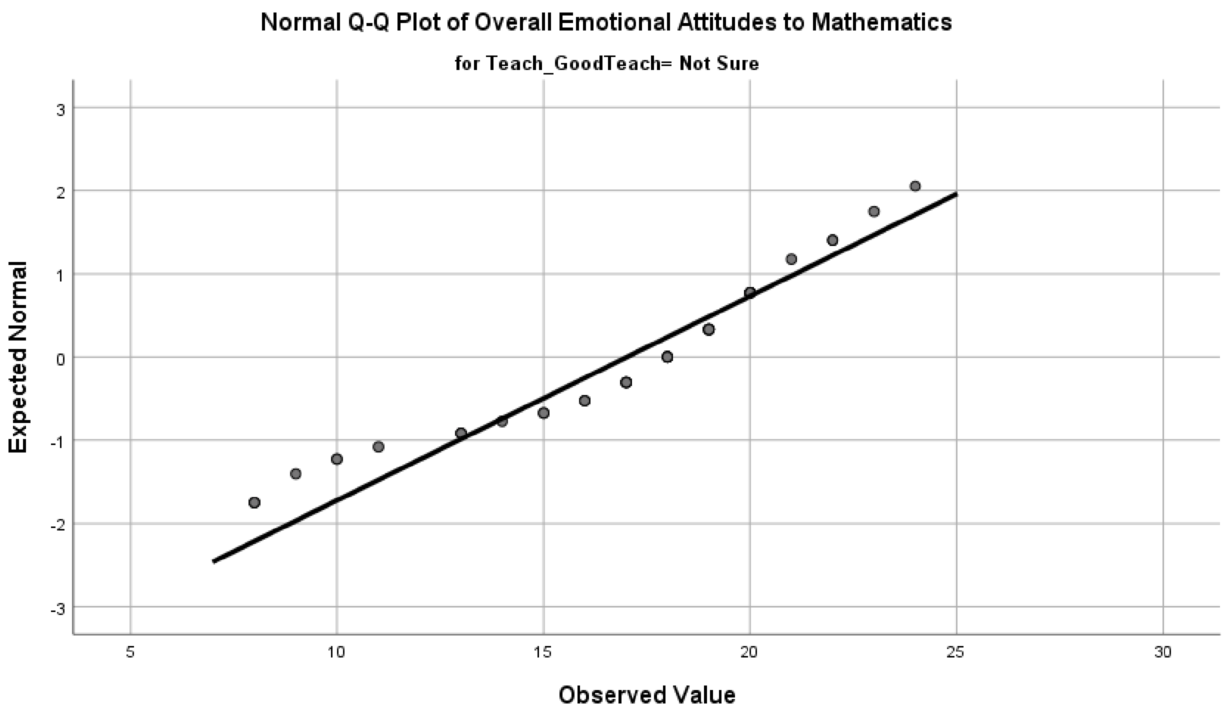
Descriptives

	Teacher: I believe I am good at teaching maths			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Strongly Agree	Mean		20.1250	.44129
		95% Confidence Interval for Mean	Lower Bound	19.2466	
			Upper Bound	21.0034	
		5% Trimmed Mean		20.4583	
		Median		20.0000	
		Variance		15.579	
		Std. Deviation		3.94704	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		6.00	
		Skewness		-.973	.269
		Kurtosis		.337	.532
	Agree	Mean		18.3794	.24582
		95% Confidence Interval for Mean	Lower Bound	17.8955	
			Upper Bound	18.8633	
		5% Trimmed Mean		18.5721	
		Median		19.0000	
		Variance		17.041	
		Std. Deviation		4.12802	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.540	.145
		Kurtosis		-.508	.289
	Not Sure	Mean		17.0204	.58211
		95% Confidence Interval for Mean	Lower Bound	15.8500	
			Upper Bound	18.1908	
		5% Trimmed Mean		17.1769	
		Median		18.0000	
		Variance		16.604	
		Std. Deviation		4.07477	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	

	Skewness	-.832	.340
	Kurtosis	.025	.668






Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for Teach_GoodTeach= Not Sure
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
5
10
15
20
25
30


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
Strongly Agree
Agree
Not Sure
Teacher: I believe I am good at teaching maths

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strongly Agree	80	20.1250	3.94704	.44129	19.2466	21.0034	9.00	24.00
Agree	282	18.3794	4.12802	.24582	17.8955	18.8633	8.00	24.00
Not Sure	49	17.0204	4.07477	.58211	15.8500	18.1908	8.00	24.00
Total	411	18.5572	4.17233	.20581	18.1526	18.9617	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	.754	2	408	.471
	Based on Median	.770	2	408	.464
	Based on Median and with adjusted df	.770	2	401.640	.464
	Based on trimmed mean	.696	2	408	.499

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	321.276	2	160.638	9.615	.000
Within Groups	6816.130	408	16.706		
Total	7137.406	410			

Multiple Comparisons

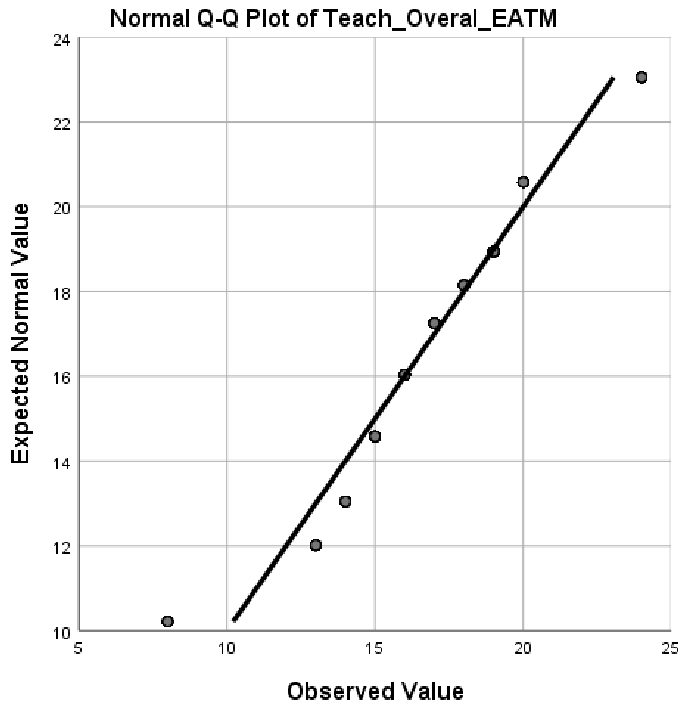
Dependent Variable: Overall Emotional Attitudes to Mathematics

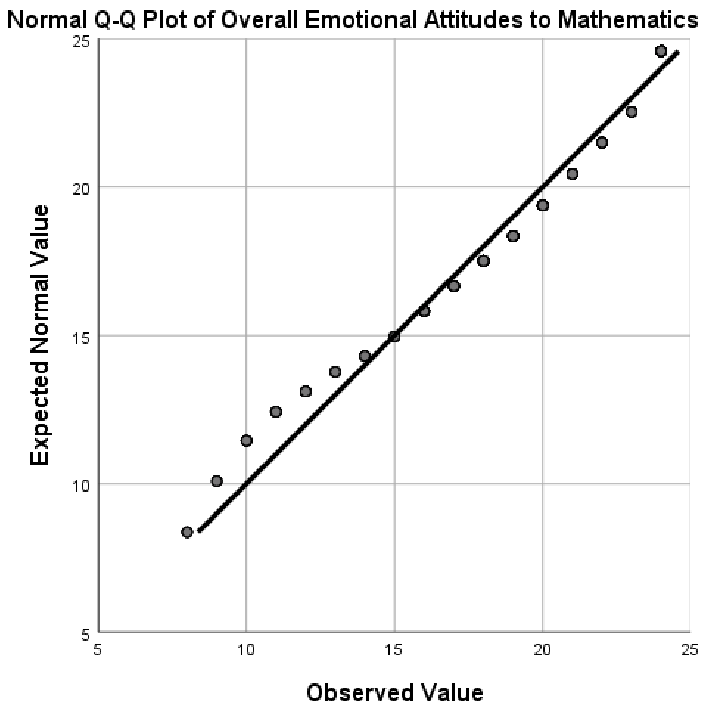
Scheffe

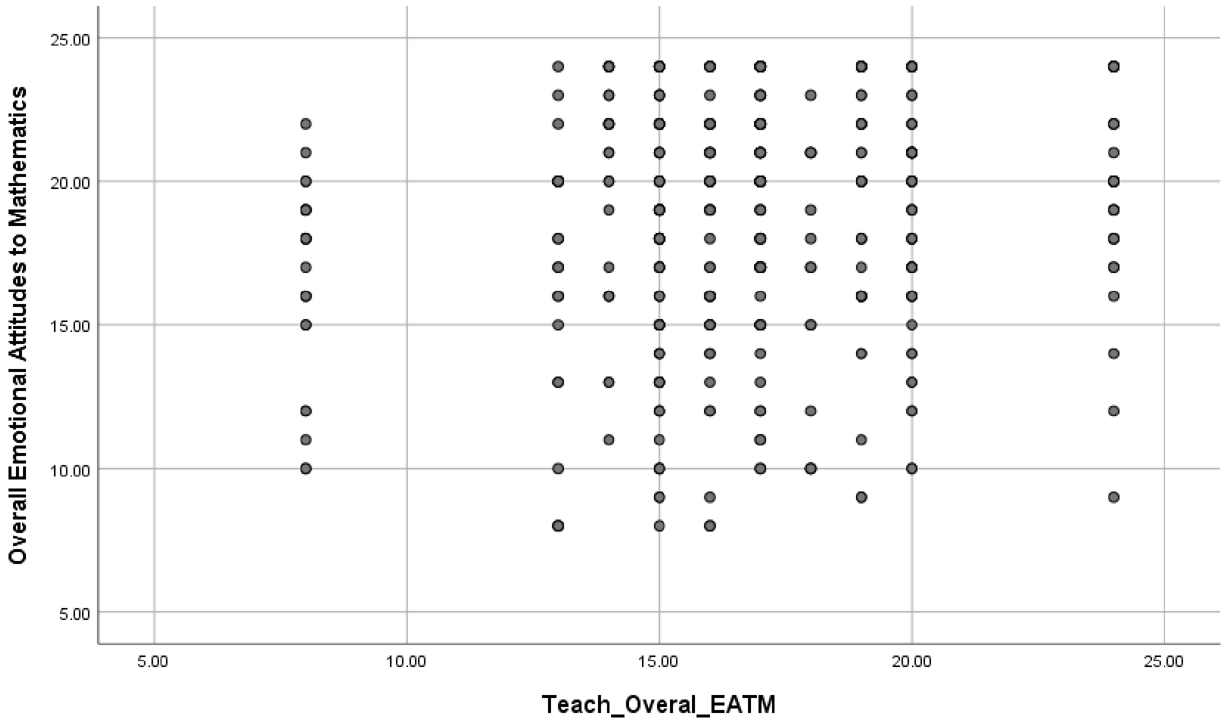
(I) Teacher: I believe I am good at teaching maths	(J) Teacher: I believe I am good at teaching maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strongly Agree	Agree	1.74557*	.51775	.004	.4736	3.0176
	Not Sure	3.10459*	.74147	.000	1.2830	4.9262
Agree	Strongly Agree	-1.74557*	.51775	.004	-3.0176	-.4736
	Not Sure	1.35902	.63260	.101	-.1951	2.9132
Not Sure	Strongly Agree	-3.10459*	.74147	.000	-4.9262	-1.2830
	Agree	-1.35902	.63260	.101	-2.9132	.1951

*. The mean difference is significant at the 0.05 level.

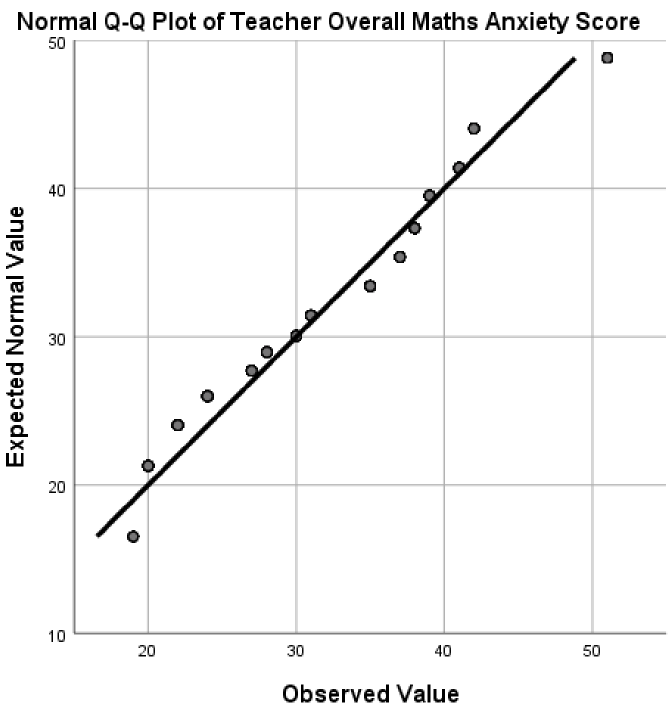
Teacher EAM and EAM

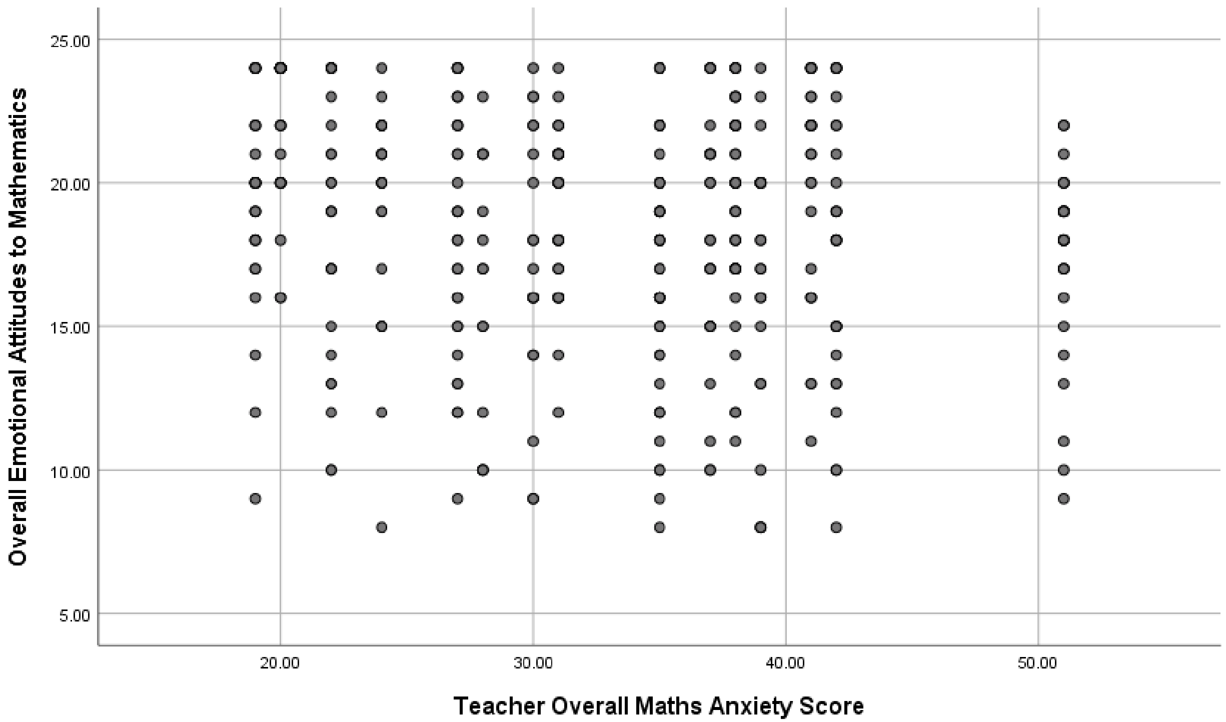






Teacher MA and EAM





25.00
20.00
15.00
10.00
5.00
Overall Emotional Attitudes to Mathematics
20.00
30.00
40.00
50.00
Teacher Overall Maths Anxiety Score

EAM and correlations with

Correlations

			Teacher Overall Maths Anxiety Score	Overall Emotional Attitudes to Mathematics	Teach_Overal_EATM
Spearman's rho	Teacher Overall Maths Anxiety Score	Correlation Coefficient	1.000	-.145**	-.648**
		Sig. (2-tailed)	.	.003	.000
		N	458	411	458
	Overall Emotional Attitudes to Mathematics	Correlation Coefficient	-.145**	1.000	.153**
		Sig. (2-tailed)	.003	.	.002
		N	411	450	411
	Teach_Overal_EATM	Correlation Coefficient	-.648**	.153**	1.000
		Sig. (2-tailed)	.000	.002	.
		N	458	411	458

**. Correlation is significant at the 0.01 level (2-tailed).

BA

Correlations

			Teacher Overall Maths Anxiety Score	Teach_Overal_EATM	Overall Behavioural Attitudes to Mathematics
Spearman's rho	Teacher Overall Maths Anxiety Score	Correlation Coefficient	1.000	-.648**	-.217**
		Sig. (2-tailed)	.	.000	.000
		N	458	458	407
	Teach_Overal_EATM	Correlation Coefficient	-.648**	1.000	.162**
		Sig. (2-tailed)	.000	.	.001
		N	458	458	407
	Overall Behavioural Attitudes to Mathematics	Correlation Coefficient	-.217**	.162**	1.000
		Sig. (2-tailed)	.000	.001	.
		N	407	407	439

**. Correlation is significant at the 0.01 level (2-tailed).

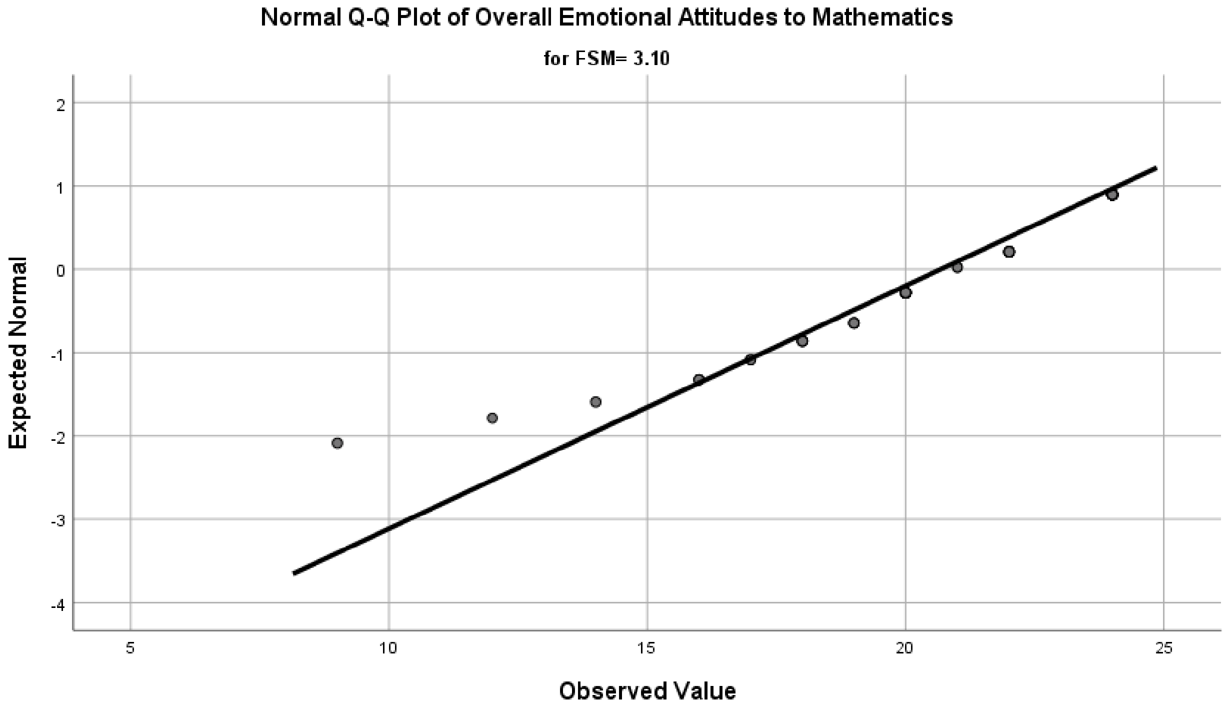
%FSM and EA

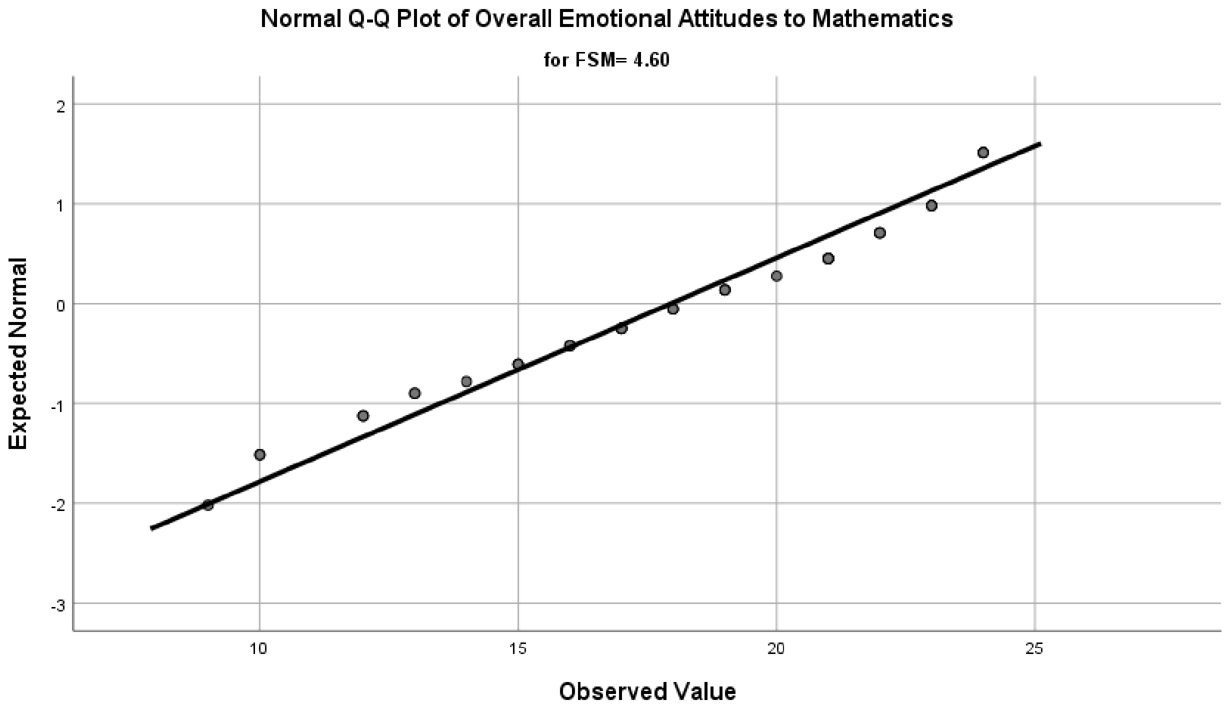
Descriptives

	% of free school meals			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	3.10	Mean		20.6792	.47106
		95% Confidence Interval for Mean	Lower Bound	19.7340	
			Upper Bound	21.6245	
		5% Trimmed Mean		21.0126	
		Median		21.0000	
		Variance		11.761	
		Std. Deviation		3.42936	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.00	
		Skewness		-1.158	.327
		Kurtosis		1.600	.644
	4.60	Mean		17.9556	.66512
		95% Confidence Interval for Mean	Lower Bound	16.6151	
			Upper Bound	19.2960	
		5% Trimmed Mean		18.0864	
		Median		18.0000	
		Variance		19.907	
		Std. Deviation		4.46173	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		7.00	
		Skewness		-.353	.354
		Kurtosis		-.946	.695
	7.50	Mean		18.3200	.62495
		95% Confidence Interval for Mean	Lower Bound	17.0641	
			Upper Bound	19.5759	
		5% Trimmed Mean		18.5556	
		Median		19.0000	
		Variance		19.528	
		Std. Deviation		4.41907	
		Minimum		8.00	
		Maximum		24.00	

		Range		16.00	
		Interquartile Range		7.00	
		Skewness		-.682	.337
		Kurtosis		-.358	.662
	12.70	Mean		17.6667	.54209
		95% Confidence Interval for Mean	Lower Bound	16.5779	
			Upper Bound	18.7555	
		5% Trimmed Mean		17.7625	
		Median		18.0000	
		Variance		14.987	
		Std. Deviation		3.87126	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.00	
		Skewness		-.512	.333
		Kurtosis		-.214	.656
	20.00	Mean		19.0185	.52238
		95% Confidence Interval for Mean	Lower Bound	17.9708	
			Upper Bound	20.0663	
		5% Trimmed Mean		19.2140	
		Median		20.0000	
		Variance		14.735	
		Std. Deviation		3.83868	
		Minimum		10.00	
		Maximum		24.00	
		Range		14.00	
		Interquartile Range		5.25	
		Skewness		-.582	.325
		Kurtosis		-.349	.639
	20.90	Mean		17.4773	.68392
		95% Confidence Interval for Mean	Lower Bound	16.0980	
			Upper Bound	18.8565	
		5% Trimmed Mean		17.6111	
		Median		17.0000	
		Variance		20.581	
		Std. Deviation		4.53661	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.75	

		Skewness		-.295	.357
		Kurtosis		-.660	.702
	27.40	Mean		19.1600	.73185
		95% Confidence Interval for Mean	Lower Bound	17.6495	
			Upper Bound	20.6705	
		5% Trimmed Mean		19.2889	
		Median		19.0000	
		Variance		13.390	
		Std. Deviation		3.65923	
		Minimum		12.00	
		Maximum		24.00	
		Range		12.00	
		Interquartile Range		5.00	
		Skewness		-.366	.464
		Kurtosis		-.704	.902
	28.50	Mean		16.6000	.62069
		95% Confidence Interval for Mean	Lower Bound	15.3491	
			Upper Bound	17.8509	
		5% Trimmed Mean		16.7037	
		Median		18.0000	
		Variance		17.336	
		Std. Deviation		4.16370	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.591	.354
		Kurtosis		-.415	.695
	57.20	Mean		19.8795	.42317
		95% Confidence Interval for Mean	Lower Bound	19.0377	
			Upper Bound	20.7213	
		5% Trimmed Mean		20.1573	
		Median		21.0000	
		Variance		14.863	
		Std. Deviation		3.85530	
		Minimum		10.00	
		Maximum		24.00	
		Range		14.00	
		Interquartile Range		5.00	
		Skewness		-.971	.264
		Kurtosis		.143	.523


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 3.10
Expected Normal
Observed Value
2
1
0
-1
-2
-3
-4
5
10
15
20
25


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 4.60
Expected Normal
Observed Value
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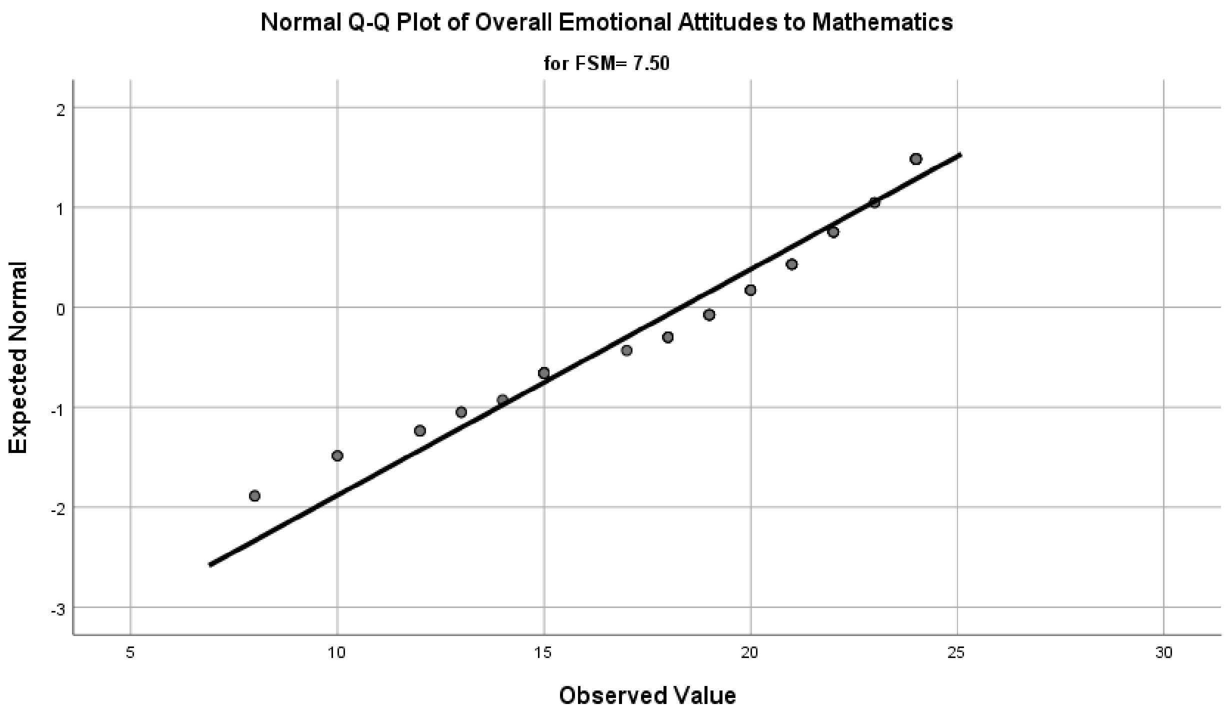
1
0
-1
-2
-3
10
15
20
25


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 7.50
Expected Normal
Observed Value
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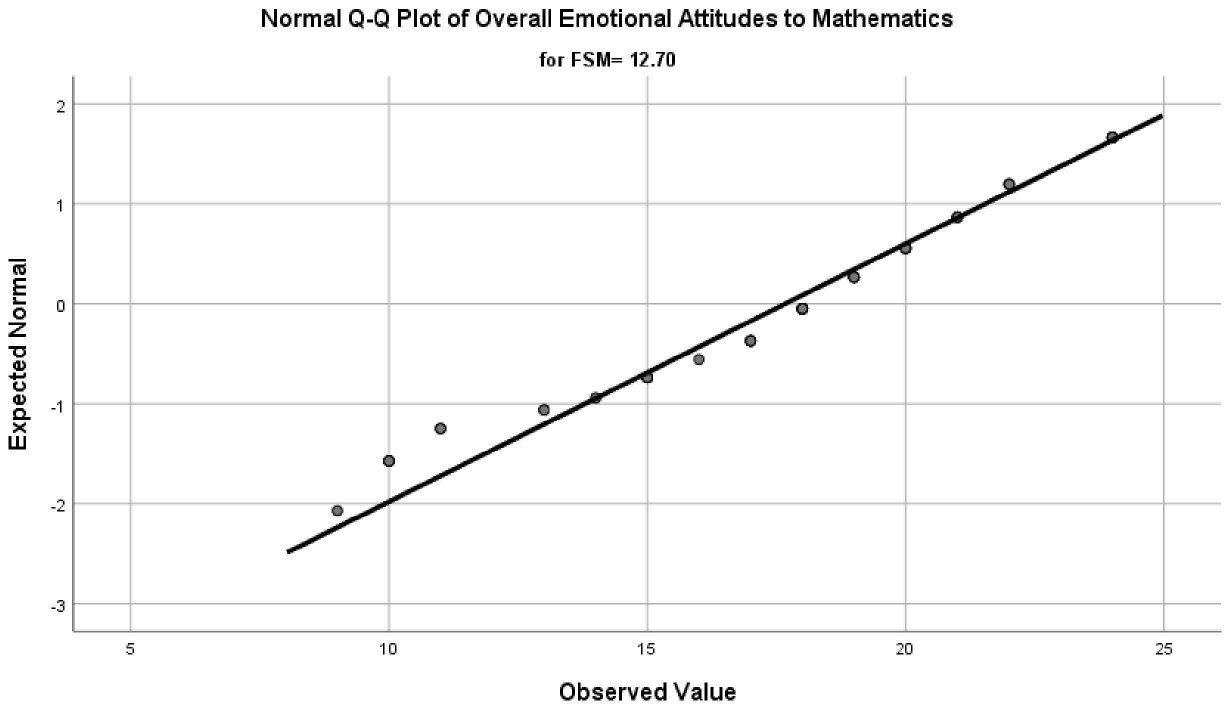
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 12.70
Expected Normal
Observed Value
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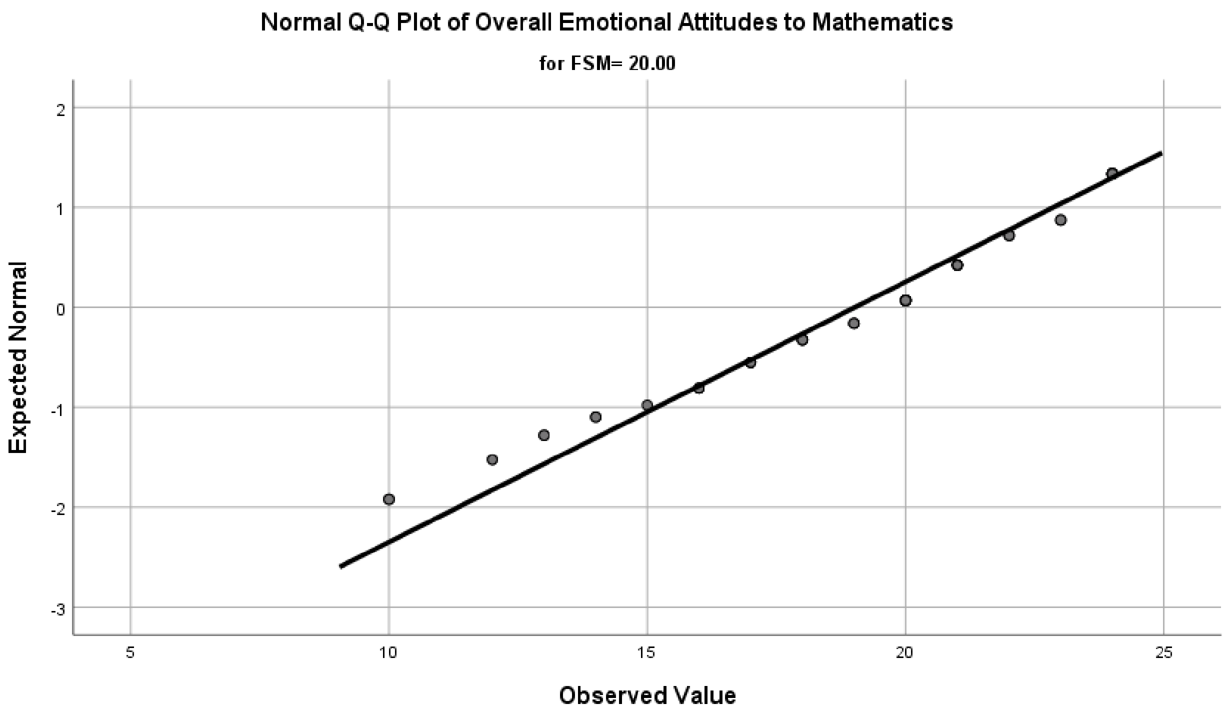
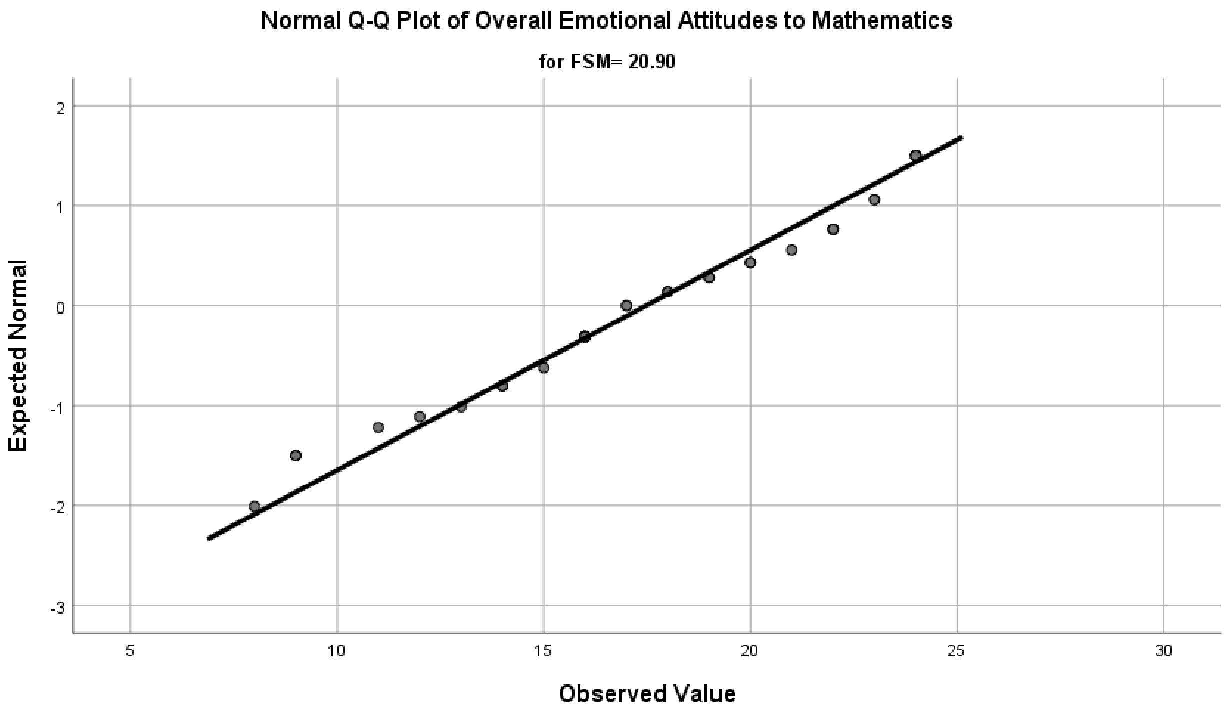
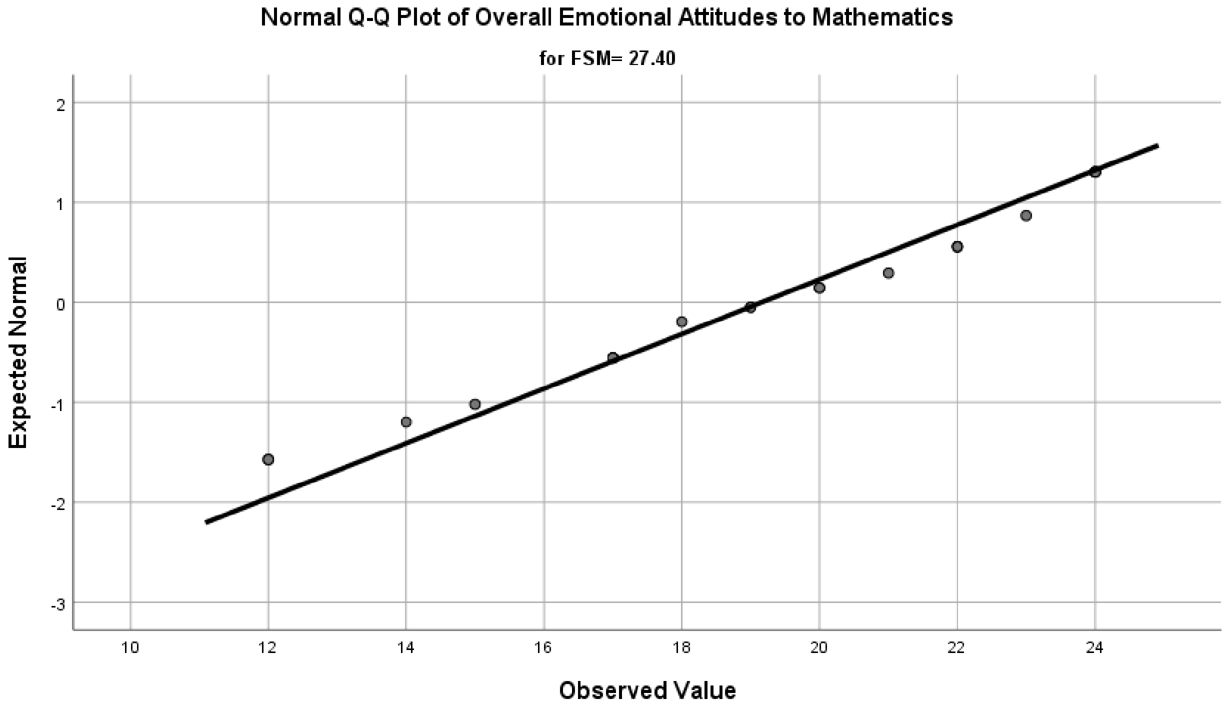
1
0
-1
-2
-3
5
10
15
20
25

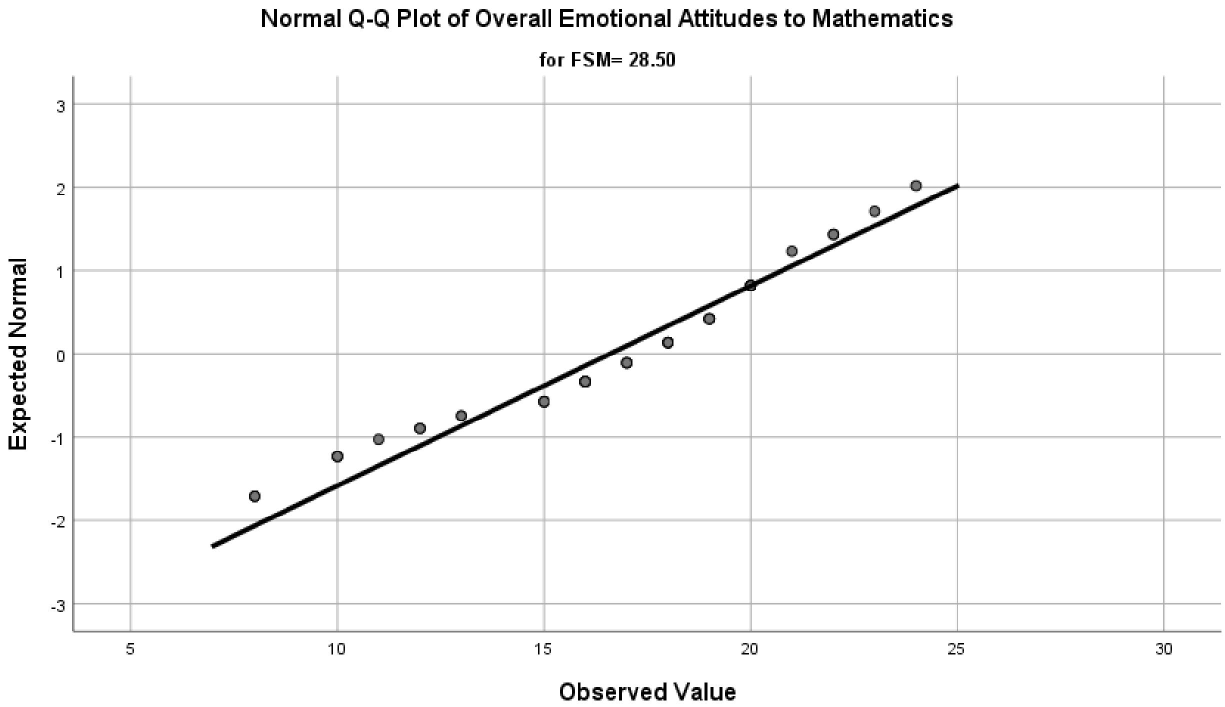


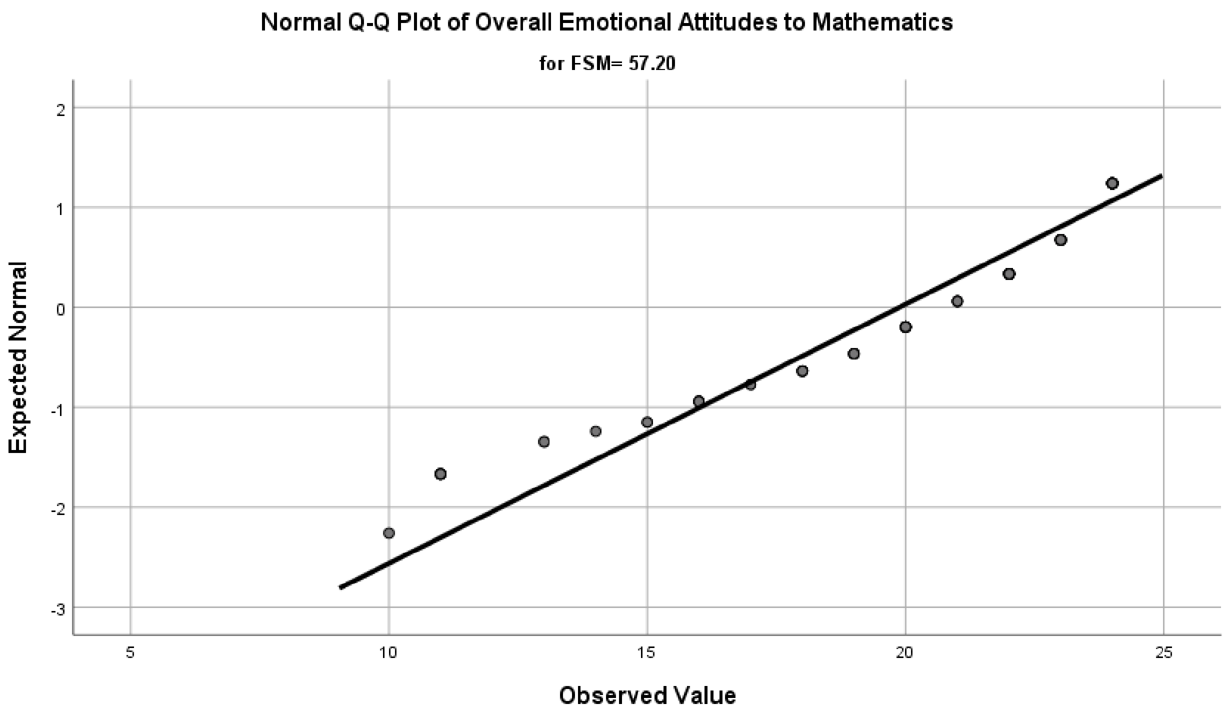
Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 20.00
Expected Normal
Observed Value



Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 20.90
Expected Normal
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 27.40
Expected Normal
2
1
0
-1
-2
-3
10
12
14
16
18
20
22
24
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 28.50
Expected Normal
3
2
1
0
-1
-2
-3
5
10
15
20
25
30
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for FSM= 57.20
Expected Normal
Observed Value
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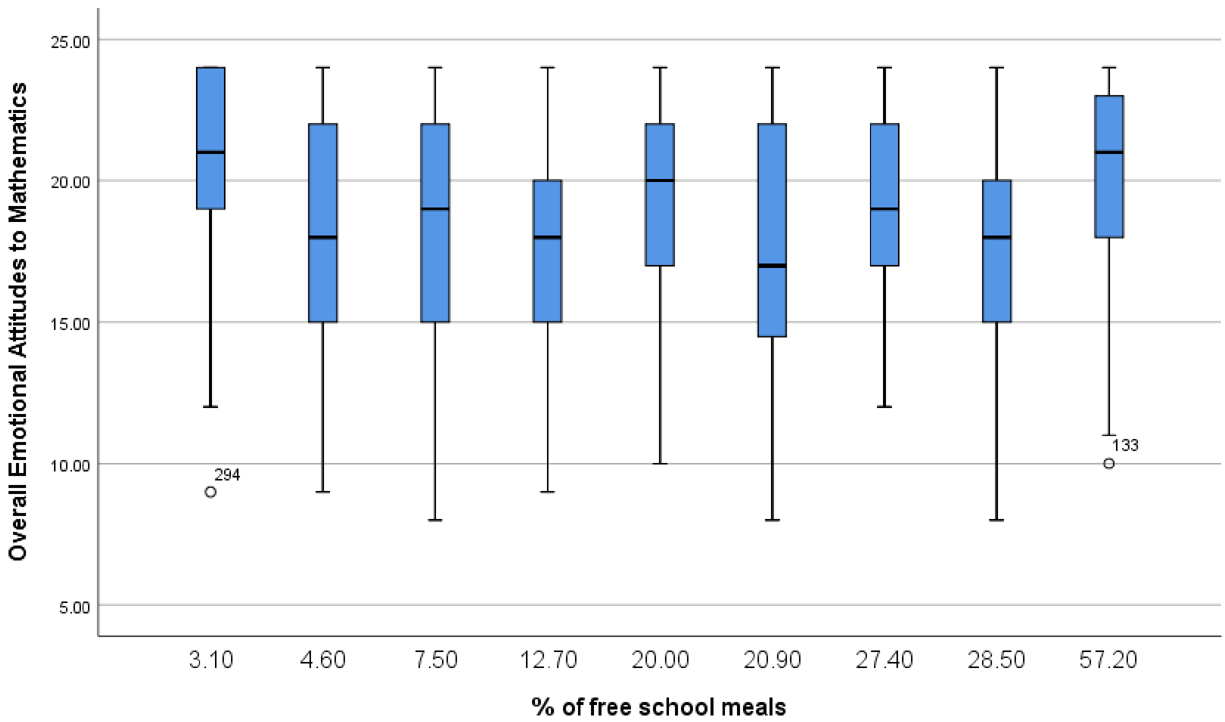
1
0
-1
-2
-3
5
10
15
20
25


Overall Emotional Attitudes to Mathematics
% of free school meals
25.00
20.00
15.00
10.00
5.00
3.10
4.60
7.50
12.70
20.00
20.90
27.40
28.50
57.20
294
133

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
3.10	53	20.6792	3.42936	.47106	19.7340	21.6245	9.00	24.00
4.60	45	17.9556	4.46173	.66512	16.6151	19.2960	9.00	24.00
7.50	50	18.3200	4.41907	.62495	17.0641	19.5759	8.00	24.00
12.70	51	17.6667	3.87126	.54209	16.5779	18.7555	9.00	24.00
20.00	54	19.0185	3.83868	.52238	17.9708	20.0663	10.00	24.00
20.90	44	17.4773	4.53661	.68392	16.0980	18.8565	8.00	24.00
27.40	25	19.1600	3.65923	.73185	17.6495	20.6705	12.00	24.00
28.50	45	16.6000	4.16370	.62069	15.3491	17.8509	8.00	24.00
57.20	83	19.8795	3.85530	.42317	19.0377	20.7213	10.00	24.00
Total	450	18.6511	4.18030	.19706	18.2638	19.0384	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	1.208	8	441	.292
	Based on Median	.995	8	441	.439
	Based on Median and with adjusted df	.995	8	425.407	.439
	Based on trimmed mean	1.190	8	441	.303

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	683.639	8	85.455	5.261	.000
Within Groups	7162.586	441	16.242		
Total	7846.224	449			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) % of free school meals	(J) % of free school meals	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
3.10	4.60	2.72369	.81693	.199	-.5107	5.9581
	7.50	2.35925	.79453	.360	-.7865	5.5049
	12.70	3.01258	.79051	.072	-.1172	6.1424
	20.00	1.66073	.77924	.804	-1.4244	4.7459
	20.90	3.20197	.82193	.059	-.0522	6.4562
	27.40	1.51925	.97781	.965	-2.3521	5.3906
	28.50	4.07925*	.81693	.002	.8449	7.3136
	57.20	.79973	.70861	.996	-2.0058	3.6053
4.60	3.10	-2.72369	.81693	.199	-5.9581	.5107
	7.50	-.36444	.82811	1.000	-3.6431	2.9142
	12.70	.28889	.82425	1.000	-2.9745	3.5523
	20.00	-1.06296	.81345	.989	-4.2836	2.1576
	20.90	.47828	.85443	1.000	-2.9046	3.8611

	27.40	-1.20444	1.00528	.994	-5.1846	2.7757
	28.50	1.35556	.84962	.959	-2.0082	4.7194
	57.20	-1.92396	.74606	.575	-4.8778	1.0298
7.50	3.10	-2.35925	.79453	.360	-5.5049	.7865
	4.60	.36444	.82811	1.000	-2.9142	3.6431
	12.70	.65333	.80206	1.000	-2.5222	3.8288
	20.00	-.69852	.79095	.999	-3.8300	2.4330
	20.90	.84273	.83304	.998	-2.4555	4.1409
	27.40	-.84000	.98717	.999	-4.7484	3.0684
	28.50	1.72000	.82811	.827	-1.5586	4.9986
	57.20	-1.55952	.72147	.791	-4.4159	1.2969
12.70	3.10	-3.01258	.79051	.072	-6.1424	.1172
	4.60	-.28889	.82425	1.000	-3.5523	2.9745
	7.50	-.65333	.80206	1.000	-3.8288	2.5222
	20.00	-1.35185	.78692	.937	-4.4674	1.7637
	20.90	.18939	.82921	1.000	-3.0936	3.4724
	27.40	-1.49333	.98394	.970	-5.3889	2.4023
	28.50	1.06667	.82425	.989	-2.1967	4.3300
	57.20	-2.21285	.71704	.303	-5.0518	.6260
20.00	3.10	-1.66073	.77924	.804	-4.7459	1.4244
	4.60	1.06296	.81345	.989	-2.1576	4.2836
	7.50	.69852	.79095	.999	-2.4330	3.8300
	12.70	1.35185	.78692	.937	-1.7637	4.4674
	20.90	1.54125	.81848	.895	-1.6993	4.7817
	27.40	-.14148	.97490	1.000	-4.0013	3.7184
	28.50	2.41852	.81345	.358	-.8021	5.6391

	57.20	-.86100	.70460	.993	-3.6506	1.9286
20.90	3.10	-3.20197	.82193	.059	-6.4562	.0522
	4.60	-.47828	.85443	1.000	-3.8611	2.9046
	7.50	-.84273	.83304	.998	-4.1409	2.4555
	12.70	-.18939	.82921	1.000	-3.4724	3.0936
	20.00	-1.54125	.81848	.895	-4.7817	1.6993
	27.40	-1.68273	1.00935	.947	-5.6790	2.3135
	28.50	.87727	.85443	.998	-2.5056	4.2601
	57.20	-2.40225	.75154	.253	-5.3777	.5732
27.40	3.10	-1.51925	.97781	.965	-5.3906	2.3521
	4.60	1.20444	1.00528	.994	-2.7757	5.1846
	7.50	.84000	.98717	.999	-3.0684	4.7484
	12.70	1.49333	.98394	.970	-2.4023	5.3889
	20.00	.14148	.97490	1.000	-3.7184	4.0013
	20.90	1.68273	1.00935	.947	-2.3135	5.6790
	28.50	2.56000	1.00528	.593	-1.4201	6.5401
	57.20	-.71952	.91943	1.000	-4.3597	2.9207
28.50	3.10	-4.07925*	.81693	.002	-7.3136	-.8449
	4.60	-1.35556	.84962	.959	-4.7194	2.0082
	7.50	-1.72000	.82811	.827	-4.9986	1.5586
	12.70	-1.06667	.82425	.989	-4.3300	2.1967
	20.00	-2.41852	.81345	.358	-5.6391	.8021
	20.90	-.87727	.85443	.998	-4.2601	2.5056
	27.40	-2.56000	1.00528	.593	-6.5401	1.4201
	57.20	-3.27952*	.74606	.015	-6.2333	-.3257
57.20	3.10	-.79973	.70861	.996	-3.6053	2.0058

	4.60	1.92396	.74606	.575	-1.0298	4.8778
	7.50	1.55952	.72147	.791	-1.2969	4.4159
	12.70	2.21285	.71704	.303	-.6260	5.0518
	20.00	.86100	.70460	.993	-1.9286	3.6506
	20.90	2.40225	.75154	.253	-.5732	5.3777
	27.40	.71952	.91943	1.000	-2.9207	4.3597
	28.50	3.27952*	.74606	.015	.3257	6.2333

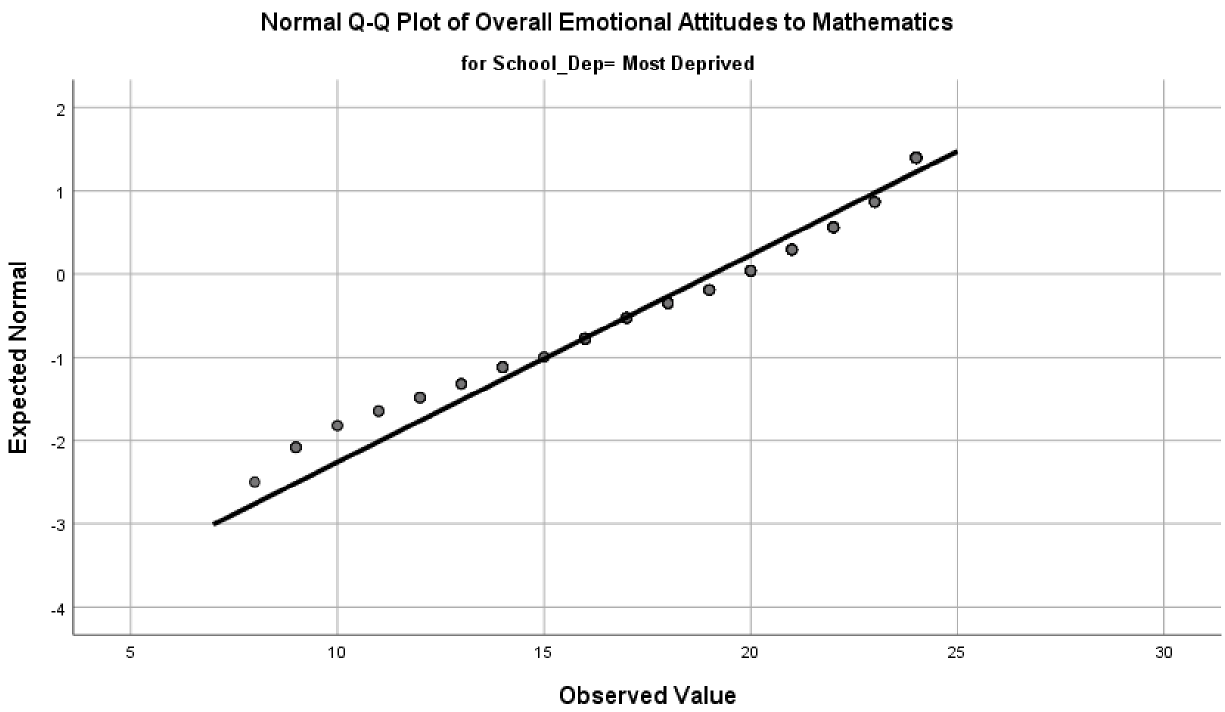
*. The mean difference is significant at the 0.05 level.

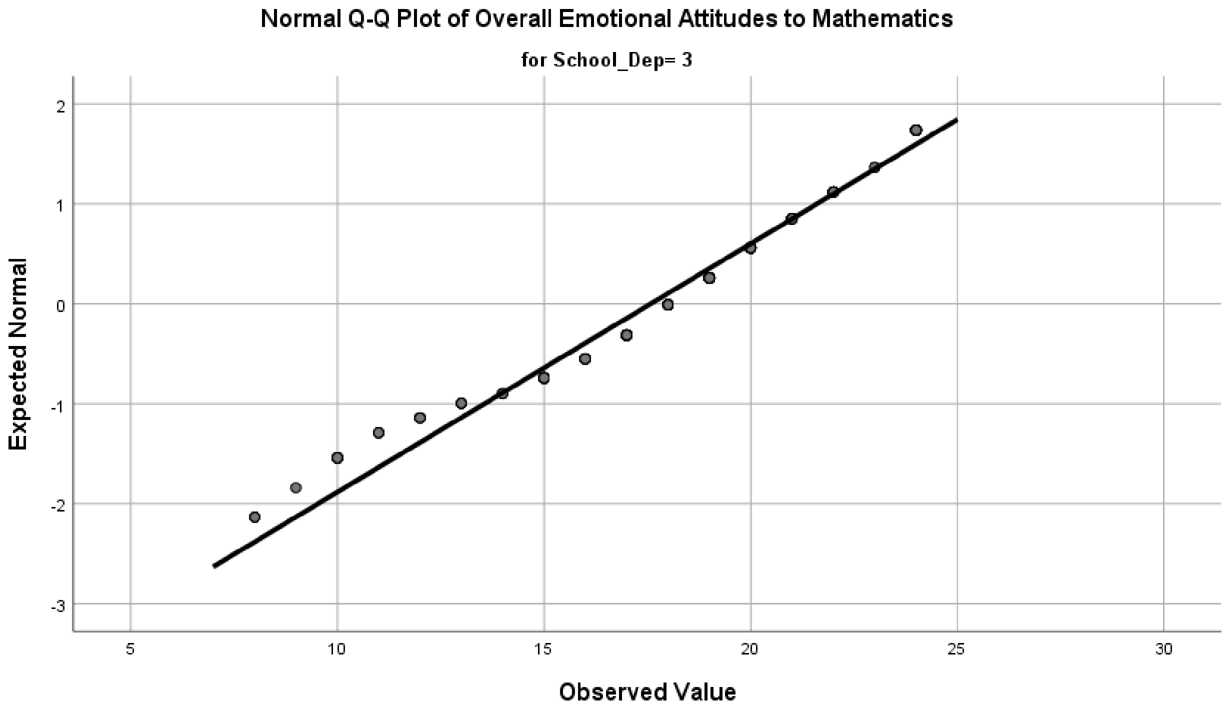
IMD and EAM

Descriptives

	School IMD Decile			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Most Deprived	Mean		19.0818	.31847
		95% Confidence Interval for Mean	Lower Bound	18.4528	
			Upper Bound	19.7108	
		5% Trimmed Mean		19.3344	
		Median		20.0000	
		Variance		16.126	
		Std. Deviation		4.01574	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.707	.192
		Kurtosis		-.212	.383
	3	Mean		17.5785	.36548
		95% Confidence Interval for Mean	Lower Bound	16.8549	
			Upper Bound	18.3021	
		5% Trimmed Mean		17.7071	
		Median		18.0000	
		Variance		16.163	
		Std. Deviation		4.02027	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		5.00	
		Skewness		-.531	.220
		Kurtosis		-.244	.437
	5	Mean		18.3200	.62495
		95% Confidence Interval for Mean	Lower Bound	17.0641	
			Upper Bound	19.5759	
		5% Trimmed Mean		18.5556	
		Median		19.0000	
		Variance		19.528	
		Std. Deviation		4.41907	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		7.00	

				Statistic	Std. Error
		Skewness		-.682	.337
		Kurtosis		-.358	.662
	6	Mean		18.2090	.55966
		95% Confidence Interval for Mean	Lower Bound	17.0916	
			Upper Bound	19.3264	
		5% Trimmed Mean		18.3599	
		Median		19.0000	
		Variance		20.986	
		Std. Deviation		4.58105	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		7.00	
		Skewness		-.393	.293
		Kurtosis		-1.016	.578
	7	Mean		20.6792	.47106
		95% Confidence Interval for Mean	Lower Bound	19.7340	
			Upper Bound	21.6245	
		5% Trimmed Mean		21.0126	
		Median		21.0000	
		Variance		11.761	
		Std. Deviation		3.42936	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.00	
		Skewness		-1.158	.327
		Kurtosis		1.600	.644


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for School_Dep= Most Deprived
Expected Normal
Observed Value
2
1
0
-1
-2
-3
-4
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for School_Dep= 3
Expected Normal
Observed Value
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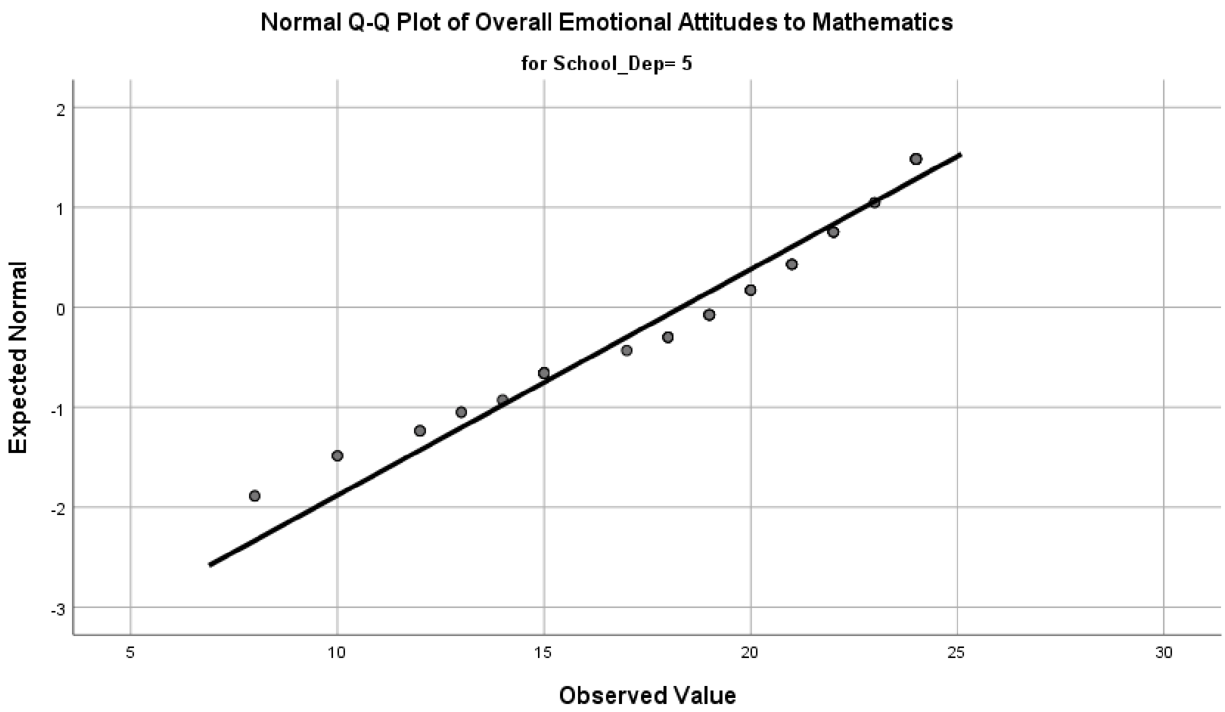
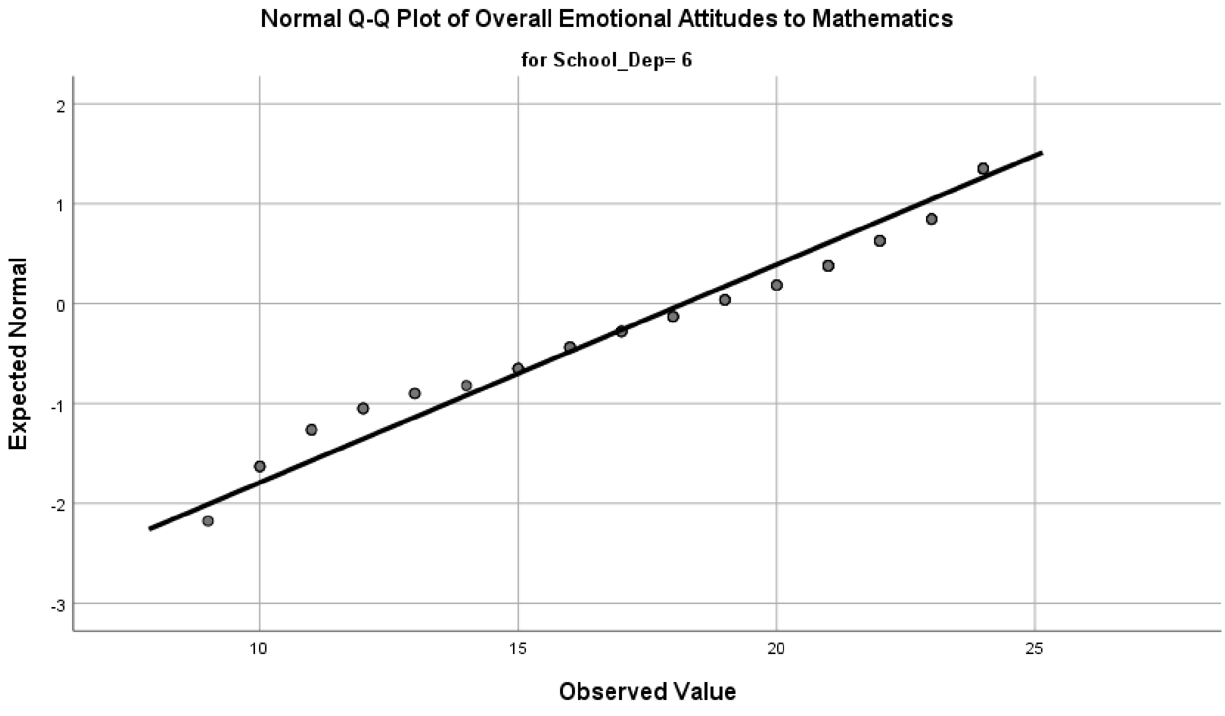
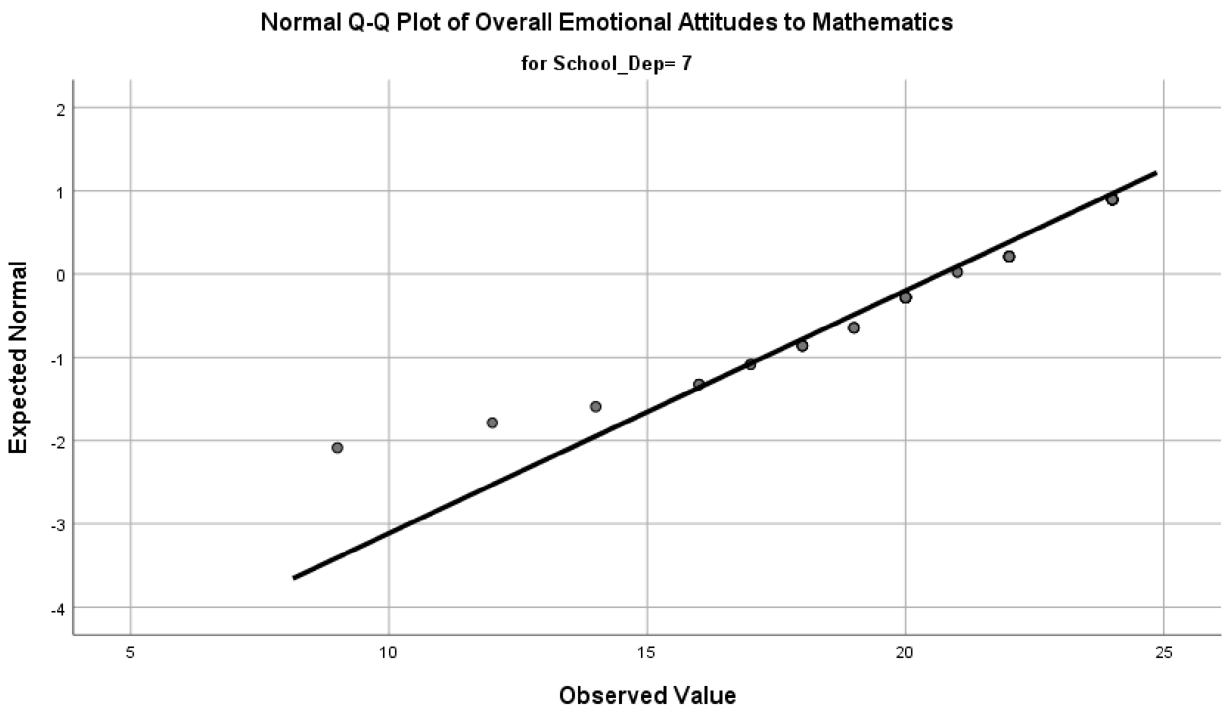
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for School_Dep= 5
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for School_Dep= 6
Expected Normal
Observed Value
2
1
0
-1
-2
-3
10
15
20
25


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for School_Dep= 7
Expected Normal
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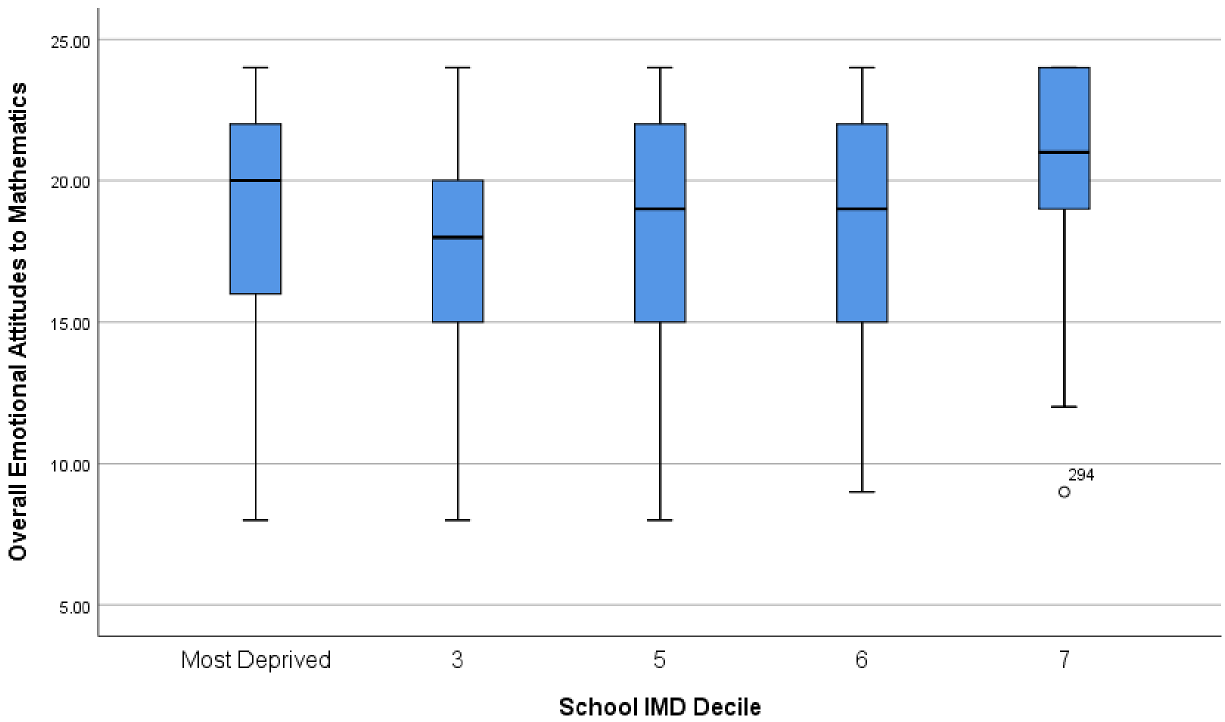
-1
-2
-3
-4
5
10
15
20
25
Observed Value


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
294
Most Deprived
3
5
6
7
School IMD Decile

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Most Deprived	159	19.0818	4.01574	.31847	18.4528	19.7108	8.00	24.00
3	121	17.5785	4.02027	.36548	16.8549	18.3021	8.00	24.00
5	50	18.3200	4.41907	.62495	17.0641	19.5759	8.00	24.00
6	67	18.2090	4.58105	.55966	17.0916	19.3264	9.00	24.00
7	53	20.6792	3.42936	.47106	19.7340	21.6245	9.00	24.00
Total	450	18.6511	4.18030	.19706	18.2638	19.0384	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	2.311	4	445	.057
	Based on Median	1.861	4	445	.116
	Based on Median and with adjusted df	1.861	4	438.950	.116
	Based on trimmed mean	2.213	4	445	.067

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	405.281	4	101.320	6.059	.000
Within Groups	7440.943	445	16.721		
Total	7846.224	449			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) School IMD Decile	(J) School IMD Decile	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Most Deprived	3	1.50325	.49331	.056	-.0227	3.0292
	5	.76176	.66302	.858	-1.2891	2.8126
	6	.87281	.59560	.709	-.9695	2.7151
	7	-1.59748	.64858	.196	-3.6037	.4087
3	Most Deprived	-1.50325	.49331	.056	-3.0292	.0227
	5	-.74149	.68747	.884	-2.8680	1.3850
	6	-.63044	.62271	.906	-2.5566	1.2957
	7	-3.10073*	.67356	.000	-5.1842	-1.0173
5	Most Deprived	-.76176	.66302	.858	-2.8126	1.2891
	3	.74149	.68747	.884	-1.3850	2.8680
	6	.11104	.76420	1.000	-2.2528	2.4749
	7	-2.35925	.80618	.075	-4.8529	.1344
6	Most Deprived	-.87281	.59560	.709	-2.7151	.9695
	3	.63044	.62271	.906	-1.2957	2.5566
	5	-.11104	.76420	1.000	-2.4749	2.2528
	7	-2.47029*	.75171	.030	-4.7955	-.1451
7	Most Deprived	1.59748	.64858	.196	-.4087	3.6037
	3	3.10073*	.67356	.000	1.0173	5.1842
	5	2.35925	.80618	.075	-.1344	4.8529
	6	2.47029*	.75171	.030	.1451	4.7955

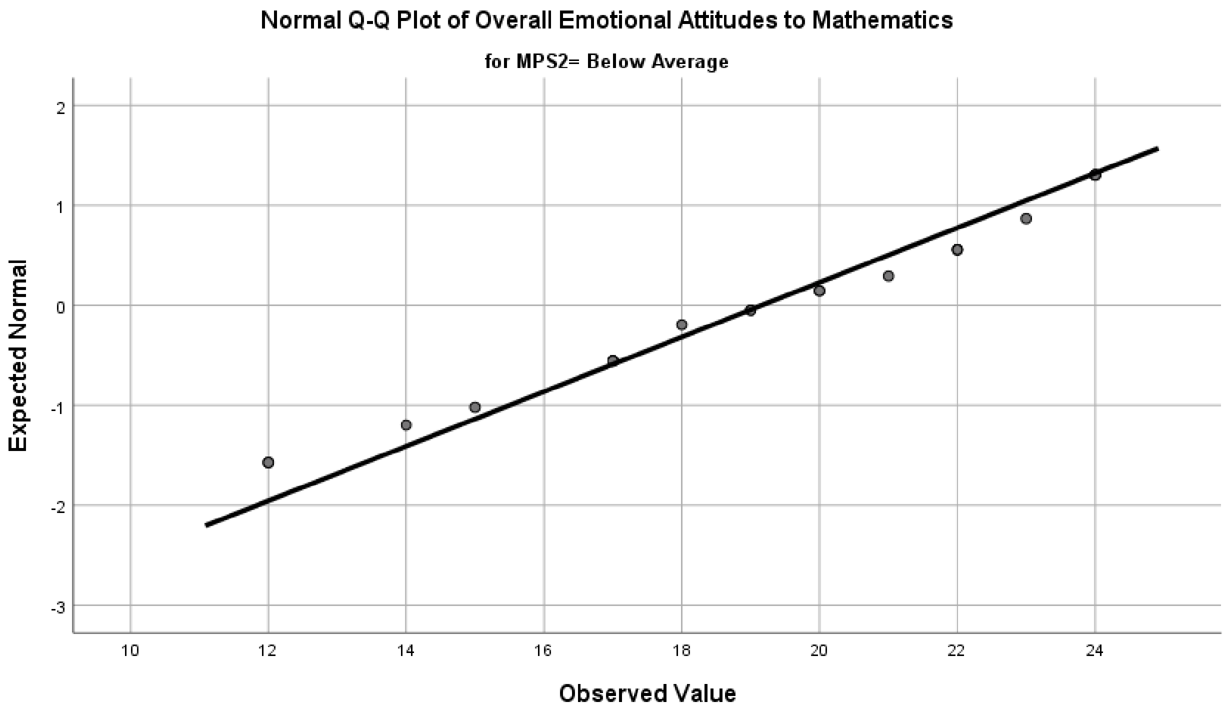
*. The mean difference is significant at the 0.05 level.

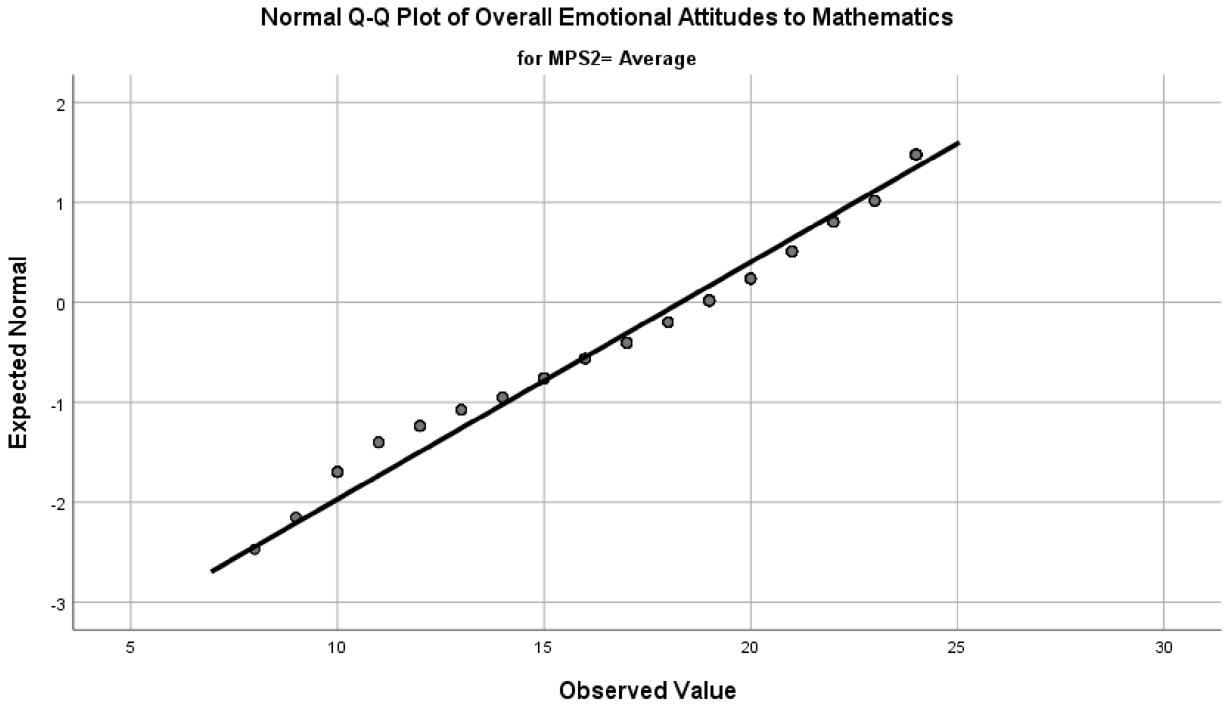
MPS2 and EA

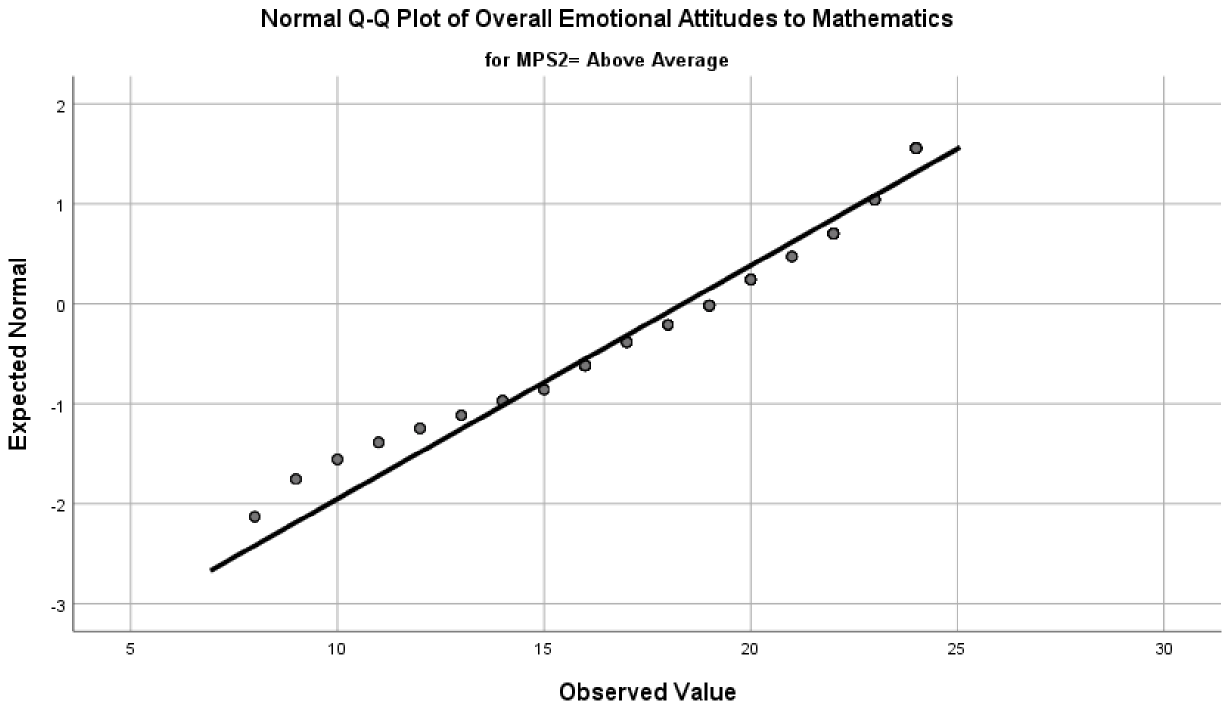
Descriptives

	Maths Progress Score 2 (Average)			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	Below Average	Mean		19.1600	.73185
		95% Confidence Interval for Mean	Lower Bound	17.6495	
			Upper Bound	20.6705	
		5% Trimmed Mean		19.2889	
		Median		19.0000	
		Variance		13.390	
		Std. Deviation		3.65923	
		Minimum		12.00	
		Maximum		24.00	
		Range		12.00	
		Interquartile Range		5.00	
		Skewness		-.366	.464
		Kurtosis		-.704	.902
	Average	Mean		18.3063	.28271
		95% Confidence Interval for Mean	Lower Bound	17.7492	
			Upper Bound	18.8635	
		5% Trimmed Mean		18.4815	
		Median		19.0000	
		Variance		17.743	
		Std. Deviation		4.21223	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.25	
		Skewness		-.515	.163
		Kurtosis		-.590	.325
	Above Average	Mean		18.3600	.34940
		95% Confidence Interval for Mean	Lower Bound	17.6696	
			Upper Bound	19.0504	
		5% Trimmed Mean		18.5926	
		Median		19.0000	
		Variance		18.312	
		Std. Deviation		4.27931	
		Minimum		8.00	
		Maximum		24.00	

		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.652	.198
		Kurtosis		-.294	.394
	Well Above Average	Mean		20.6792	.47106
		95% Confidence Interval for Mean	Lower Bound	19.7340	
			Upper Bound	21.6245	
		5% Trimmed Mean		21.0126	
		Median		21.0000	
		Variance		11.761	
		Std. Deviation		3.42936	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.00	
		Skewness		-1.158	.327
		Kurtosis		1.600	.644




Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for MPS2= Average
Expected Normal
2
1
0
-1
-2
-3
5
10
15
20
25
30
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for MPS2= Above Average
Expected Normal
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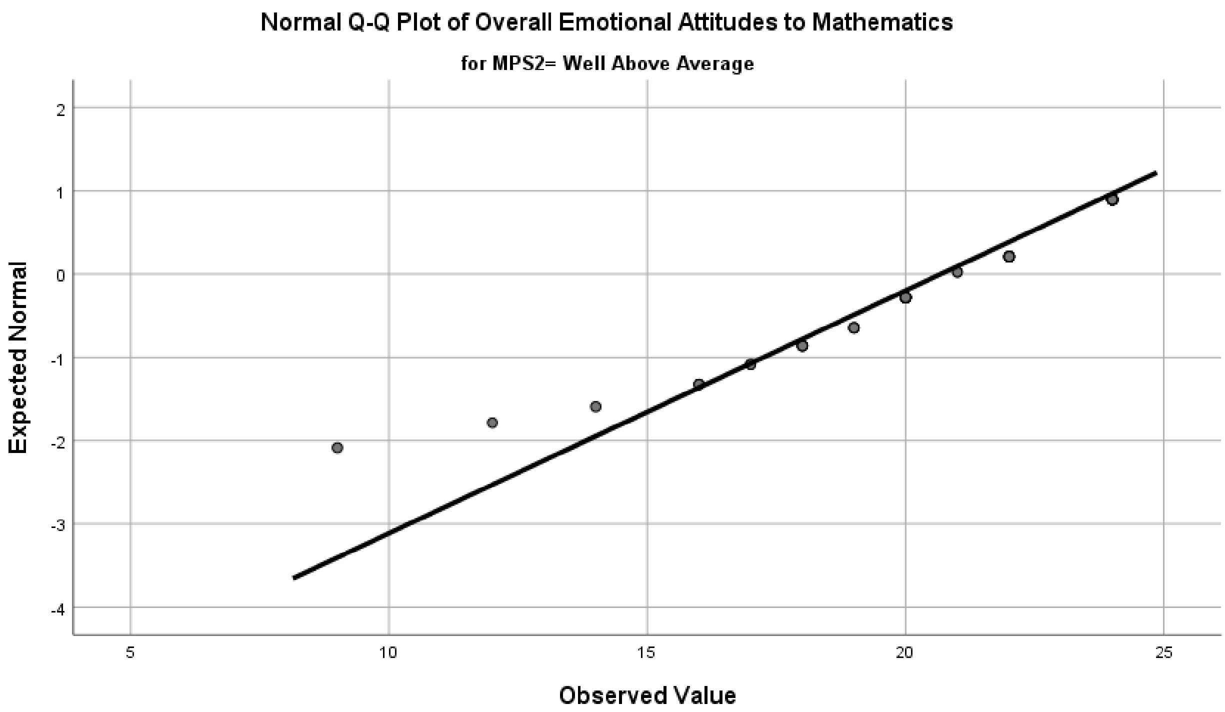
-2
-3
5
10
15
20
25
30
Observed Value


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for MPS2= Well Above Average
Expected Normal
Observed Value
2
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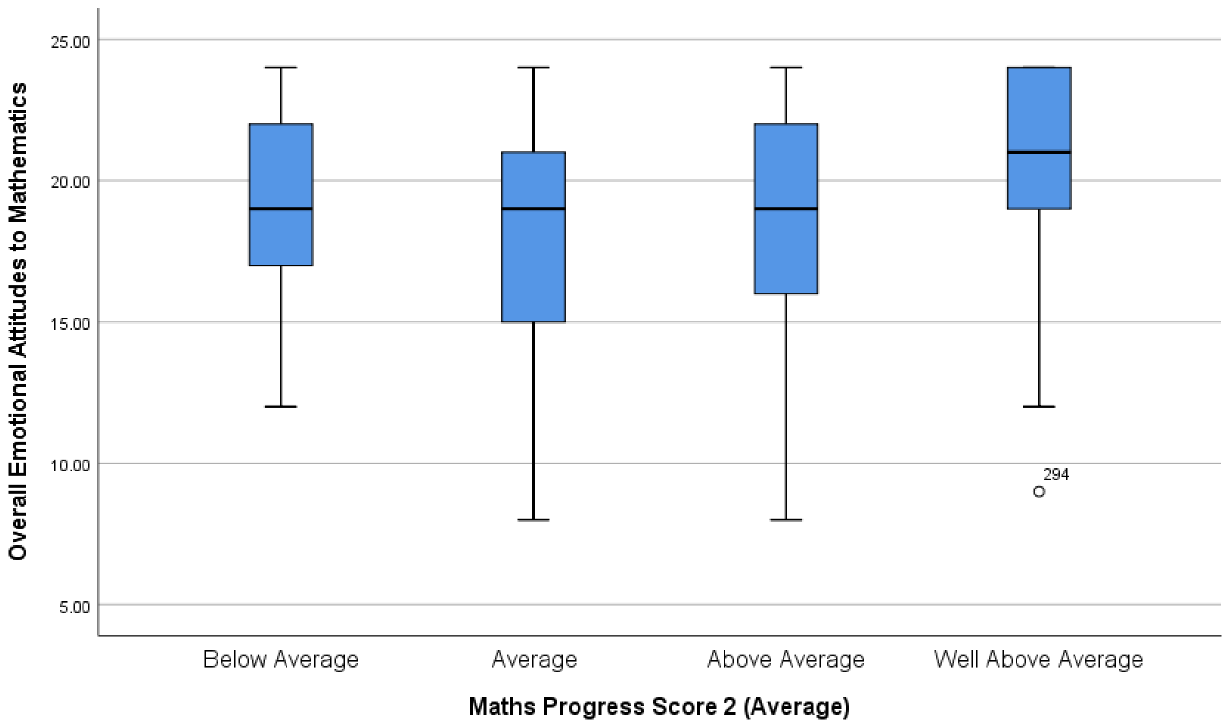
0
-1
-2
-3
-4
5
10
15
20
25


Overall Emotional Attitudes to Mathematics
25.00
20.00
15.00
10.00
5.00
294
Below Average
Average
Above Average
Well Above Average
Maths Progress Score 2 (Average)

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Below Average	25	19.1600	3.65923	.73185	17.6495	20.6705	12.00	24.00
Average	222	18.3063	4.21223	.28271	17.7492	18.8635	8.00	24.00
Above Average	150	18.3600	4.27931	.34940	17.6696	19.0504	8.00	24.00
Well Above Average	53	20.6792	3.42936	.47106	19.7340	21.6245	9.00	24.00
Total	450	18.6511	4.18030	.19706	18.2638	19.0384	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	1.857	3	446	.136
	Based on Median	1.452	3	446	.227
	Based on Median and with adjusted df	1.452	3	436.580	.227
	Based on trimmed mean	1.753	3	446	.155

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	263.586	3	87.862	5.168	.002
Within Groups	7582.638	446	17.001		
Total	7846.224	449			

Multiple Comparisons

Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) Maths Progress Score 2 (Average)	(J) Maths Progress Score 2 (Average)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Below Average	Average	.85369	.86985	.810	-1.5873	3.2947
	Above Average	.80000	.89073	.848	-1.6996	3.2996
	Well Above Average	-1.51925	1.00042	.512	-4.3266	1.2881
Average	Below Average	-.85369	.86985	.810	-3.2947	1.5873
	Above Average	-.05369	.43580	1.000	-1.2766	1.1693
	Well Above Average	-2.37294*	.63037	.003	-4.1419	-.6040
Above Average	Below Average	-.80000	.89073	.848	-3.2996	1.6996
	Average	.05369	.43580	1.000	-1.1693	1.2766
	Well Above Average	-2.31925*	.65888	.007	-4.1682	-.4703
Well Above Average	Below Average	1.51925	1.00042	.512	-1.2881	4.3266
	Average	2.37294*	.63037	.003	.6040	4.1419
	Above Average	2.31925*	.65888	.007	.4703	4.1682

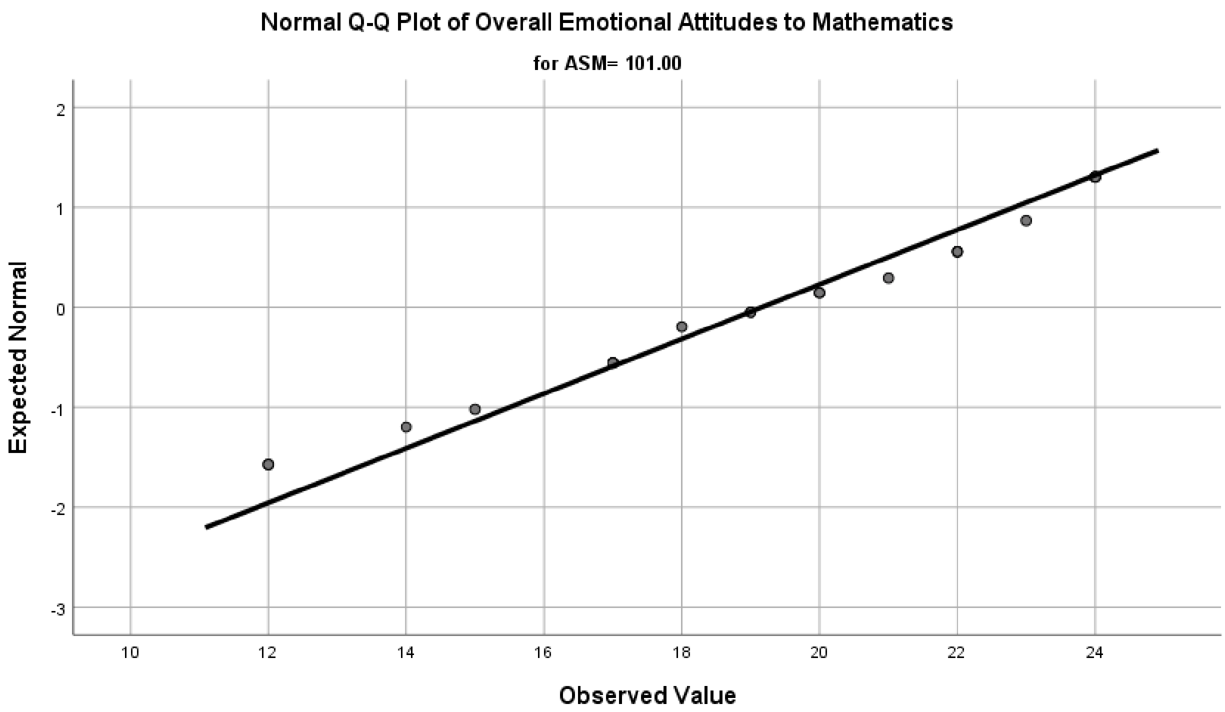
*. The mean difference is significant at the 0.05 level.

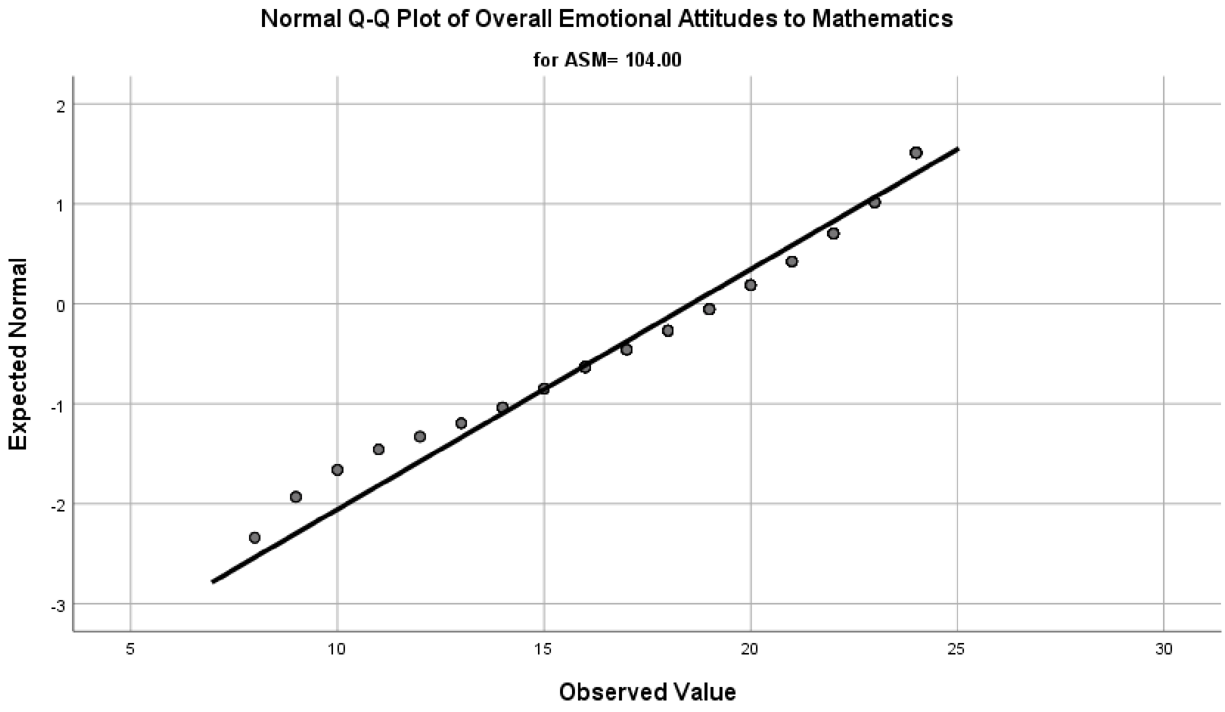
ASM and EA

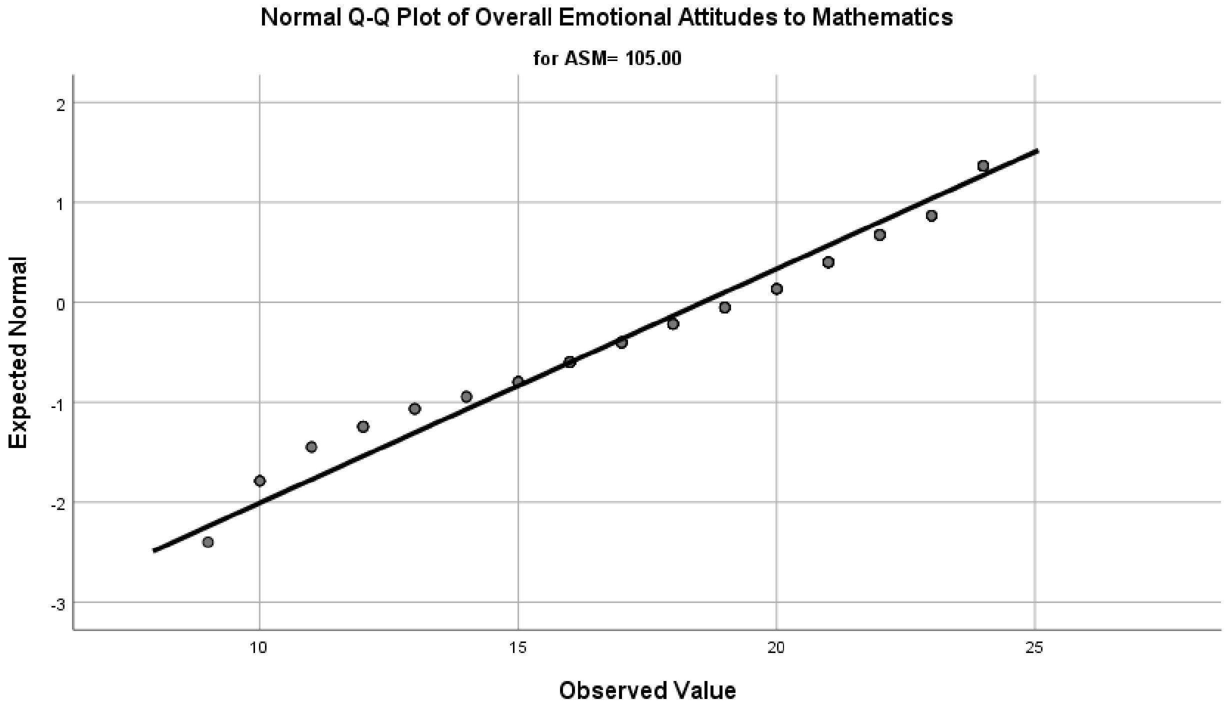
Descriptives

	Average Score in Maths			Statistic	Std. Error
Overall Emotional Attitudes to Mathematics	101.00	Mean		19.1600	.73185
		95% Confidence Interval for Mean	Lower Bound	17.6495	
			Upper Bound	20.6705	
		5% Trimmed Mean		19.2889	
		Median		19.0000	
		Variance		13.390	
		Std. Deviation		3.65923	
		Minimum		12.00	
		Maximum		24.00	
		Range		12.00	
		Interquartile Range		5.00	
		Skewness		-.366	.464
		Kurtosis		-.704	.902
	104.00	Mean		18.5631	.28988
		95% Confidence Interval for Mean	Lower Bound	17.9916	
			Upper Bound	19.1346	
		5% Trimmed Mean		18.7907	
		Median		19.0000	
		Variance		17.311	
		Std. Deviation		4.16060	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.650	.169
		Kurtosis		-.309	.337
	105.00	Mean		18.5702	.38798
		95% Confidence Interval for Mean	Lower Bound	17.8021	
			Upper Bound	19.3384	
		5% Trimmed Mean		18.7539	
		Median		19.0000	
		Variance		18.214	
		Std. Deviation		4.26776	
		Minimum		9.00	
		Maximum		24.00	

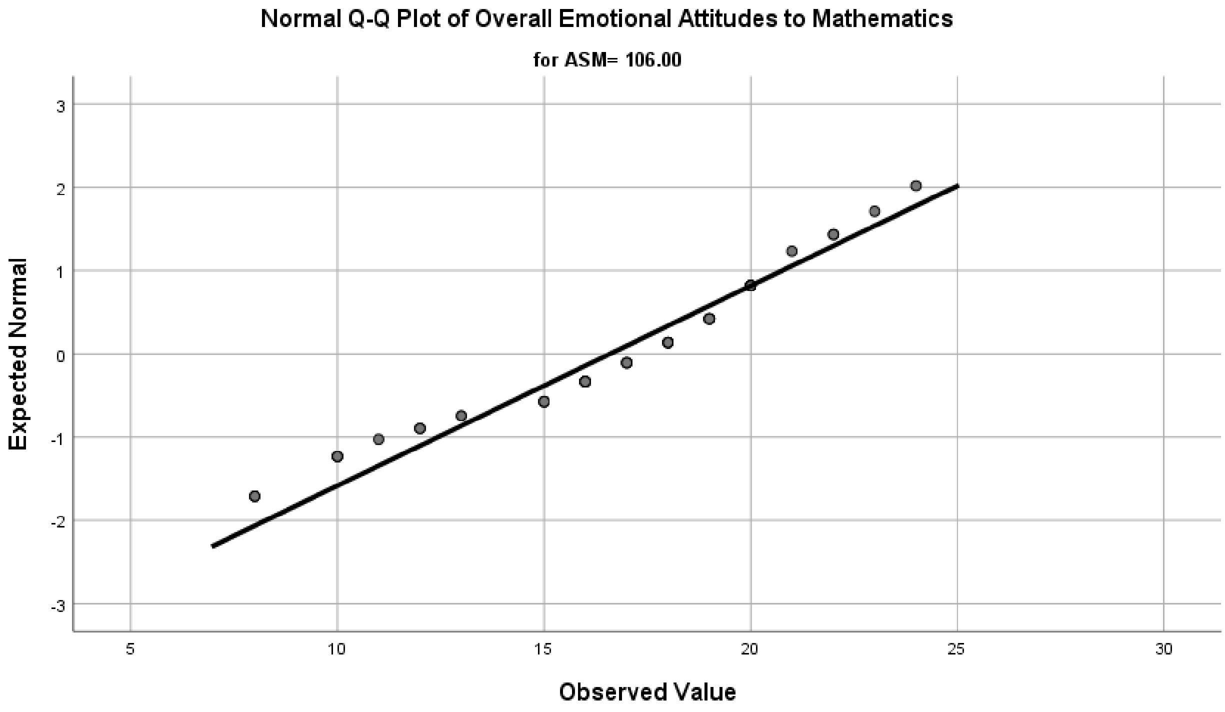
		Range		15.00	
		Interquartile Range		6.00	
		Skewness		-.496	.220
		Kurtosis		-.753	.437
	106.00	Mean		16.6000	.62069
		95% Confidence Interval for Mean	Lower Bound	15.3491	
			Upper Bound	17.8509	
		5% Trimmed Mean		16.7037	
		Median		18.0000	
		Variance		17.336	
		Std. Deviation		4.16370	
		Minimum		8.00	
		Maximum		24.00	
		Range		16.00	
		Interquartile Range		6.00	
		Skewness		-.591	.354
		Kurtosis		-.415	.695
	109.00	Mean		20.6792	.47106
		95% Confidence Interval for Mean	Lower Bound	19.7340	
			Upper Bound	21.6245	
		5% Trimmed Mean		21.0126	
		Median		21.0000	
		Variance		11.761	
		Std. Deviation		3.42936	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.00	
		Skewness		-1.158	.327
		Kurtosis		1.600	.644


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for ASM= 101.00
Expected Normal
Observed Value
2
1
0
-1
-2
-3
10
12
14
16
18
20
22
24

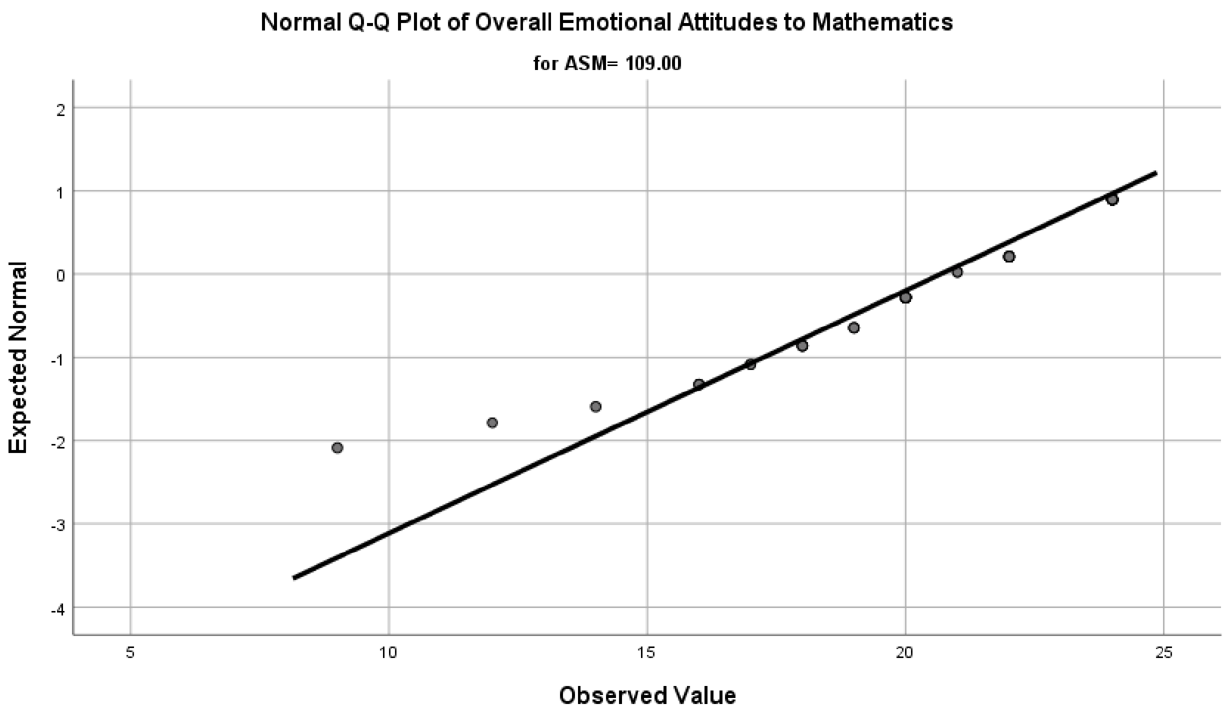

Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for ASM= 104.00
Expected Normal
Observed Value
2
1
0
-1
-2
-3
5
10
15
20
25
30



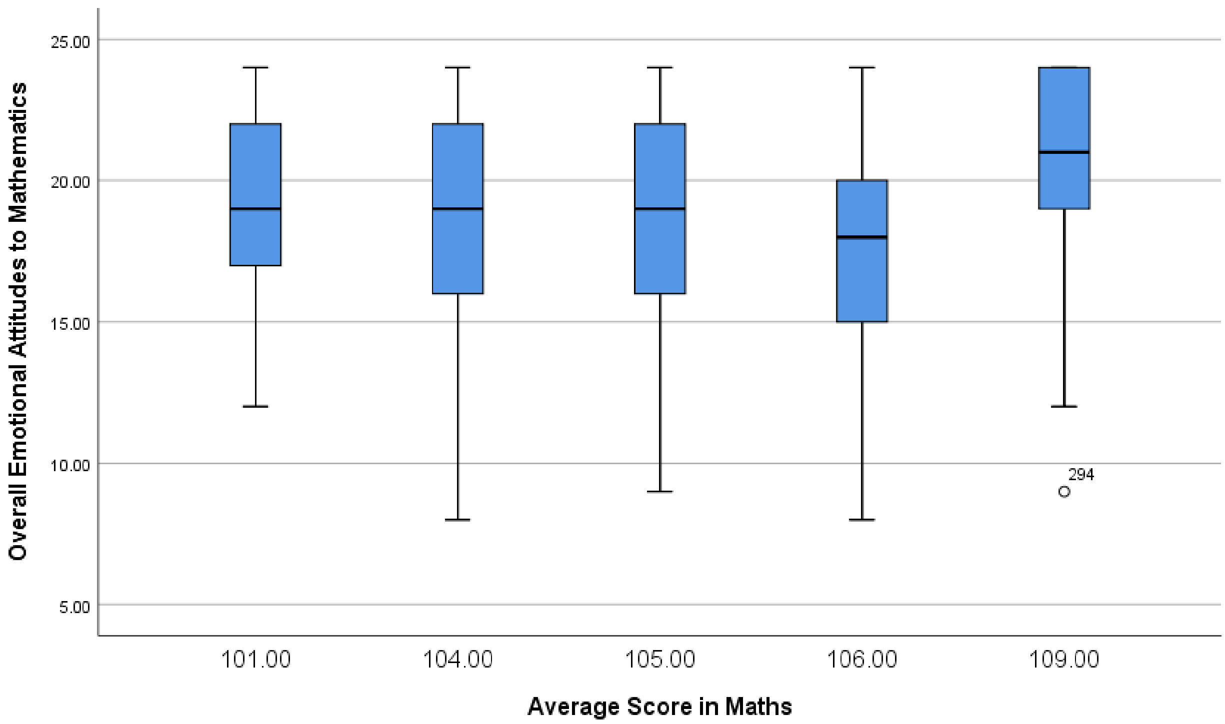
Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for ASM= 105.00
Expected Normal
Observed Value
2
1
0
-1
-2
-3
10
15
20
25



Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for ASM= 106.00
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
5
10
15
20
25
30



Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
for ASM= 109.00
Expected Normal
Observed Value
2
1
0
-1
-2
-3
-4
5
10
15
20
25



Overall Emotional Attitudes to Mathematics
Average Score in Maths
25.00
20.00
15.00
10.00
5.00
101.00
104.00
105.00
106.00
109.00
294

Descriptives

Overall Emotional Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
101.00	25	19.1600	3.65923	.73185	17.6495	20.6705	12.00	24.00
104.00	206	18.5631	4.16060	.28988	17.9916	19.1346	8.00	24.00
105.00	121	18.5702	4.26776	.38798	17.8021	19.3384	9.00	24.00
106.00	45	16.6000	4.16370	.62069	15.3491	17.8509	8.00	24.00
109.00	53	20.6792	3.42936	.47106	19.7340	21.6245	9.00	24.00
Total	450	18.6511	4.18030	.19706	18.2638	19.0384	8.00	24.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Overall Emotional Attitudes to Mathematics	Based on Mean	1.488	4	445	.205
	Based on Median	1.180	4	445	.319
	Based on Median and with adjusted df	1.180	4	430.991	.319
	Based on trimmed mean	1.367	4	445	.244

ANOVA

Overall Emotional Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	416.185	4	104.046	6.232	.000
Within Groups	7430.040	445	16.697		
Total	7846.224	449			

Multiple Comparisons

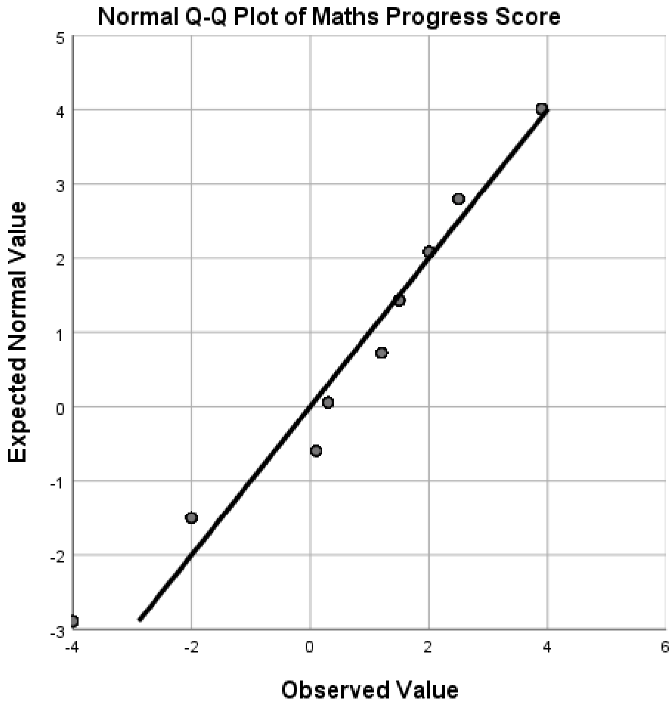
Dependent Variable: Overall Emotional Attitudes to Mathematics

Scheffe

(I) Average Score in Maths	(J) Average Score in Maths	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
101.00	104.00	.59689	.86540	.976	-2.0800	3.2738
	105.00	.58975	.89770	.980	-2.1870	3.3665
	106.00	2.56000	1.01927	.179	-.5928	5.7128
	109.00	-1.51925	.99141	.672	-4.5859	1.5474
104.00	101.00	-.59689	.86540	.976	-3.2738	2.0800
	105.00	-.00714	.46802	1.000	-1.4548	1.4405
	106.00	1.96311	.67238	.076	-.1167	4.0429
	109.00	-2.11614*	.62935	.025	-4.0629	-.1694
105.00	101.00	-.58975	.89770	.980	-3.3665	2.1870
	104.00	.00714	.46802	1.000	-1.4405	1.4548
	106.00	1.97025	.71346	.108	-.2366	4.1771
	109.00	-2.10900*	.67307	.045	-4.1909	-.0271
106.00	101.00	-2.56000	1.01927	.179	-5.7128	.5928
	104.00	-1.96311	.67238	.076	-4.0429	.1167
	105.00	-1.97025	.71346	.108	-4.1771	.2366
	109.00	-4.07925*	.82829	.000	-6.6413	-1.5172
109.00	101.00	1.51925	.99141	.672	-1.5474	4.5859
	104.00	2.11614*	.62935	.025	.1694	4.0629
	105.00	2.10900*	.67307	.045	.0271	4.1909
	106.00	4.07925*	.82829	.000	1.5172	6.6413

*. The mean difference is significant at the 0.05 level.

MPS and EA


Normal Q-Q Plot of Maths Progress Score
Expected Normal Value
Observed Value
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3
2
1
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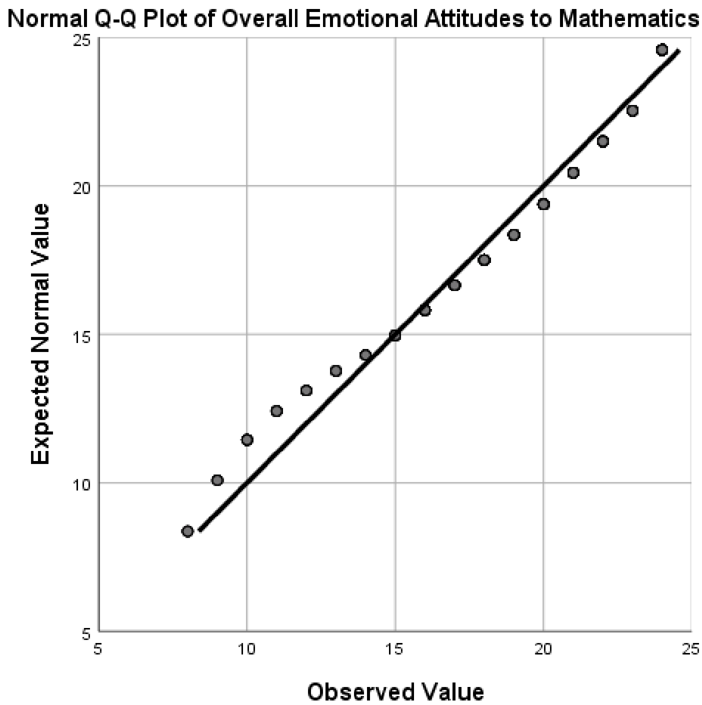
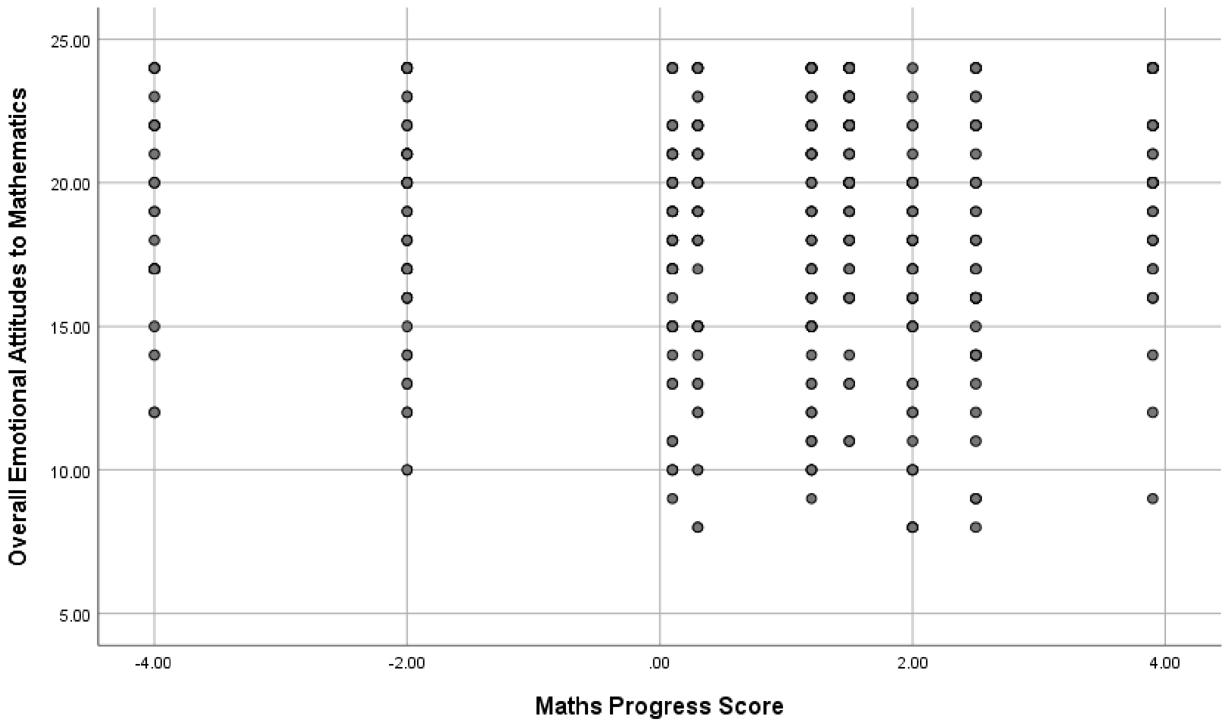
-1
-2
-3
-4
-2
0
2
4
6


Normal Q-Q Plot of Overall Emotional Attitudes to Mathematics
Expected Normal Value
Observed Value
25
20
15
10
5
5
10
15
20
25



Correlations

			Overall Behavioural Attitudes to Mathematics	Maths Progress Score
Spearman's rho	Overall Behavioural Attitudes to Mathematics	Correlation Coefficient	1.000	.124**
		Sig. (2-tailed)	.	.009
		N	439	439
	Maths Progress Score	Correlation Coefficient	.124**	1.000
		Sig. (2-tailed)	.009	.
		N	439	508

**. Correlation is significant at the 0.01 level (2-tailed).

Additional Exploratory Bivariate tests

Chi Square test for Gender and Favourite Subject (Value)

Pupil Favourite Subject * Pupil Gender Crosstabulation

			Pupil Gender		Total
			Male	Female	
Pupil Favourite Subject	Other	Count	128	173	301
		% within Pupil Gender	53.3%	70.0%	61.8%
	Maths	Count	112	74	186
		% within Pupil Gender	46.7%	30.0%	38.2%
Total		Count	240	247	487
		% within Pupil Gender	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	14.393[a]	1	.000		
Continuity Correction[b]	13.694	1	.000		
Likelihood Ratio	14.471	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	14.364	1	.000		
N of Valid Cases	487				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 91.66.

b. Computed only for a 2x2 table

Bivariate Analysis for Gender and Perception of Someone good at maths

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	Gen_MATHS	N	Percent	N	Percent	N	Percent
Overall Behavioural Attitudes to Mathematics	Males - Female at Maths	28	87.5%	4	12.5%	32	100.0%
	Males - Male at Maths	168	86.6%	26	13.4%	194	100.0%
	Females - Female at Maths	153	91.6%	14	8.4%	167	100.0%
	Females - Male at Maths	66	88.0%	9	12.0%	75	100.0%

Descriptives

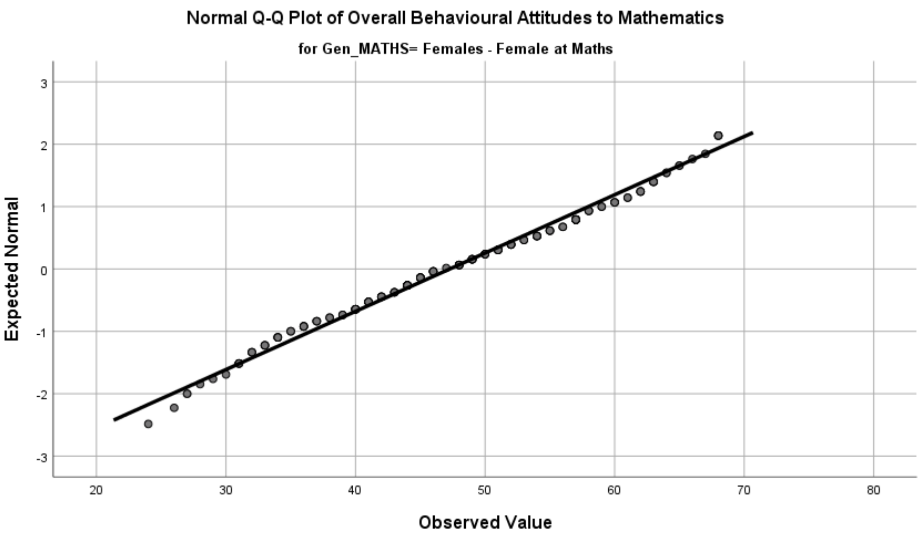
	Gen_MATHS			Statistic	Std. Error
Overall Behavioural Attitudes to Mathematics	Males - Female at Maths	Mean		44.3571	2.45769
		95% Confidence Interval for Mean	Lower Bound	39.3144	
			Upper Bound	49.3999	
		5% Trimmed Mean		44.2302	
		Median		45.5000	
		Variance		169.127	
		Std. Deviation		13.00488	
		Minimum		24.00	
		Maximum		67.00	
		Range		43.00	

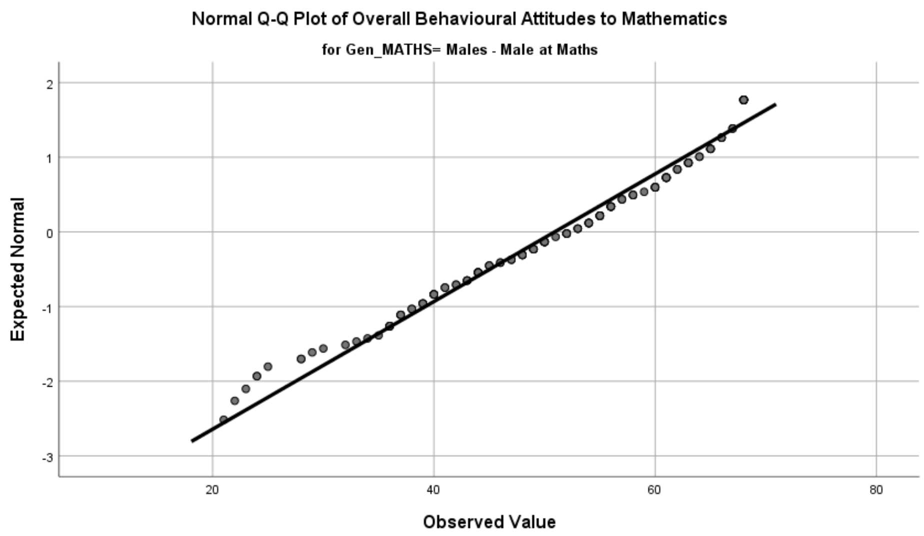
	Interquartile Range		21.50	
	Skewness		.183	.441
	Kurtosis		-.992	.858
Males - Male at Maths	Mean		50.9107	.90254
	95% Confidence Interval for Mean	Lower Bound	49.1289	
		Upper Bound	52.6926	
	5% Trimmed Mean		51.4233	
	Median		52.0000	
	Variance		136.848	
	Std. Deviation		11.69822	
	Minimum		21.00	
	Maximum		68.00	
	Range		47.00	
	Interquartile Range		18.00	
	Skewness		-.441	.187
	Kurtosis		-.490	.373
Females - Female at Maths	Mean		47.2680	.86548
	95% Confidence Interval for Mean	Lower Bound	45.5581	
		Upper Bound	48.9779	
	5% Trimmed Mean		47.2665	
	Median		46.0000	
	Variance		114.605	
	Std. Deviation		10.70539	
	Minimum		24.00	
	Maximum		68.00	
	Range		44.00	

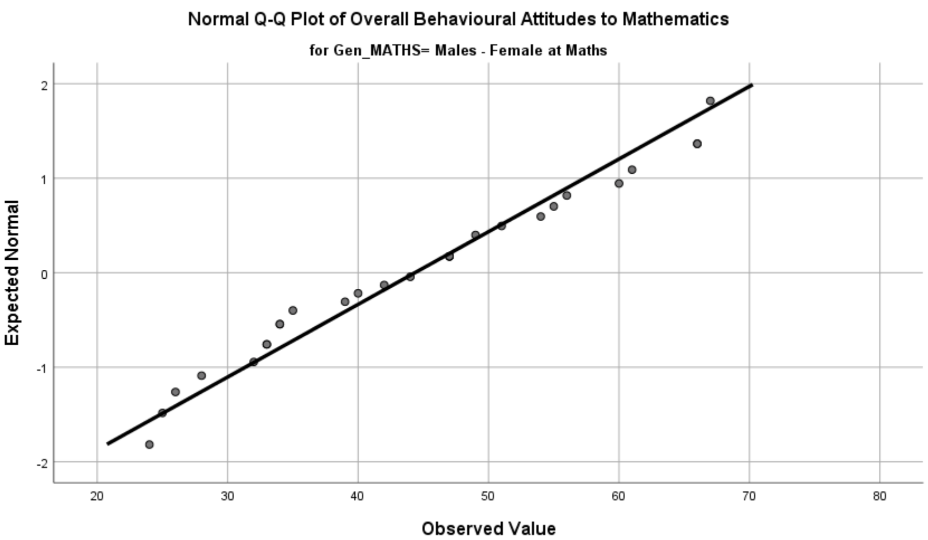
		Interquartile Range		16.00	
		Skewness		.005	.196
		Kurtosis		-.810	.390
	Females - Male at Maths	Mean		44.8636	1.39578
		95% Confidence Interval for Mean	Lower Bound	42.0761	
			Upper Bound	47.6512	
		5% Trimmed Mean		44.8316	
		Median		46.0000	
		Variance		128.581	
		Std. Deviation		11.33936	
		Minimum		25.00	
		Maximum		66.00	
		Range		41.00	
		Interquartile Range		17.75	
		Skewness		-.129	.295
		Kurtosis		-.966	.582

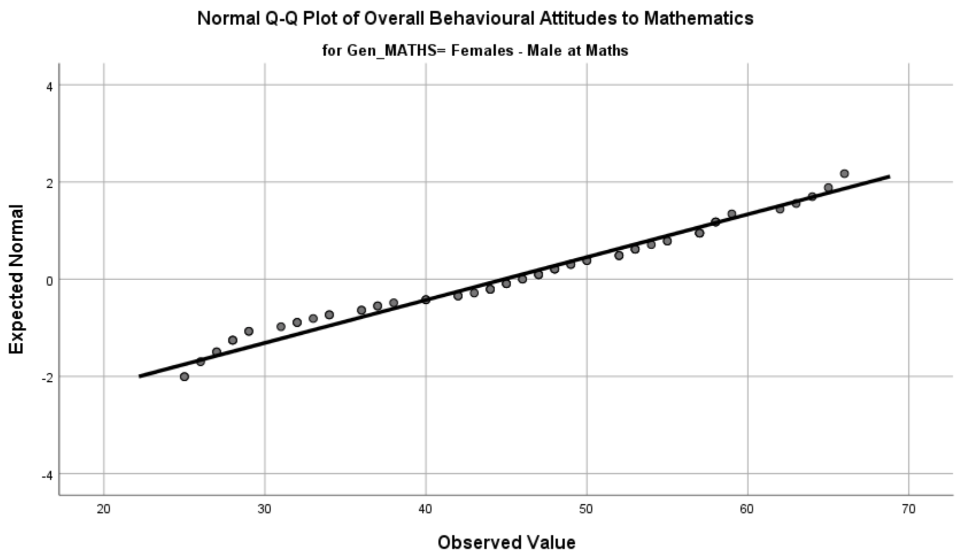
Test of Homogeneity of Variance

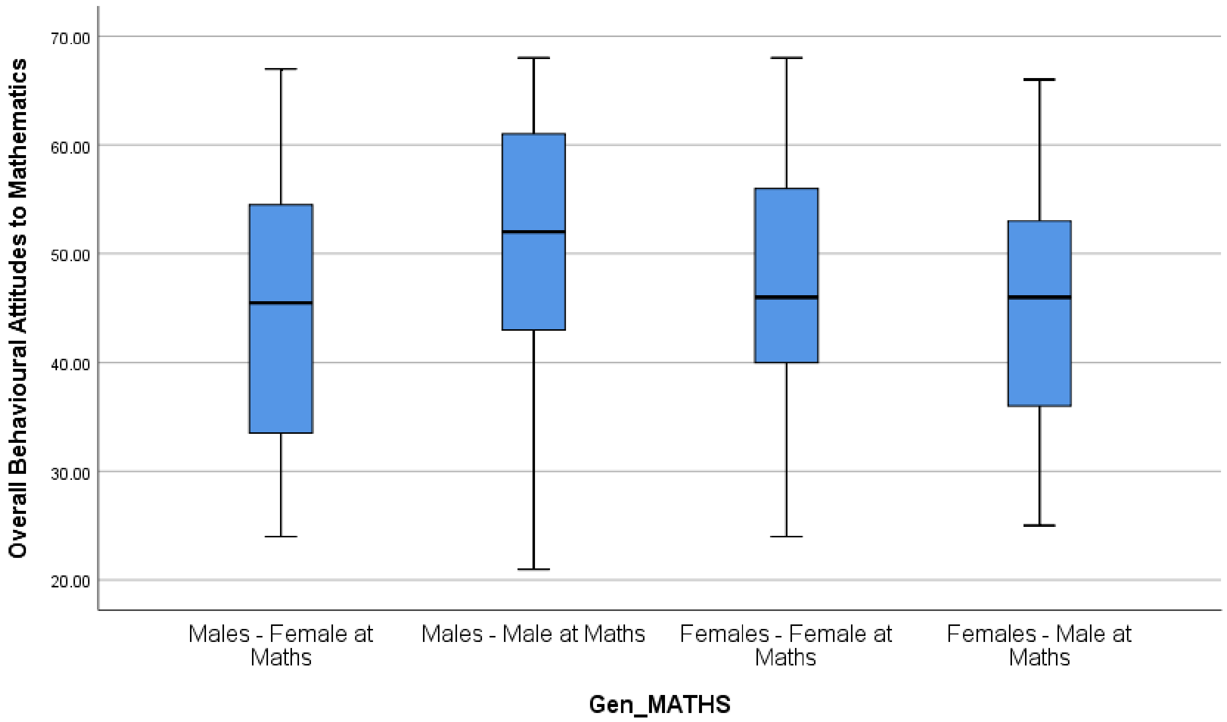
		Levene Statistic	df1	df2	Sig.
Overall Behavioural Attitudes to Mathematics	Based on Mean	.922	3	411	.430
	Based on Median	.859	3	411	.462
	Based on Median and with adjusted df	.859	3	407.019	.462
	Based on trimmed mean	.897	3	411	.443


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gen_MATHS= Females - Female at Maths
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gen_MATHS= Males - Male at Maths
Expected Normal
Observed Value
2
1
0
-1
-2
-3
20
40
60
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gen_MATHS= Males - Female at Maths
Expected Normal
Observed Value
2
1
0
-1
-2
20
30
40
50
60
70
80


Normal Q-Q Plot of Overall Behavioural Attitudes to Mathematics
for Gen_MATHS= Females - Male at Maths
Expected Normal
Observed Value
4
2
0
-2
-4
20
30
40
50
60
70



Descriptives

Overall Behavioural Attitudes to Mathematics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Males - Female at Maths	28	44.3571	13.00488	2.45769	39.3144	49.3999	24.00	67.00
Males - Male at Maths	168	50.9107	11.69822	.90254	49.1289	52.6926	21.00	68.00

Females - Female at Maths	153	47.2680	10.70539	.86548	45.5581	48.9779	24.00	68.00
Females - Male at Maths	66	44.8636	11.33936	1.39578	42.0761	47.6512	25.00	66.00
Total	415	48.1639	11.60052	.56945	47.0445	49.2832	21.00	68.00

ANOVA

Overall Behavioural Attitudes to Mathematics

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2514.983	3	838.328	6.477	.000
Within Groups	53197.875	411	129.435		
Total	55712.858	414			

Multiple Comparisons

Dependent Variable: Overall Behavioural Attitudes to Mathematics

Scheffe

(I) Gen_MATHS	(J) Gen_MATHS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Males - Female at Maths	Males - Male at Maths	-6.55357*	2.32231	.048	-13.0725	-.0346
	Females - Female at Maths	-2.91083	2.33852	.671	-9.4753	3.6536
	Females - Male at Maths	-.50649	2.56590	.998	-7.7092	6.6963
Males - Male at Maths	Males - Female at Maths	6.55357*	2.32231	.048	.0346	13.0725
	Females - Female at Maths	3.64274*	1.27139	.043	.0738	7.2117
	Females - Male at Maths	6.04708*	1.65275	.004	1.4076	10.6865
Females - Female at Maths	Males - Female at Maths	2.91083	2.33852	.671	-3.6536	9.4753

	Males - Male at Maths	-3.64274*	1.27139	.043	-7.2117	-.0738
	Females - Male at Maths	2.40434	1.67545	.561	-2.2988	7.1075
Females - Male at Maths	Males - Female at Maths	.50649	2.56590	.998	-6.6963	7.7092
	Males - Male at Maths	-6.04708*	1.65275	.004	-10.6865	-1.4076
	Females - Female at Maths	-2.40434	1.67545	.561	-7.1075	2.2988

*. The mean difference is significant at the 0.05 level.

Appendix F: Multivariate Analysis

Multiple Regression for BAM

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject[b]	.	Enter

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.605[a]	.366	.348	9.27586

a. Predictors: (Constant), Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12016.524	7	1716.646	19.951	.000[b]

	Residual	20822.052	242	86.042		
	Total	32838.576	249			

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	30.712	2.538		12.099	.000
	Pupil Gender	-1.433	1.239	-.062	-1.157	.249
	Pupil Favourite Subject	.943	1.265	.041	.746	.457
	Ethnicity (White = 1 and BME = 0)	-1.159	1.302	-.047	-.890	.374
	I am good at maths	15.747	2.326	.364	6.769	.000
	I do maths at home	10.186	1.459	.382	6.980	.000
	Parents help	-2.045	1.229	-.088	-1.664	.097
	Gender_Ability_Beliefs	.274	.878	.016	.313	.755

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

Multiple Regression EAM

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.603[a]	.363	.345	3.12478

a. Predictors: (Constant), Gender_Ability_Beliefs, Pupil Favourite Subject, Ethnicity (White = 1 and BME = 0), Parents help, I am good at maths, I do maths at home, Pupil Gender

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1380.088	7	197.155	20.192	.000[b]
	Residual	2421.533	248	9.764		
	Total	3801.621	255			

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, Pupil Favourite Subject, Ethnicity (White = 1 and BME = 0), Parents help, I am good at maths, I do maths at home, Pupil Gender

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	10.833	1.024		10.583	.000
	Pupil Gender	.086	.414	.011	.208	.835

Pupil Favourite Subject	1.606	.412	.208	3.895	.000
Ethnicity (White = 1 and BME = 0)	.384	.430	.046	.894	.372
I am good at maths	7.626	.909	.434	8.390	.000
I do maths at home	1.772	.486	.192	3.646	.000
Parents help	-1.153	.418	-.146	-2.755	.006
Gender_Ability_Beliefs	.058	.296	.010	.195	.845

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

MLM Model 2.1.1: BAM Unconditional with Teacher Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	3395.975
Akaike's Information Criterion (AIC)	3399.975
Hurvich and Tsai's Criterion (AICC)	3400.002
Bozdogan's Criterion (CAIC)	3410.139
Schwarz's Bayesian Criterion (BIC)	3408.139

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	18.479	3275.640	.000

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	47.933603	.837514	18.479	57.233	.000	46.177315	49.689891

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Residual		129.896572	8.955930	14.504	.000	113.477621	148.691164
Intercept [subject = Teacher_ID]	Variance	7.591636	4.367780	1.738	.082	2.458126	23.445883

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 2.1.2: BAM Conditional Model with Pupil Characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1791.899
Akaike's Information Criterion (AIC)	1795.899
Hurvich and Tsai's Criterion (AICC)	1795.949
Bozdogan's Criterion (CAIC)	1804.868
Schwarz's Bayesian Criterion (BIC)	1802.868

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	52.714610	1.601981	134.448	32.906	.000	49.546268	55.882953
[Gender=.00]	1.407794	1.231549	237.332	1.143	.254	-1.018369	3.833958
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-1.171421	1.268165	240.995	-.924	.357	-3.669525	1.326682
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.
[Eth_R=.00]	1.251840	1.374910	100.740	.910	.365	-1.475697	3.979377
[Eth_R=1.00]	0[b]	0	.	.	.	.	.

[S6Q1R=.00]	-15.955373	2.321410	240.984	-6.873	.000	-20.528218	-11.382527
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-9.665683	1.476484	230.342	-6.546	.000	-12.574824	-6.756542
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	2.141466	1.219870	236.812	1.755	.080	-.261717	4.544649
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-1.247407	1.845952	239.596	-.676	.500	-4.883774	2.388961
[Gender_Ability_Beliefs=.00]	.736728	1.306595	237.749	.564	.573	-1.837253	3.310709
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Residual		83.561891	7.926502	10.542	.000	69.384921	100.635548
Intercept [subject = Teacher_ID]	Variance	2.647298	3.402353	.778	.437	.213218	32.868659

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Covariance Matrix for Estimates of Covariance Parameters[a]

Parameter	Residual	Intercept [subject = Teacher_ID]

			Variance
Residual		62.829440	-5.663373
Intercept [subject = Teacher_ID]	Variance	-5.663373	11.576009

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 2.1.3: BAM Conditional Model with Pupil Characteristics and Teacher characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1666.176
Akaike's Information Criterion (AIC)	1670.176
Hurvich and Tsai's Criterion (AICC)	1670.232
Bozdogan's Criterion (CAIC)	1678.964
Schwarz's Bayesian Criterion (BIC)	1676.964

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	8.728	44.727	.000
Gender	1	218.444	1.021	.313
Fav_Sub	1	214.513	1.136	.288
Eth_R	1	55.848	1.491	.227
S6Q1R	1	219.321	46.436	.000
S6Q2R	1	219.346	34.083	.000
S6Q3R	1	219.905	2.708	.101
Gender_Ability_Beliefs	2	210.089	.379	.685
Teach_Good	2	7.966	2.053	.191
Teach_Home	1	11.068	1.135	.309
Teach_GoodTeach	1	12.709	1.931	.188
Teach_Ov_Beh	1	9.748	4.849	.053
Teach_Overal_EATM	1	8.756	.582	.466

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	67.446094	10.045689	9.948	6.714	.000	45.047047	89.845141
[Gender=.00]	1.301350	1.287824	218.444	1.011	.313	-1.236800	3.839500
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-1.439601	1.350693	214.513	-1.066	.288	-4.101931	1.222729
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.

[Eth_R=.00]	1.750016	1.433115	55.848	1.221	.227	-1.121032	4.621063
[Eth_R=1.00]	0[b]	0	.	.	.	.	.
[S6Q1R=.00]	-16.231837	2.381991	219.321	-6.814	.000	-20.926358	-11.537315
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-9.554218	1.636529	219.346	-5.838	.000	-12.779550	-6.328885
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	2.076102	1.261543	219.905	1.646	.101	-.410159	4.562363
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-1.457497	1.885415	209.778	-.773	.440	-5.174285	2.259291
[Gender_Ability_Beliefs=.00]	.059898	1.357627	205.691	.044	.965	-2.616751	2.736547
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.
[Teach_Good=1.00]	-9.855008	6.348889	8.922	-1.552	.155	-24.236292	4.526276
[Teach_Good=2.00]	-5.679568	2.886501	5.783	-1.968	.098	-12.807421	1.448285
[Teach_Good=3.00]	-3.140979	3.157027	7.744	-.995	.350	-10.463260	4.181301
[Teach_Good=4.00]	0[b]	0	.	.	.	.	.
[Teach_Home=1.00]	0[b]	0	.	.	.	.	.
[Teach_Home=2.00]	1.915573	1.798262	11.068	1.065	.309	-2.039431	5.870577
[Teach_Home=4.00]	0[b]	0	.	.	.	.	.
[Teach_GoodTeach=1.00]	0[b]	0	.	.	.	.	.
[Teach_GoodTeach=2.00]	-4.351797	3.131303	12.709	-1.390	.188	-11.132323	2.428729
[Teach_GoodTeach=3.00]	0[b]	0	.	.	.	.	.
Teach_Ov_Beh	-.337260	.153154	9.748	-2.202	.053	-.679707	.005186
Teach_Overal_EATM	.225085	.295016	8.756	.763	.466	-.445131	.895300

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		84.171267	8.188514	10.279	.000	69.559365	101.852599
Intercept [subject = Teacher_ID]	Variance	.388084	3.386998	.115	.909	1.445662E-8	10417985.225626

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 2.2.1 EAM Unconditional Model with Teacher Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	2550.063
Akaike's Information Criterion (AIC)	2554.063
Hurvich and Tsai's Criterion (AICC)	2554.089
Bozdogan's Criterion (CAIC)	2564.277
Schwarz's Bayesian Criterion (BIC)	2562.277

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	17.088	3069.327	.000

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	18.633564	.336337	17.088	55.402	.000	17.924233	19.342894

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Residual		16.160208	1.101867	14.666	.000	14.138673	18.470780
Intercept [subject = Teacher_ID]	Variance	1.451748	.734441	1.977	.048	.538601	3.913049

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

MLM Model 2.2.2: EAM Conditional Model with Pupil Characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1291.154
Akaike's Information Criterion (AIC)	1295.154
Hurvich and Tsai's Criterion (AICC)	1295.203
Bozdogan's Criterion (CAIC)	1304.173
Schwarz's Bayesian Criterion (BIC)	1302.173

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	128.006	914.299	.000
Gender	1	242.178	.027	.868
Fav_Sub	1	246.925	19.948	.000
Eth_R	1	149.798	.021	.884
S6Q1R	1	245.739	71.003	.000
S6Q2R	1	246.495	10.357	.001
S6Q3R	1	241.783	8.643	.004
Gender_Ability_Beliefs	2	245.928	.208	.812

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	20.939609	.551231	123.383	37.987	.000	19.848516	22.030703
[Gender=.00]	-.067047	.404436	242.178	-.166	.868	-.863708	.729613
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-1.831957	.410171	246.925	-4.466	.000	-2.639837	-1.024077
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.
[Eth_R=.00]	-.069489	.474461	149.798	-.146	.884	-1.006990	.868012
[Eth_R=1.00]	0[b]	0	.	.	.	.	.
[S6Q1R=.00]	-7.563386	.897587	245.739	-8.426	.000	-9.331332	-5.795440
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-1.567222	.486992	246.495	-3.218	.001	-2.526419	-.608026
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	1.197810	.407443	241.783	2.940	.004	.395218	2.000401
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-.114587	.615392	245.742	-.186	.852	-1.326702	1.097528
[Gender_Ability_Beliefs=.00]	.206608	.430935	246.929	.479	.632	-.642169	1.055385
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter	Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval

						Lower Bound	Upper Bound
Residual		8.962226	.833978	10.746	.000	7.468054	10.755344
Intercept [subject = Teacher_ID]	Variance	.791371	.493114	1.605	.109	.233338	2.683954

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

MLM Model 2.2.3: EAM Conditional Model with Pupil and Teacher Characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1210.118
Akaike's Information Criterion (AIC)	1214.118
Hurvich and Tsai's Criterion (AICC)	1214.172
Bozdogan's Criterion (CAIC)	1222.950
Schwarz's Bayesian Criterion (BIC)	1220.950

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.807	29.461	.000
Gender	1	220.709	.135	.714
Fav_Sub	1	219.597	22.346	.000
Eth_R	1	98.321	.008	.931
S6Q1R	1	224.748	62.389	.000
S6Q2R	1	222.353	8.739	.003
S6Q3R	1	223.425	6.349	.012
Gender_Ability_Beliefs	2	224.295	.125	.883
Teach_Good	2	8.827	.306	.744
Teach_Home	1	9.855	2.383	.154
Teach_GoodTeach	1	11.177	.377	.551
Teach_Ov_Beh	1	9.725	.047	.833
Teach_Overal_EATM	1	10.107	1.497	.249

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	20.364721	4.371306	10.398	4.659	.001	10.675100	30.054341
[Gender=.00]	-.157522	.429151	220.709	-.367	.714	-1.003280	.688235
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-2.088282	.441760	219.597	-4.727	.000	-2.958914	-1.217649
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.

[Eth_R=.00]	.044917	.515070	98.321	.087	.931	-.977181	1.067016
[Eth_R=1.00]	0[b]	0	.	.	.	.	.
[S6Q1R=.00]	-7.302292	.924494	224.748	-7.899	.000	-9.124077	-5.480507
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-1.576106	.533143	222.353	-2.956	.003	-2.626766	-.525445
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	1.077930	.427782	223.425	2.520	.012	.234927	1.920934
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-.098947	.638600	225.000	-.155	.877	-1.357348	1.159455
[Gender_Ability_Beliefs=.00]	.165786	.457234	224.981	.363	.717	-.735222	1.066795
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.
[Teach_Good=1.00]	4.850668	2.773815	9.055	1.749	.114	-1.418297	11.119632
[Teach_Good=2.00]	1.042282	1.335771	7.098	.780	.460	-2.107496	4.192060
[Teach_Good=3.00]	.752490	1.409430	8.184	.534	.608	-2.484985	3.989964
[Teach_Good=4.00]	0[b]	0	.	.	.	.	.
[Teach_Home=1.00]	0[b]	0	.	.	.	.	.
[Teach_Home=2.00]	1.181094	.765172	9.855	1.544	.154	-.527227	2.889414
[Teach_Home=4.00]	0[b]	0	.	.	.	.	.
[Teach_GoodTeach=1.00]	0[b]	0	.	.	.	.	.
[Teach_GoodTeach=2.00]	.815669	1.328395	11.177	.614	.551	-2.102483	3.733820
[Teach_GoodTeach=3.00]	0[b]	0	.	.	.	.	.
Teach_Ov_Beh	.014192	.065704	9.725	.216	.833	-.132769	.161152
Teach_Overal_EATM	-.160663	.131293	10.107	-1.224	.249	-.452781	.131456

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		9.220680	.886546	10.401	.000	7.636986	11.132788
Intercept [subject = Teacher_ID]	Variance	.651675	.652657	.998	.318	.091527	4.639964

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

MLM Model 3.1: Unconditional Model BAM with School Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	3396.625
Akaike's Information Criterion (AIC)	3400.625
Hurvich and Tsai's Criterion (AICC)	3400.652
Bozdogan's Criterion (CAIC)	3410.789
Schwarz's Bayesian Criterion (BIC)	3408.789

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.324	2560.252	.000

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	47.874231	.946151	9.324	50.599	.000	45.745172	50.003291

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		131.856311	8.995841	14.657	.000	115.352777	150.721008
Intercept [subject = School_ID]	Variance	5.721873	4.069412	1.406	.160	1.419585	23.062963

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 3.2: EAM Unconditional Model with School Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	2543.762
Akaike's Information Criterion (AIC)	2547.762
Hurvich and Tsai's Criterion (AICC)	2547.789
Bozdogan's Criterion (CAIC)	2557.976
Schwarz's Bayesian Criterion (BIC)	2555.976

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.528	2018.619	.000

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	18.595436	.413885	9.528	44.929	.000	17.667016	19.523856

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Residual		16.176065	1.089830	14.843	.000	14.175059	18.459541
Intercept [subject = School_ID]	Variance	1.326823	.780238	1.701	.089	.419048	4.201089

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

MLM Model 4.1.1 BAM Unconditional Model with Teacher and School Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	3396.625
Akaike's Information Criterion (AIC)	3400.625
Hurvich and Tsai's Criterion (AICC)	3400.652
Bozdogan's Criterion (CAIC)	3410.789
Schwarz's Bayesian Criterion (BIC)	3408.789

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.324	2560.252	.000

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	47.874231	.946151	9.324	50.599	.000	45.745172	50.003291

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		131.856311	8.995841	14.657	.000	115.352777	150.721008
Intercept [subject = School_ID]	Variance	5.721873	4.069412	1.406	.160	1.419585	23.062963

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 4.1.1: BAM Conditional Model with Pupil, Teacher and School Characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1679.958
Akaike's Information Criterion (AIC)	1685.958
Hurvich and Tsai's Criterion (AICC)	1686.069
Bozdogan's Criterion (CAIC)	1699.153
Schwarz's Bayesian Criterion (BIC)	1696.153

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	7.327	39.747	.000
Gender	1	218.111	1.104	.295
Fav_Sub	1	214.396	1.117	.292
Eth_R	1	42.983	1.065	.308
S6Q1R	1	219.225	44.390	.000
S6Q2R	1	213.663	39.940	.000
S6Q3R	1	219.199	2.668	.104
Gender_Ability_Beliefs	2	216.110	.341	.712
Teach_Ov_Beh	1	8.875	1.732	.221
Teach_Overal_EATM	1	7.610	1.174	.312
Teach_Good	3	6.402	1.146	.400
FSM	1	3.881	.098	.770

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	57.829256	8.142598	5.664	7.102	.001	37.615335	78.043177
[Gender=.00]	1.356463	1.290913	218.111	1.051	.295	-1.187797	3.900723
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-1.428022	1.351002	214.396	-1.057	.292	-4.090969	1.234925
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.
[Eth_R=.00]	1.510530	1.463767	42.983	1.032	.308	-1.441472	4.462531

[Eth_R=1.00]	0[b]	0	.	.	.	.	.
[S6Q1R=.00]	-15.765354	2.366243	219.225	-6.663	.000	-20.428851	-11.101857
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-10.062561	1.592223	213.663	-6.320	.000	-13.201037	-6.924084
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	2.067311	1.265658	219.199	1.633	.104	-.427105	4.561728
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-1.315749	1.911645	218.527	-.688	.492	-5.083371	2.451873
[Gender_Ability_Beliefs=.00]	.161917	1.388096	219.674	.117	.907	-2.573773	2.897607
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.
Teach_Ov_Beh	-.202965	.154229	8.875	-1.316	.221	-.552609	.146679
Teach_Overal_EATM	.330039	.304537	7.610	1.084	.312	-.378546	1.038624
[Teach_Good=1.00]	-4.878040	4.832431	6.330	-1.009	.350	-16.554530	6.798450
[Teach_Good=2.00]	-4.684145	3.312957	6.054	-1.414	.207	-12.773033	3.404742
[Teach_Good=3.00]	-1.146072	3.222335	6.239	-.356	.734	-8.958268	6.666124
[Teach_Good=4.00]	0[b]	0	.	.	.	.	.
FSM	-.017616	.056297	3.881	-.313	.770	-.175829	.140597

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		84.276714	8.209320	10.266	.000	69.629425	102.005216
Intercept [subject = School_ID]	Variance	.586323	5.238675	.112	.911	1.454860E-8	23629359.325640

Intercept [subject = School_ID * T_N_s]	Variance	.958291	5.306242	.181	.857	1.854514E-5	49518.180199

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics.

MLM Model 4.2.1: EAM Unconditional Model with Teacher and School Groupings

Information Criteria[a]

-2 Restricted Log Likelihood	2543.762
Akaike's Information Criterion (AIC)	2547.762
Hurvich and Tsai's Criterion (AICC)	2547.789
Bozdogan's Criterion (CAIC)	2557.976
Schwarz's Bayesian Criterion (BIC)	2555.976

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.528	2018.619	.000

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	18.595436	.413885	9.528	44.929	.000	17.667016	19.523856

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		16.176065	1.089830	14.843	.000	14.175059	18.459541
Intercept [subject = School_ID]	Variance	1.326823	.780238	1.701	.089	.419048	4.201089

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

MLM Model 4.2.2: EAM Conditional Model with Pupil, Teacher and School Characteristics

Information Criteria[a]

-2 Restricted Log Likelihood	1220.379
Akaike's Information Criterion (AIC)	1226.379
Hurvich and Tsai's Criterion (AICC)	1226.487
Bozdogan's Criterion (CAIC)	1239.640
Schwarz's Bayesian Criterion (BIC)	1236.640

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	9.659	41.455	.000
Gender	1	222.066	.106	.745
Fav_Sub	1	219.922	22.686	.000
Eth_R	1	88.269	.050	.824
S6Q1R	1	225.816	65.429	.000
S6Q2R	1	225.539	10.195	.002
S6Q3R	1	223.514	5.913	.016
Gender_Ability_Beliefs	2	223.697	.196	.822
Teach_Ov_Beh	1	9.749	.308	.592
Teach_Overal_EATM	1	9.846	1.284	.284
Teach_Good	3	8.436	.812	.521
FSM	1	5.169	1.478	.277

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound

Intercept	23.745155	3.442672	8.092	6.897	.000	15.822101	31.668209
[Gender=.00]	-.139432	.428186	222.066	-.326	.745	-.983259	.704395
[Gender=1.00]	0[b]	0	.	.	.	.	.
[Fav_Sub=.00]	-2.103783	.441696	219.922	-4.763	.000	-2.974281	-1.233285
[Fav_Sub=1.00]	0[b]	0	.	.	.	.	.
[Eth_R=.00]	-.114726	.514408	88.269	-.223	.824	-1.136960	.907508
[Eth_R=1.00]	0[b]	0	.	.	.	.	.
[S6Q1R=.00]	-7.392472	.913909	225.816	-8.089	.000	-9.193353	-5.591591
[S6Q1R=1.00]	0[b]	0	.	.	.	.	.
[S6Q2R=.00]	-1.671074	.523360	225.539	-3.193	.002	-2.702375	-.639773
[S6Q2R=1.00]	0[b]	0	.	.	.	.	.
[S6Q3R=.00]	1.040766	.427988	223.514	2.432	.016	.197359	1.884173
[S6Q3R=1.00]	0[b]	0	.	.	.	.	.
[Gender_Ability_Beliefs=-1.00]	-.055264	.641509	225.258	-.086	.931	-1.319390	1.208862
[Gender_Ability_Beliefs=.00]	.239903	.461053	223.449	.520	.603	-.668666	1.148472
[Gender_Ability_Beliefs=1.00]	0[b]	0	.	.	.	.	.
Teach_Ov_Beh	-.034373	.061961	9.749	-.555	.592	-.172913	.104167
Teach_Overal_EATM	-.140433	.123952	9.846	-1.133	.284	-.417203	.136337
[Teach_Good=1.00]	1.764410	2.022119	8.674	.873	.406	-2.836248	6.365069
[Teach_Good=2.00]	.063879	1.395733	7.979	.046	.965	-3.156149	3.283907
[Teach_Good=3.00]	-.463655	1.353501	7.995	-.343	.741	-3.585158	2.657847
[Teach_Good=4.00]	0[b]	0	.	.	.	.	.
FSM	.028781	.023675	5.169	1.216	.277	-.031485	.089047

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		9.219947	.885698	10.410	.000	7.637642	11.130062
Intercept [subject = School_ID]	Variance	.301758	.685022	.441	.660	.003527	25.820959
Intercept [subject = School_ID * T_N_s]	Variance	.401521	.658727	.610	.542	.016116	10.003970

a. Dependent Variable: Overall Emotional Attitudes to Mathematics.

Appendix G: Pilot Study

Overview of Pilot Study Factor Analysis

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Section 1	1	x4by3	comp1		Items		KMO	Alpha	Mean	SD		items	Statements
2		2	write_board_class	comp2		2	Comp 1	0.5	0.493	7.9	1.8		1	havingg to multiply 4by3
3		3	calc10div_four	comp2		3	Comp 2	0.614	0.588	10.9	2.6		2	Being asked to add up the number of people in a room
4		4	maths_q_class	comp2		5	Comp 3	0.77	0.68	18.1	4.1		1	Being asked to write an answer on the board at the front of your class
5		5	add_num_room	comp1		4	Comp 4	0.671	0.689	16.3	3.1		2	Being asked to calculate £10 divided by four in front of your teacher
6	Section 2	1	maths_test	comp3		6	comp 5	0.85	0.829	25	4.7		3	Being asked a maths question by a teacher in front of your class
7		2	calc_pencil	comp4									1	Taking a maths test
8		3	surprise_test	comp3									2	Being given a surprise maths test in a class
9		4	calc_perc	comp3									3	Being asked to calculate a percentage
10		5	add_change	comp4									4	Working out how much time you have left before you set off to school
11		6	cal_bithday	comp4									5	Deciding how many sweets each friend can have if you are all sharing
12		7	tel_number	NA									1	Calculating with a pencil on paper
13		8	time_left	comp3									2	Adding up a pile of change
14		9	sweets	comp4									3	Calculating how many days until a person's birthday
15		10	sweet_share	comp3									4	Working out how much change you should have after buying sweets
16	Section 3	1	memorise_times_table										1	Reading the word, "Multiplication"
17	Section 4	1	multiplication_Word	Comp 5									2	Listening to someone talk about maths
18		2	someone_tal_maths	Comp 5									3	Reading a book that is about maths
19		3	read_book	Comp 5									4	Watching someone times a one digit number by a two digit number
20		4	times_one_digit_two	comp 5									5	Sitting in a maths class
21		5	sitting_class	comp 5									6	Watching a teacher write "times table" on the board
22		6	time_table_board	comp5										

Exploratory Factor Analysis of whole scale

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.760
Bartlett's Test of Sphericity	Approx. Chi-Square	723.422
	df	231
	Sig.	.000

Communalities

	Initial	Extraction
X4by3	.585	.636
write_board_class	.549	.666
calc10div_four	.596	.633
maths_q_class	.456	.636
add_num_room	.564	.942
maths_test	.506	.487
calc_pencil	.578	.596
surprise_test	.359	.382
calc_perc	.476	.364
add_change	.472	.443
cal_bithday	.507	.575
tel_number	.487	.266
time_left	.495	.296
sweets	.620	.691
sweet_share	.612	.566

memorise_times_table	.453	.433
multiplication_Word	.589	.454
someone_tal_maths	.669	.770
read_book	.442	.421
times_one_digit_two	.594	.513
sitting_class	.558	.483
time_table_board	.645	.716

Extraction Method: Principal Axis Factoring.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.109	32.315	32.315	6.671	30.321	30.321
2	1.706	7.755	40.070	1.274	5.790	36.110
3	1.452	6.600	46.671	1.066	4.846	40.957
4	1.306	5.937	52.607	.912	4.145	45.101
5	1.194	5.427	58.034	.831	3.776	48.877
6	1.074	4.881	62.915	.630	2.864	51.741
7	1.017	4.624	67.539	.586	2.663	54.405
8	.974	4.426	71.964			
9	.943	4.286	76.250			
10	.705	3.205	79.456			
11	.649	2.951	82.406			
12	.607	2.761	85.168			
13	.520	2.363	87.531			

14	.489	2.221	89.752			
15	.461	2.096	91.848			
16	.382	1.735	93.583			
17	.338	1.536	95.119			
18	.325	1.475	96.594			
19	.239	1.088	97.682			
20	.201	.914	98.596			
21	.176	.799	99.395			
22	.133	.605	100.000			

Extraction Method: Principal Axis Factoring.

Factor Matrix[a]

	Factor						
	1	2	3	4	5	6	7
X4by3	.580						
write_board_class	.412	.464					
calc10div_four	.598						
maths_q_class	.429	.411				-.405	
add_num_room	.527		-.491	.573			
maths_test	.591						
calc_pencil	.529				-.426		
surprise_test	.444						
calc_perc	.499						
add_change	.517						
cal_bithday	.552						

tel_number							
time_left	.438						
sweets	.626						
sweet_share	.672						
memorise_times_table	.518						
multiplication_Word	.617						
someone_tal_maths	.631						
read_book	.537						
times_one_digit_two	.676						
sitting_class	.622						
time_table_board	.644						

Extraction Method: Principal Axis Factoring.

a. Attempted to extract 7 factors. More than 25 iterations required. (Convergence=.006). Extraction was terminated.

Exploratory Factor Analysis – Section 1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.475
Bartlett's Test of Sphericity	Approx. Chi-Square	60.416
	df	10
	Sig.	.000

Communalities

	Initial	Extraction
X4by3	1.000	.755
write_board_class	1.000	.575
calc10div_four	1.000	.603
maths_q_class	1.000	.550
add_num_room	1.000	.521

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues Total	Initial Eigenvalues % of Variance	Initial Eigenvalues Cumulative %	Extraction Sums of Squared Loadings Total	Extraction Sums of Squared Loadings % of Variance	Extraction Sums of Squared Loadings Cumulative %	Rotation Sums of Squared Loadings[a] Total
1	1.930	38.590	38.590	1.930	38.590	38.590	1.701
2	1.075	21.495	60.085	1.075	21.495	60.085	1.486
3	.908	18.170	78.255				
4	.733	14.660	92.915				
5	.354	7.085	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix[a]

	Component 1	Component 2
X4by3	.604	.625
write_board_class	.670	
calc10div_four	.759	
maths_q_class	.534	-.515
add_num_room	.505	.516

Extraction Method: Principal Component Analysis.

Reliability Statistics

Cronbach's Alpha	N of Items
.588	3

Reliability Statistics

Cronbach's Alpha	N of Items
.493	2

a. 2 components extracted.

Component 2 became New Section 1 and Component 1 became new section 2

Exploratory Factor Analysis of Section 2

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.753
Bartlett's Test of Sphericity	Approx. Chi-Square	182.518
	df	45
	Sig.	.000

Communalities

	Initial	Extraction
maths_test	1.000	.611
calc_pencil	1.000	.645
surprise_test	1.000	.486
calc_perc	1.000	.430
add_change	1.000	.585
cal_bithday	1.000	.617
tel_number	1.000	.711
time_left	1.000	.415
sweets	1.000	.723
sweet_share	1.000	.561

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.349	33.494	33.494	3.349	33.494	33.494	2.783
2	1.327	13.272	46.766	1.327	13.272	46.766	1.325
3	1.107	11.071	57.837	1.107	11.071	57.837	2.621
4	.873	8.732	66.570				
5	.764	7.643	74.213				
6	.712	7.123	81.336				
7	.599	5.986	87.322				
8	.482	4.822	92.144				
9	.454	4.543	96.687				
10	.331	3.313	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Component Matrix[a]

	Component		
	1	2	3
maths_test	.602		
calc_pencil	.555	-.500	
surprise_test	.521	-.449	
calc_perc	.548		
add_change	.587		-.479
cal_bithday	.644	.406	
tel_number		.744	
time_left	.545		
sweets	.680		-.507
sweet_share	.679		

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Component Correlation Matrix

Component	1	2	3
1	1.000	.013	-.422
2	.013	1.000	-.035
3	-.422	-.035	1.000

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Reliability Statistics

Cronbach's Alpha	N of Items
.680	5

Reliability Statistics

Cronbach's Alpha	N of Items
.689	4

Component Correlation between components 1 and 3 resulted in conducting an oblique (Varimax) rotation method.

Rotated Component Matrix[a]

	Component		
	1	2	3
maths_test	.771		
calc_pencil	.401	.572	
surprise_test	.604		
calc_perc	.620		
add_change		.748	
cal_bithday		.576	.497
tel_number			.830
time_left	.523		
sweets		.829	
sweet_share	.648		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Component 1 became new section 3 and component 2 became new section 4. The iItem in component 3 was removed.

Section 3 was only one variable. No Factor Analysis was needed.

Exploratory Factor Analysis of Section 4

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.850
Bartlett's Test of Sphericity	Approx. Chi-Square	158.153
	df	15
	Sig.	.000

Communalities

	Initial	Extraction
multiplication_Word	1.000	.581
someone_tal_maths	1.000	.581
read_book	1.000	.451
times_one_digit_two	1.000	.519
sitting_class	1.000	.537
time_table_board	1.000	.600

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.269	54.485	54.485	3.269	54.485	54.485
2	.754	12.568	67.053			
3	.591	9.857	76.910			
4	.535	8.913	85.824			
5	.475	7.925	93.748			
6	.375	6.252	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
multiplication_Word	.762
someone_tal_maths	.762
read_book	.671
times_one_digit_two	.720
sitting_class	.733
time_table_board	.775

Extraction Method: Principal Component Analysis.

Reliability Statistics

Cronbach's Alpha	N of Items
.829	6

Component 1 became new section 5.

Exploratory Tests for Relationships for Teacher and School Characteristics

Correlations

			% of free school meals	School IMD Decile	Maths Progress Score	Average Score in Maths	Teach_Overal_EATM	Teacher Overall Maths Anxiety Score
Spearman's rho	% of free school meals	Correlation Coefficient	1.000	-.636**	-.030	-.322**	-.397**	.560**
		Sig. (2-tailed)	.	.000	.496	.000	.000	.000
		N	508	508	508	508	458	458
	School IMD Decile	Correlation Coefficient	-.636**	1.000	.202**	.479**	-.007	-.356**
		Sig. (2-tailed)	.000	.	.000	.000	.877	.000
		N	508	508	508	508	458	458
	Maths Progress Score	Correlation Coefficient	-.030	.202**	1.000	.448**	-.046	-.314**
		Sig. (2-tailed)	.496	.000	.	.000	.324	.000
		N	508	508	508	508	458	458
	Average Score in Maths	Correlation Coefficient	-.322**	.479**	.448**	1.000	.188**	-.580**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000
		N	508	508	508	508	458	458
	Teach_Overal_EATM	Correlation Coefficient	-.397**	-.007	-.046	.188**	1.000	-.648**
		Sig. (2-tailed)	.000	.877	.324	.000	.	.000
		N	458	458	458	458	458	458
	Teacher Overall Maths Anxiety Score	Correlation Coefficient	.560**	-.356**	-.314**	-.580**	-.648**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.
		N	458	458	458	458	458	458

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix H: Research Materials

Ethical Approval Confirmation

Manchester Metropolitan
University

Faculty of Arts and Humanities
Research and Knowledge Exchange

Manchester Metropolitan University, Room 123,
Geoffrey Manton Building,
Rosamund Street West,
Off Oxford Road,
Manchester, M15 6LL, UK

+44 (0)161 247 6673

Name – Simon Massey
Department – Sociology

21 February 2018

Dear Mr Simon Massey,

Application for Ethical Approval: Simon Massey

Project Title: The Aetiology of Maths Anxiety

Ethics Reference Number: A&H1718-35

I am pleased to inform you that the above Ethical Application has been approved unconditionally.

I would be grateful if you could inform the other member(s) of the supervisory team.

Yours sincerely

Katherine Walthall
Research Group Officer

Tel: +44 (0)161 247 6673
Email: k.walthall@mmu.ac.uk

cc. Julie Scott Jones

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Information Sheets:

Head of School Information Sheet

Manchester Metropolitan University

Head of School Information Sheet

Title of PhD Research Project: The Aetiology of Maths Anxiety

Name PhD Research Student: Simon Massey

Email: S.Massey@mmu.ac.uk

Project Start and End Date: September 2017 to July 2018

This information sheet contains details regarding research with your school, which requires the participation of your pupils and teachers answering an anonymous questionnaire regarding their attitudes towards mathematics.

Details of the Research

The aim of this research is to identify factors associated with attitudes to mathematics in children aged 8-9 years old. The reason this research is taking place, is to try to identify reasons behind negative attitudes to mathematics which previous research has found can be associated with poor performance in maths related subjects. The research aims to specifically look at year 4 pupils.

Taking part in this research means that your pupils will simply answer a questionnaire anonymously. The questionnaire states they must not write their names in order to protect their anonymity.

By taking part in the questionnaire, your pupils will help a research project that aims to discover if certain areas of mathematics in school contribute to how children's attitudes towards working with numbers are shaped, and therefore causing impact later on in education.

How your school can benefit from taking part

In exchange for your pupils' time. I will visit with a maths game that is designed for children to apply addition and subtraction skills to get rewards. I will provide those rewards myself, which will be various stickers related to maths and achievement. More information has been provided in the document titled "Game Rules". The game provides your pupils with an opportunity to enhance learning, not disrupt it. Therefore, I am happy to visit when at a time most convenient for your pupils, for example, when they will be involved in 'golden time' or free time. Your school will also receive a report containing an analysis of the results of the questionnaires answered by pupils.

1

What is required of you, as Head Teacher?

I have prepared an information sheet and consent form for parents to read and complete. These forms would need to be distributed, subject to your consent, to parents using school-based communication platforms. Parents will have the right to withdraw their children from this activity and research at any time. I ask that you notify parents with a minimum of 2 weeks before my visit via information sheets, which I will provide. Parents have the right to withdraw their child from the research at any time.

What is required of your pupils?

Your pupils would be asked to complete a questionnaire by the researcher. The questionnaire has been designed to be easily completed by pupils 8 and 9 years old, so they can do so freely and without teacher assistance. With the questionnaire, there will be an information sheet fully disclosing the information regarding the project. The information sheet will also clearly state that your pupils' participation is strictly voluntary and that they do not have to answer any questions if they do not want to. They will also be informed that the questionnaire will be anonymous and that they must not write their name on the questionnaire to ensure only they know how they have individually answered the questionnaire.

In exchange for their time and at the discretion of their teachers, I will provide an extracurricular activity where the pupils can play a maths based game that enhances their addition and subtraction skills.

How long will it take?

The questionnaire should take approximately 10 minutes.

The maths based game/activity should take approximately 15 minutes per group of 4 pupils.

What is required of your teachers?

I will distribute the questionnaires to teachers and run the maths game, with minimal assistance from teaching staff. As this will take place in a classroom, teachers and assistants would be required to provide the pupils with the questionnaires, whilst I work with the pupils running the maths game. Teachers would be asked to answer the same questionnaire as pupils, but obviously it is an adult version. Teachers have the right to refuse or withdraw their participation from the research.

How I will keep your pupils' information secure?

The information provided from your pupils, which will be answers from the questionnaire, will be safeguarded in compliance with the Data Protection Act 1998. Details will not be shared, and anonymity is of utmost important to the research. All questionnaires will be completed on paper and all answers will be inputted into an excel file which will be stored on an encrypted hard drive. Once answers are securely stored, the paper copies will be physically destroyed. The paper copy will explicitly state that your pupil must not write their name.

How will I keep your teachers' information secure?

As the anonymity of your school is of utmost importance, all details regarding who participates in the questionnaire, will be kept confidential. However, a copy of the questionnaire has been provided to fully disclose the nature of the research.

How will I keep your school's information secure?

The identity of your school will remain strictly confidential at all times. The only detail to be disclosed of any participating school in this research, is that the school is located in Greater Manchester.

What if you don't want your school to take part?

Allowing me to ask your year 4 pupils and teachers to take part in the research is strictly your choice. You have the right to withdraw your consent at any time. Your pupils and teachers also have the right to withdraw from the research at any time. If allowing this to take place, both pupils and teachers will be provided with a questionnaire and an information sheet informing them of their right to withdraw and ensuring them that their participation is strictly voluntary. I ask that you notify parents with a minimum of 2 weeks before my visit via information sheets which I will provide. Parents have the right to withdraw their child from the research at any time. I have provided both questionnaires in order to provide full disclosure.

Further information

Please contact me via the details provided if you require any additional information before agreeing to take part in the study.

Teacher Information Sheet

Date of information sheet sending: 20/06/2018

Teacher Information Sheet

Manchester Metropolitan University

Title of PhD Research Project: The Aetiology of Maths Anxiety

Name PhD Research Student: Simon Massey

Email: S.Massey@mmu.ac.uk

Project Start and End Date: September 2017 to July 2018

Details of the Research

The aim of this research is to identify factors associated with attitudes to mathematics in children aged 8-9 years old. This is to try to identify reasons behind negative attitudes to mathematics which previous research has found can be associated with poor performance in maths related subjects. The research aims to specifically look at year 4 pupils.

Another aim is to identify the views of year 4 teachers along with their own experiences and attitudes towards mathematics. This will be through an anonymous questionnaire that aims to measure attitudes to different areas of mathematics.

By taking part in the questionnaire, your participation will help this PhD research identify how teachers feel about the mathematics they teach to year 4 pupils.

How your school can benefit from taking part

In exchange for you and your pupils' time, I will visit with a maths game that is designed for children to apply addition and subtraction skills to get rewards. I will provides those rewards myself, which will be various stickers related to maths and achievement. More information has been provided in the document titled "Game Rules". The game provides your pupils with an opportunity to enhance learning, not disrupt it. Therefore, I am happy to visit when at a time most convenient for your pupils, for example, when they will be involved in 'golden time' or free time. Your school will also receive a report containing an analysis of the results of the questionnaires answered by pupils.

What is required of you, as a Teacher?

If you are happy to take part in this research, then please answer the questionnaire provided by circling the answers that represent how you wish to respond to each question. Before doing so, please ensure you have read all of the information provided, including your

1

right to refuse to take part. This questionnaire is an adult version of the questionnaire provided for the Year 4 pupils.

How long will it take?

The questionnaire should take approximately 5 minutes.

The maths based game activity should take approximately 15 minutes per group of 4 pupils.

How do I withdraw?

It is very important that you understand you have the right to withdraw from this research if you wish. You can exercise the right to withdraw from the questionnaire at any time before or after the research takes place. I have requested that you are notified at least two weeks before my visit. The date arranged to visit your school is *(date will be added when negotiated with school).* If you do not wish to take part then please do not complete a questionnaire.

How I will keep your information secure?

The information provided from you, which will be the answers from the questionnaire, will be safeguarded in compliance with the Data Protection Act 1998. Personal details will not be shared, and anonymity is of the utmost important to the research. All questionnaires will be completed on paper and all answers will be inputted into an Excel file which will be stored on an encrypted hard drive. Once answers are securely stored, the paper copies will be physically destroyed.

How will I keep your work place information secure?

As the anonymity of the school is of utmost importance, all details regarding who participates in the questionnaire, will be kept confidential. The identity of the school will remain strictly confidential at all times. The only detail to be disclosed of any participating school in this research is that the school is located in Greater Manchester.

Further information

Please contact me via the details provided if you require any additional information before agreeing to take part in the study. Please also feel free to ask me any questions when I visit the school to conduct the research.

Pupil Information Sheet

Manchester Metropolitan University

Information for Research Helpers

Title of Research Project: The Aetiology of Maths Anxiety

PhD Researcher: Simon Massey **Contact Details:** S.Massey@mmu.ac.uk

Who am I?

Hello, my name is Simon and I would like ask you some questions about maths. I want to do this because I am interested in what children think about doing sums. This is part of a project that I am doing at University and I would like you to take part.

This is not school work and I am not a teacher. If you don't want to do this then you don't have to and no one will be cross about it.

If you would like to take part in my project, you can answer the questions once you have read this and understand everything. If you are not sure you can ask me any questions you would like about it.

It is OK if you do not want to answer any questions. If you do not want to answer any questions, then you do not need to do anything with the questionnaire, I will just collect it from you.

If you do answer the questionnaire, it is very important that you do not write your name anywhere on the questionnaire, so that only you know how you answered it.

How long will it take?

It will take about 10 minutes.

If you need help...

If you do not understand this information, then I will help explain it for you.

If you do not want to answer the questions, leave the pages blank and I will collect it later.

Thank you!

Parent Information

Parent of Participant Information Sheet

Title of PhD Research Project: The Aetiology of Maths Anxiety

Name PhD Research Student: Simon Massey

Email: S.Massey@mmu.ac.uk

Project Start and End Date: September 2017 to December 2018

This information sheet contains details regarding research in your child's school, which requires their participation in answering an anonymous questionnaire regarding their attitudes towards mathematics.

Details of the Research

The aim of this PhD is to identify factors associated with attitudes to mathematics in children aged 8-9 years old. The reason this research is taking place, is to try to identify reasons behind negative attitudes to mathematics which previous research has found can be associated with poor performance in maths related subjects. As your child is in Year 4 and therefore the age this research concerns, I would like to ask for you and your child's cooperation in answering a questionnaire that discusses how they feel about different areas of mathematics.

Taking part in this research, means that your child will simply answer a short questionnaire which takes about 5 minutes to complete. The questionnaire states they must not write their name on it, as it is very important that when answering the questionnaire, you child does so anonymously.

By taking part in the questionnaire, your child will help a PhD research project that aims to discover if certain areas of mathematics in school contribute to how children's attitudes towards working with numbers are shaped. This is aimed to then inform our understanding of whether there are factors linked to those attitudes that can help identify why attitudes to mathematics are negative amongst certain children.

What is required of your child?

Your child will be asked to complete a questionnaire by the researcher. With the questionnaire, there will be an information sheet fully disclosing information regarding the project. The information sheets will also clearly state that your child's participation is strictly voluntary and that they do not have to answer any questions if they do not need to. They will also be informed that the questionnaire will be anonymous and that they must not write their name on the questionnaire to ensure that only they know how they have individually answered the questionnaire.

How long will it take?

The questionnaire should take approximately 10 minutes.

How I will keep your child's information secure.

The answers provided by your child on the questionnaire, will be safeguarded in compliance with the Data Protection Act 1998. Details will not be shared, as anonymity is of utmost importance to the research. All questionnaires will be completed on paper and all answers will be inputted into an excel file which will be stored on an encrypted hard drive. Once answers are securely stored, the paper copies will be physically destroyed. The paper copy will explicitly state that your child must not write their name.

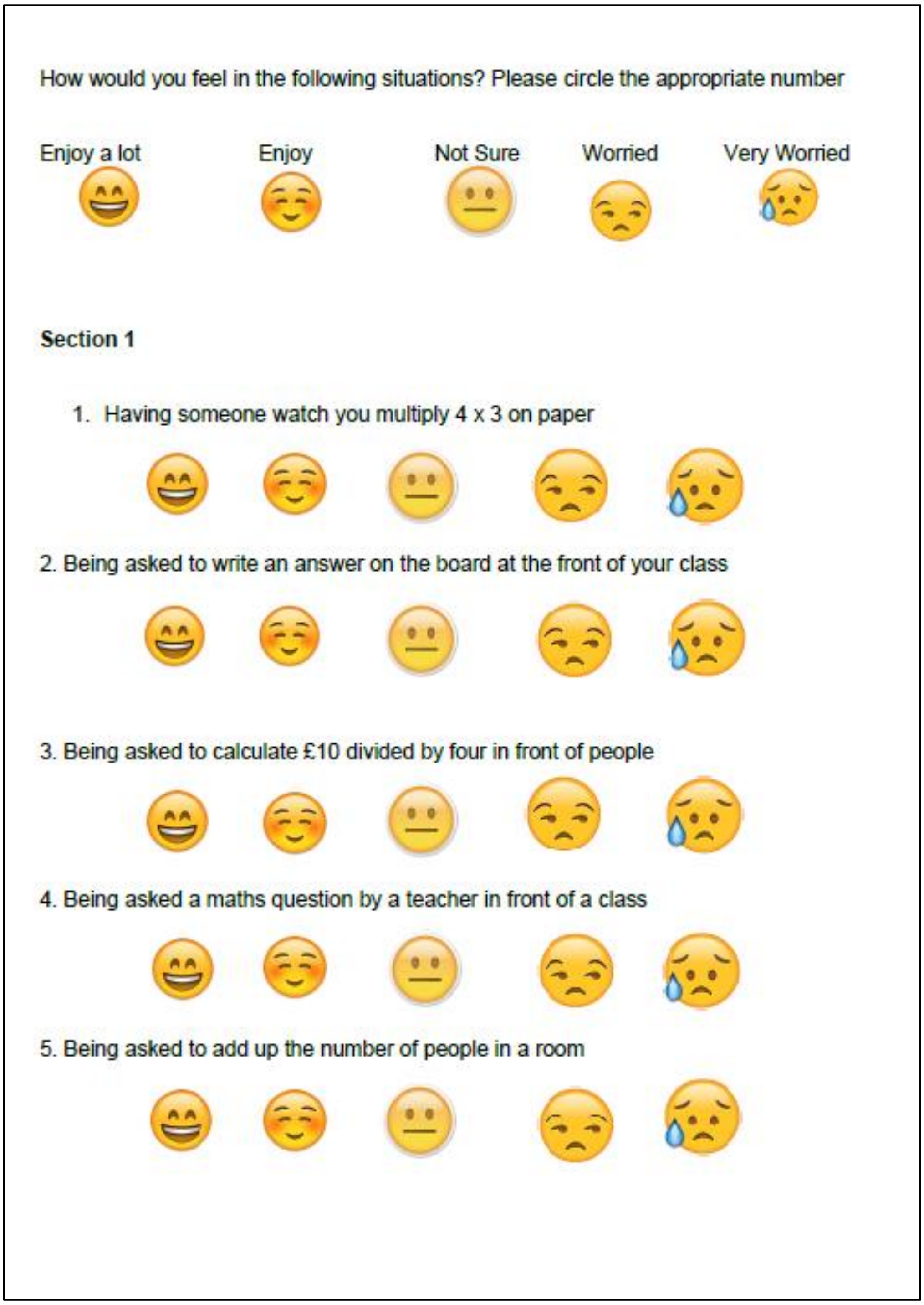
How do you withdraw your child?

It is very important that you understand you have the right to withdraw your child from this research if you wish. Your child also has the right to withdraw at any time, and will be made aware of this before completing the questionnaire. You can exercise the right to withdraw your child at any time before the research takes place, and I have requested you are notified at least two weeks before my visit. The date arranged to visit your school is *(date will be added once negotiated with school).* Please ensure that if you do not wish for your child to take part, that you inform the school directly. By exercising your right to withdraw your child, the KS2 lead, and your child's teacher, will ensure that your child is not provided with a questionnaire to answer.

Further Questions

Please do not hesitate to contact me by email, if you would any more information regarding this research project before your child takes part. My email can be found at the beginning of this information sheet.

Pilot Questionnaire



How would you feel in the following situations? Please circle the appropriate number

Enjoy a lot	Enjoy	Not Sure	Worried	Very Worried

Section 1

1. Having someone watch you multiply 4 x 3 on paper

2. Being asked to write an answer on the board at the front of your class

3. Being asked to calculate £10 divided by four in front of people

4. Being asked a maths question by a teacher in front of a class

5. Being asked to add up the number of people in a room

Section 2

1. Taking a maths test

2. Calculating with a pencil on paper

3. Being given a surprise maths test in a class

4. Being asked to calculate a percentage

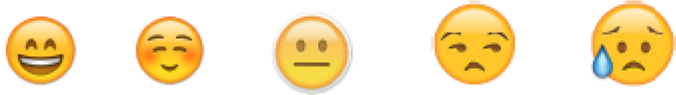
5. Adding up a pile of change

6. Calculating how many days until a person's birthday

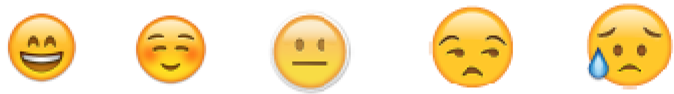
7. Being given a telephone number and having to remember it

8. Working out how much time you have left before you set off to school

9. Working out how much change you should have after buying sweets

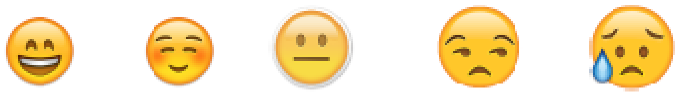


10. Deciding how much each person should give you after you buy something that you are all sharing



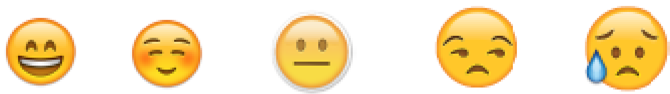
Section 3

1. Being asked to memorise your times table

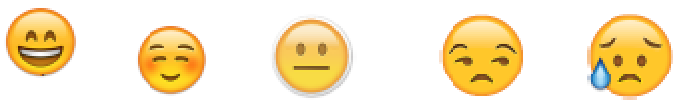


Section 4

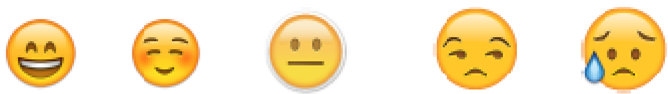
1. Reading the word "algebra" – what's the tough thing for year 4's?



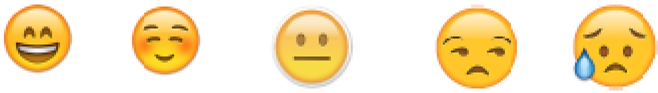
2. Listening to someone talk about maths



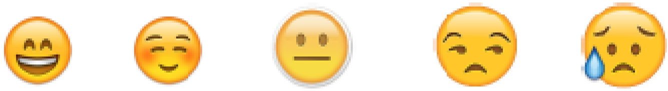
3. Reading a maths textbook



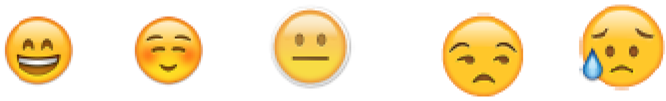
4. Watching someone work out an algebra problem



5. Sitting in a maths class



6. Watching a teacher write times table on the board



Finalised Questionnaire

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Research Helper Booklet

Simon Massey

S.Massey@mmu.ac.uk

Please answer all the questions

I am a….. Boy Girl

I am ___________ years old

My favourite subject is ______________________________

Please state your ethnic group. PLEASE TICK ONE BOX ONLY

White	British	
	Irish	
	Any other White background	
Asian or Asian British	Indian	
	Pakistani	
	Bangladeshi	
	Any other Asian background	
Black or Black British	African	
	Caribbean	
	Any other Black background	
Chinese or Any other	British Chinese	
	Chinese	
	Any Other	
Mixed	White and Asian	
	White and Black	
	White and Chinese	
	White and any other	

Part 1

Please circle one face for each statement that you think shows how you feel.

Enjoy a lot	Enjoy	Not Sure	Worried	Very Worried
😄	☺️	😐	😒	😥

How would you feel…

Section 1

1. Having a teacher watch you multiply 4 x 3 on paper

😄 ☺️ 😐 😒 😥

2. Being asked to add up the number of people in a room

😄 ☺️ 😐 😒 😥

Section 2

1. Being asked to write an answer on the board at the front of your class

😄 ☺️ 😐 😒 😥

2. Being asked to calculate £10 divided by four in front of your teacher

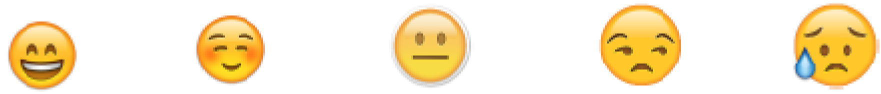
😄 ☺️ 😐 😒 😥

3. Being asked a maths question by a teacher in front of your class

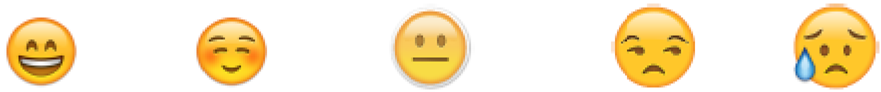
😄 ☺️ 😐 😒 😥

Section 3

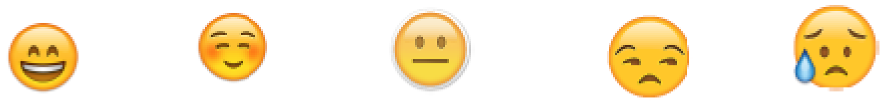
1. Taking a maths test



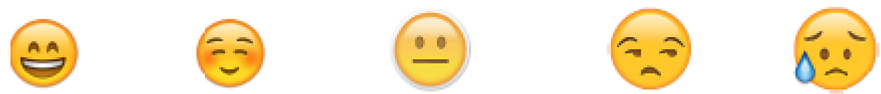
2. Being asked to calculate a percentage



3. Working out how much time you have left before you set off to school

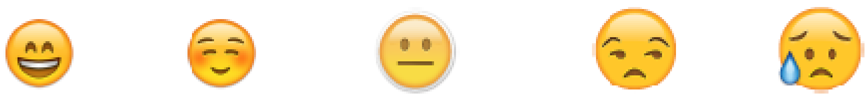


4. Deciding how many sweets each friend can have if you are all sharing

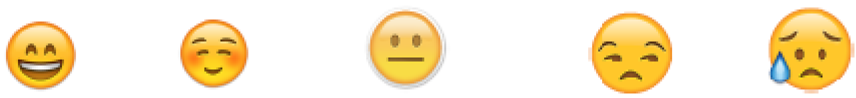


Section 4

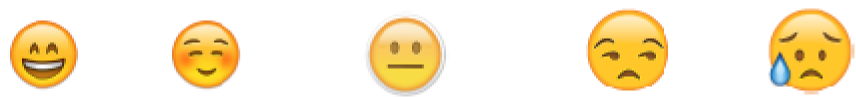
1. Calculating with a pencil on paper



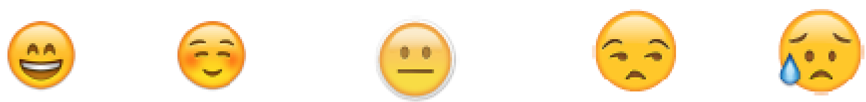
2. Adding up a pile of change



3. Calculating how many days until a person's birthday

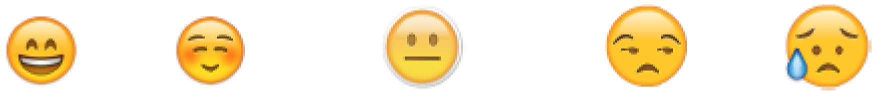


4. Working out how much change you should have after buying sweets

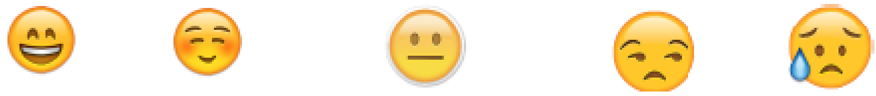


Section 5

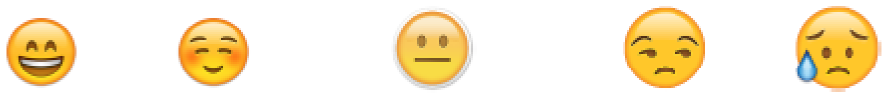
1. Listening to someone talk about maths



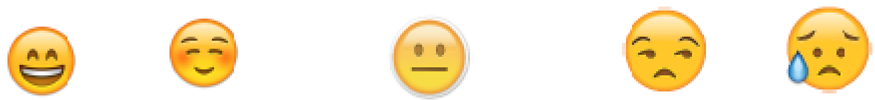
2. Watching someone multiply a one digit number by a two digit number



3. Sitting in a maths class



4. Watching the teacher doing times tables on the board



Section 6

There are 3 statements. Please tick only 1 box in each row to answer how you feel about each statement.

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	I am good at maths					
2	I do maths at home					
3	My parents help me with maths homework					

Part 2

Please draw only one face in a blank circle for each row, to state how you feel.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
I like Maths					
I think Maths is important					
I do not like maths					
I think maths is hard					
I think Maths is easy					
I enjoy maths when I am in class					

Part 3

Please draw a picture of a person in each box.

Someone who is good at MATHS	Someone who is good at READING
PLEASE TICK Have you drawn a... Boy ☐ Or Girl ☐	PLEASE TICK Have you drawn a... Boy ☐ Or Girl ☐

for answering the questions!

Teacher Questionnaire

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Teacher Questionnaire: Exploring Attitudes to Mathematics

Researcher: Simon Massey
Email: S.Massey@mmu.ac.uk

The following questions aim to identify how in certain situations you feel regarding teaching and learning mathematics. The scale below shows which number you should circle to indicate how you would feel. A score of 1 indicates you very much enjoy the task. A score of 5 indicates you would feel very anxious completing the task.

Please circle the appropriate number to represent how you would feel.

How would you feel in the following situations?

Not at all Anxious	Not Anxious	Not Sure	Anxious	Very Anxious
1	2	3	4	5

Section 1 – Being Asked by Pupils

1. Being asked to write an answer on the board at the front of your class

1 2 3 4 5

2. Being asked to calculate £644 divided by four in front of people

1 2 3 4 5

3. Being asked a maths question by a pupil in front of a class

1 2 3 4 5

4. Being asked to add up the number of people in a room

1 2 3 4 5

How would you feel in the following situations?

Not at all Anxious	Not Anxious	Not Sure	Anxious	Very Anxious
1	2	3	4	5

Section 2 – Demonstrating

1. Being asked to show something about maths on the board in front of your class

1 2 3 4 5

2. Being asked to show how to calculate a percentage to your pupils

1 2 3 4 5

3. Being asked a maths question by a pupil and demonstrating how to answer it

1 2 3 4 5

Section 3 – Confidence

1. Taking a maths test yourself

1 2 3 4 5

2. Being asked to calculate a percentage yourself

1 2 3 4 5

3. Working out how much time you have left before you set off to work

1 2 3 4 5

4. Deciding how much money each person owes you after you buy something that you are all sharing

1 2 3 4 5

How would you feel in the following situations?

Not at all Anxious	Not Anxious	Not Sure	Anxious	Very Anxious
1	2	3	4	5

Section 4 – Practical Cognition

1. Calculating with a pencil on paper

1 2 3 4 5

2. Adding up a pile of change

1 2 3 4 5

3. Calculating how many days until a person birthday

1 2 3 4 5

4. Working out how much change you should have after buying something

1 2 3 4 5

Section 5 – Passive Maths

1. Listening to someone talk about maths

1 2 3 4 5

2. Watching someone multiply a one digit number by a two digit number

1 2 3 4 5

3. Sitting in a maths class as a student

1 2 3 4 5

4. Observing a colleague in their class teach maths

1 2 3 4 5

Part 2

There are three statements below. Please state how you feel towards each statement by ticking one box.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
I am good at maths					
I do maths at home					
I believe I am good at teaching maths					

There are six statements below. Please state how you feel towards each statement by ticking one box.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
I like Maths					
I do not enjoy teaching maths					
I think maths is easy					
I enjoy teaching maths					
I think maths is hard					
I do not like maths					

Part 3

1. What is your Gender? Please circle one of the four options.

Male Female Trans Male Trans Female

2. What is your Ethnicity? Please tick one box only.

White	British	
	Irish	
	Any other White background	
Asian	British	
	Indian	
	Pakistani	
	Bangladeshi	
	Any other Asian background	
Black	British	
	African	
	Caribbean	
	Any other Black background	
Chinese or Any other	British Chinese	
	Chinese	
	Any Other	
Mixed	White and Asian	
	White and Black	
	White and Chinese	
	White and any other	

4. How many years have you been teaching maths to year 4 pupils?

(Please provide number) ______ Years

Declaration: I have read the information sheet provided by the researcher, Simon Massey, and accept that the only information shared will be the answers I provide on this questionnaire. (please circle)

Yes No

I am willing to take part in a confidential focus group or phone interview at another date. (please circle)

Yes No

If yes, please provide an email address to be contacted by:

Email: ______________________________

Thank you for taking the time to answer this questionnaire.

Head of School Signed Consent Forms (Anonymised)

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 1

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 2

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 3

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

[redacted]

Name of [redacted] giving consent: [redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 4

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted]

I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

Date: [redacted]

Signature: [redacted]

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Q-Step

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 5

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

[redacted]

[redacted]

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Q-Step

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 6

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted]

I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent: [redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 7

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 9

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent: [redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 10

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent: [redacted]

Date: [redacted]

Signature: [redacted]

Q-Step

A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

Manchester Metropolitan University

Project: The Aetiology of Maths Anxiety

Principal Investigator: Simon Massey

Location access has been granted: [redacted]

School Anonymous ID number for the Project: 11

Reason for visit: Data collection through the use of an anonymous questionnaire

I confirm that I have read and understand the information sheet for the project: The Aetiology of Maths Anxiety, led by Simon Massey, From Manchester Metropolitan University. I have the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I also confirm that Simon Massey has been granted access to [redacted] I understand that our pupils participation in this project is voluntary and any pupil or teacher has the right to withdraw at any given time without any reason.

I agree to the school taking part in the project and for the project to take place on school premises.

Name of Head giving consent:

[redacted]

Date: [redacted]

Signature: [redacted]

Appendix I: Additional Multivariate Models Post-Viva

Assumptions and Collinearity Diagnostics of Model 1.1 (Multiple Regression BAM)

Regression

Notes

Output Created		20-APR-2020 13:43:22
Comments		
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	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	508
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA COLLIN TOL ZPP /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT Overall_Beh_Att /METHOD=ENTER Gender Fav_Sub Eth_R S6Q1R S6Q2R S6Q3R Gender_Ability_Beliefs /PARTIALPLOT ALL /SCATTERPLOT=(*ZRESID ,*ZPRED).
Resources	Processor Time	00:00:01.06
	Elapsed Time	00:00:00.93
	Memory Required	8032 bytes
	Additional Memory Required for Residual Plots	1768 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
Overall Behavioural Attitudes to Mathematics	50.7360	11.48398	250

Pupil Gender	.4720	.50022	250
Pupil Favourite Subject	.4400	.49738	250
Ethnicity (White = 1 and BME = 0)	.6920	.46259	250
I am good at maths	.9240	.26553	250
I do maths at home	.7560	.43035	250
Parents help	.5960	.49168	250
Gender_Ability_Beliefs	.2040	.67840	250

Correlations

		Overall Behavioural Attitudes to Mathematics	Pupil Gender	Pupil Favourite Subject	Ethnicity (White = 1 and BME = 0)	I am good at maths	I do maths at home	Parents help	Gender_Ability_Beliefs
Pearson Correlation	Overall Behavioural Attitudes to Mathematics	1.000	-.059	.203	-.061	.461	.461	-.076	.027
	Pupil Gender	-.059	1.000	-.192	-.046	-.061	.127	.174	-.119
	Pupil Favourite Subject	.203	-.192	1.000	.120	.224	.166	-.124	.019
	Ethnicity (White = 1 and BME = 0)	-.061	-.046	.120	1.000	.070	-.137	-.055	-.042
	I am good at maths	.461	-.061	.224	.070	1.000	.224	-.021	-.003
	I do maths at home	.461	.127	.166	-.137	.224	1.000	.083	.020
	Parents help	-.076	.174	-.124	-.055	-.021	.083	1.000	.067
	Gender_Ability_Beliefs	.027	-.119	.019	-.042	-.003	.020	.067	1.000
Sig. (1-tailed)	Overall Behavioural Attitudes to Mathematics	.	.175	.001	.166	.000	.000	.116	.335
	Pupil Gender	.175	.	.001	.234	.167	.023	.003	.030
	Pupil Favourite Subject	.001	.001	.	.029	.000	.004	.025	.385
	Ethnicity (White = 1 and BME = 0)	.166	.234	.029	.	.134	.015	.194	.254
	I am good at maths	.000	.167	.000	.134	.	.000	.372	.483
	I do maths at home	.000	.023	.004	.015	.000	.	.096	.377
	Parents help	.116	.003	.025	.194	.372	.096	.	.144
	Gender_Ability_Beliefs	.335	.030	.385	.254	.483	.377	.144	.
N	Overall Behavioural Attitudes to Mathematics	250	250	250	250	250	250	250	250

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject[b]	.	Enter

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.605[a]	.366	.348	9.27586

a. Predictors: (Constant), Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject

b. Dependent Variable: Overall Behavioural Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12016.524	7	1716.646	19.951	.000[b]
	Residual	20822.052	242	86.042		
	Total	32838.576	249			

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, I am good at maths, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Gender, I do maths at home, Pupil Favourite Subject

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	30.712	2.538		12.099	.000	25.712	35.712					
	Pupil Gender	-1.433	1.239	-.062	-1.157	.249	-3.873	1.007	-.059	-.074	-.059	.900	1.111
	Pupil Favourite Subject	.943	1.265	.041	.746	.457	-1.549	3.435	.203	.048	.038	.873	1.146
	Ethnicity (White = 1 and BME = 0)	-1.159	1.302	-.047	-.890	.374	-3.724	1.406	-.061	-.057	-.046	.952	1.050
	I am good at maths	15.747	2.326	.364	6.769	.000	11.165	20.329	.461	.399	.347	.906	1.104
	I do maths at home	10.186	1.459	.382	6.980	.000	7.311	13.060	.461	.409	.357	.876	1.141
	Parents help	-2.045	1.229	-.088	-1.664	.097	-4.465	.375	-.076	-.106	-.085	.947	1.056
	Gender_Ability_Beliefs	.274	.878	.016	.313	.755	-1.454	2.003	.027	.020	.016	.975	1.026

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Pupil Gender	Pupil Favourite Subject	Ethnicity (White = 1 and BME = 0)	I am good at maths	I do maths at home	Parents help	Gender_Ability_Beliefs
1	1	5.257	1.000	.00	.01	.01	.01	.00	.01	.01	.00
	2	.931	2.376	.00	.03	.00	.00	.00	.00	.00	.89
	3	.686	2.767	.00	.22	.37	.01	.00	.00	.06	.04
	4	.369	3.775	.00	.51	.18	.11	.00	.01	.28	.04
	5	.344	3.911	.00	.04	.11	.43	.00	.04	.36	.02
	6	.257	4.520	.01	.16	.33	.05	.02	.36	.22	.01
	7	.121	6.595	.08	.00	.00	.35	.19	.58	.03	.00
	8	.035	12.287	.91	.03	.00	.04	.78	.00	.03	.00

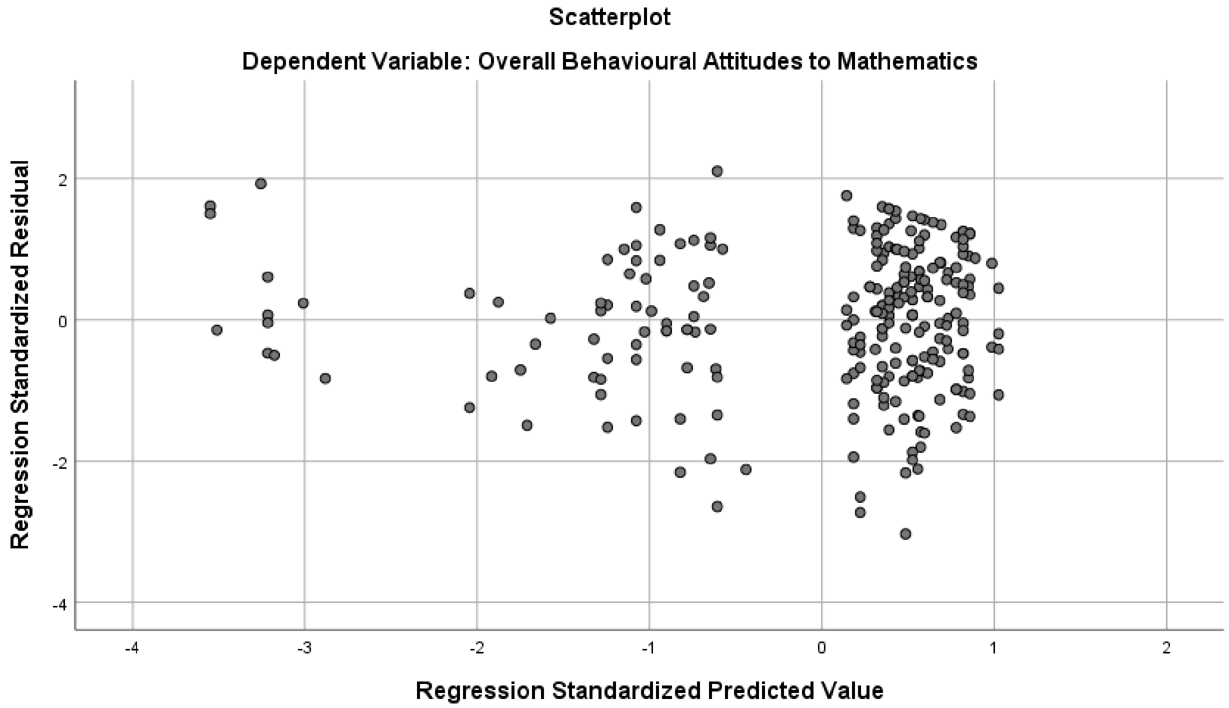
a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

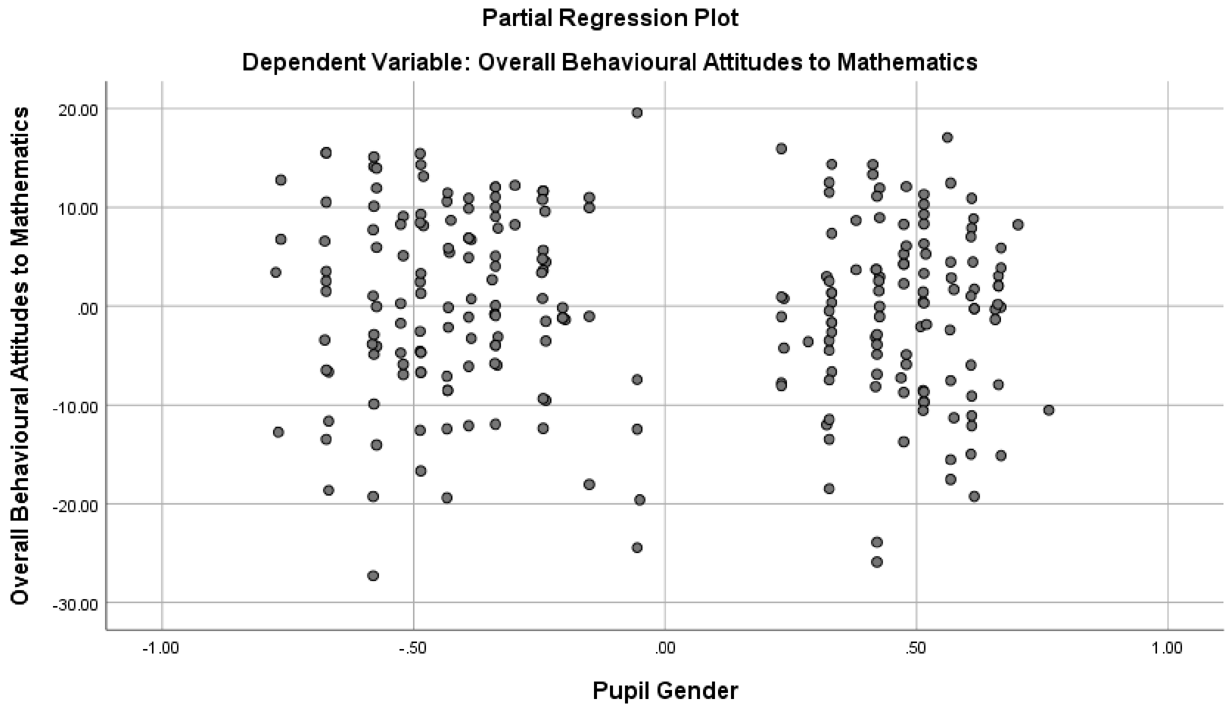
Residuals Statistics[a]

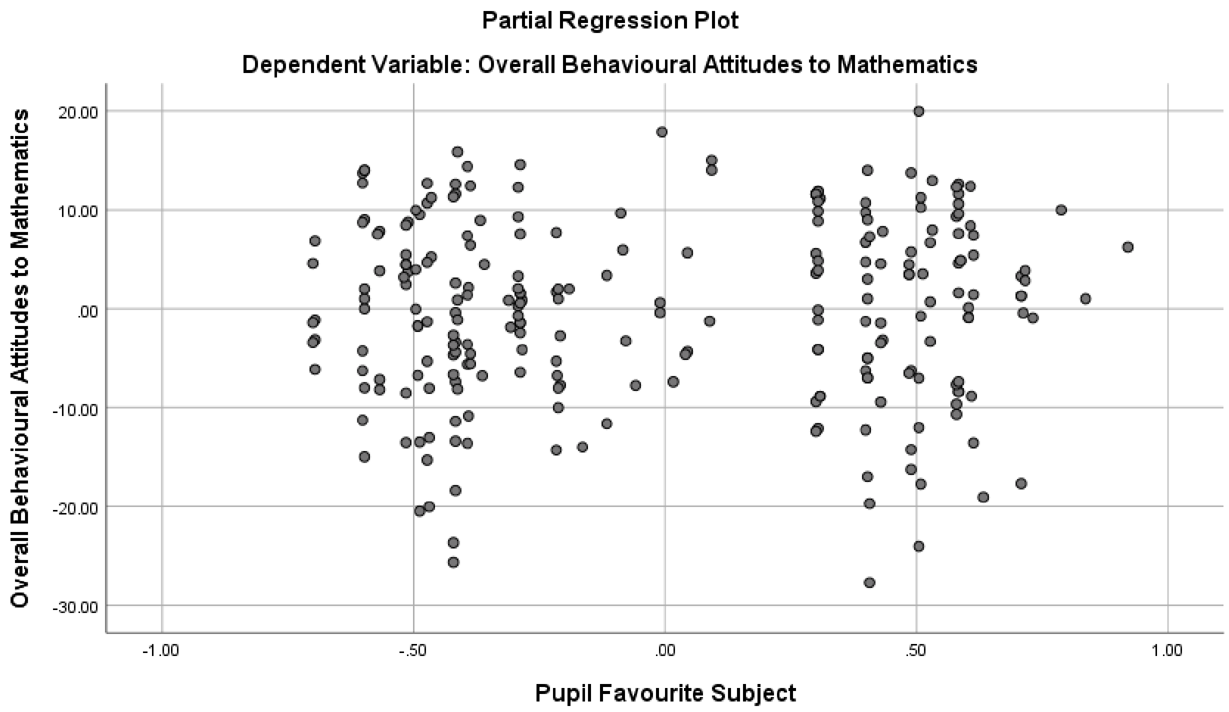
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	26.0749	57.8620	50.7360	6.94688	250
Residual	-28.10902	19.48269	.00000	9.14454	250
Std. Predicted Value	-3.550	1.026	.000	1.000	250
Std. Residual	-3.030	2.100	.000	.986	250

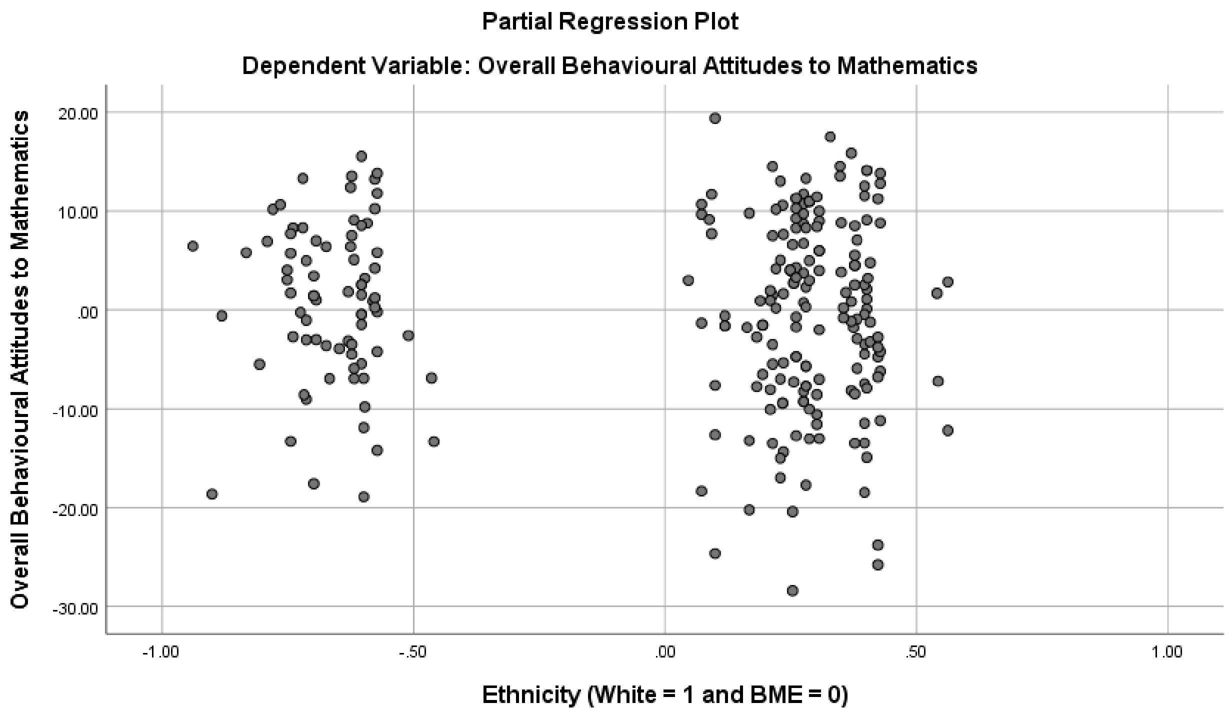
a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

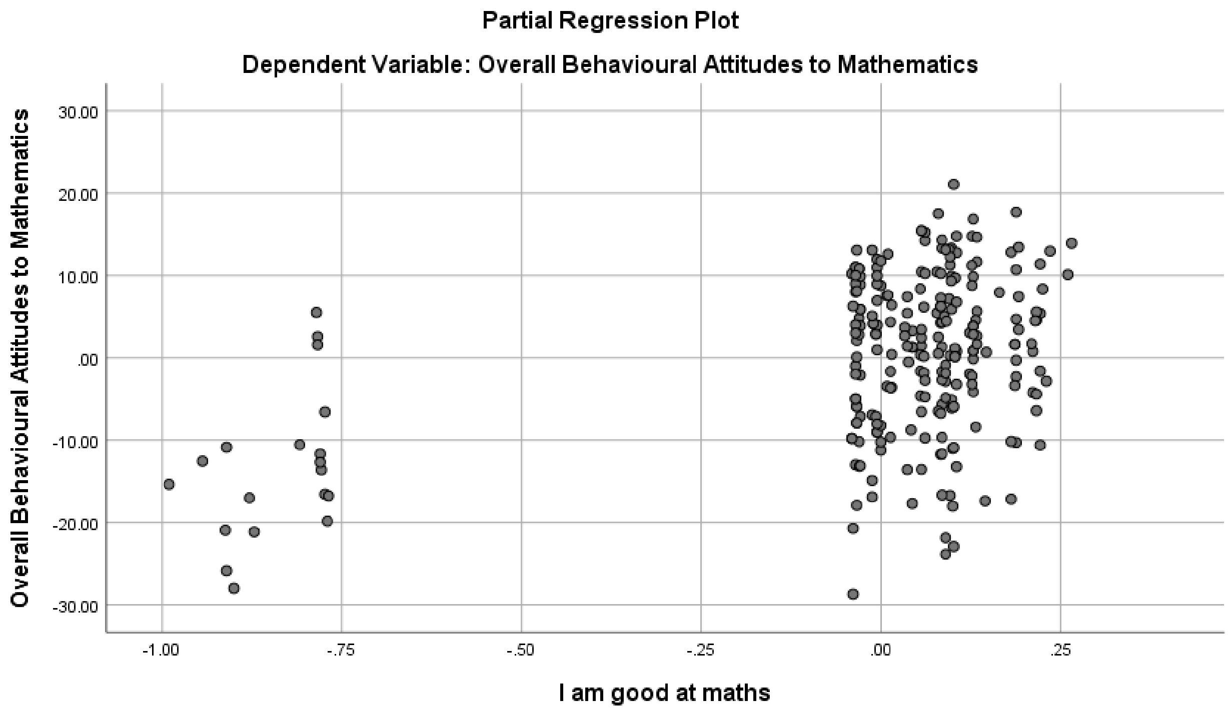
Charts

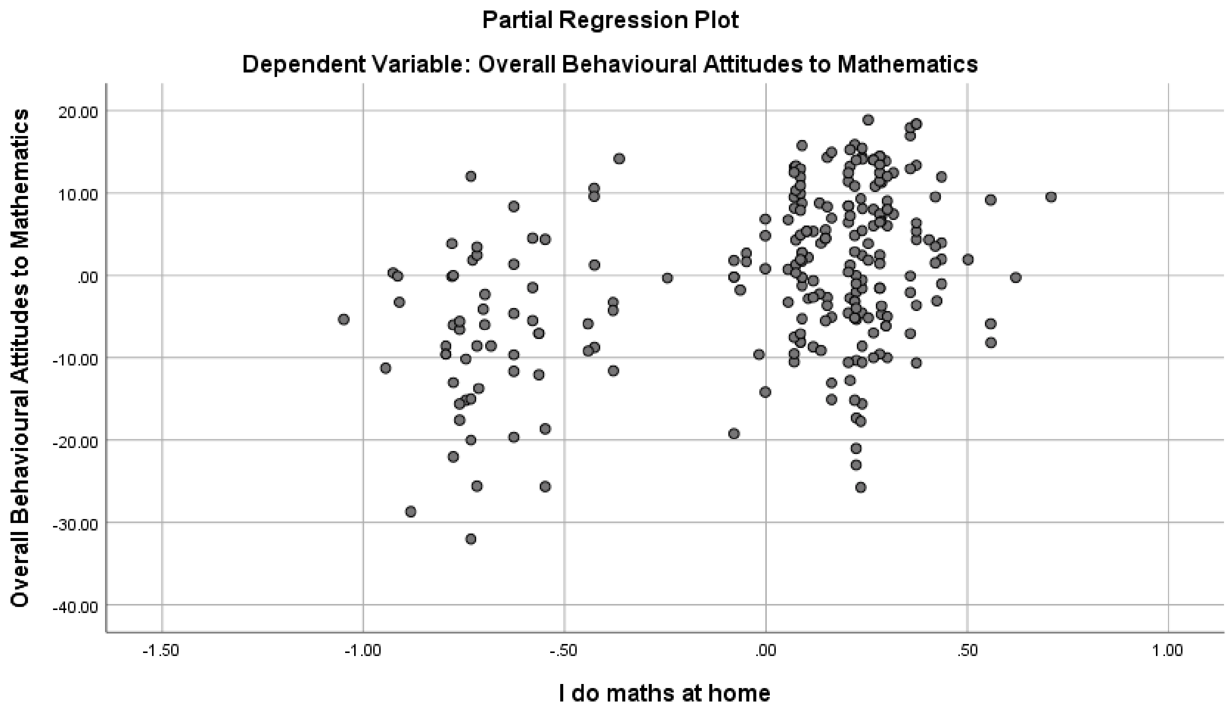

Scatterplot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Regression Standardized Residual
Regression Standardized Predicted Value
2
0
-2
-4
-4
-3
-2
-1
0
1
2

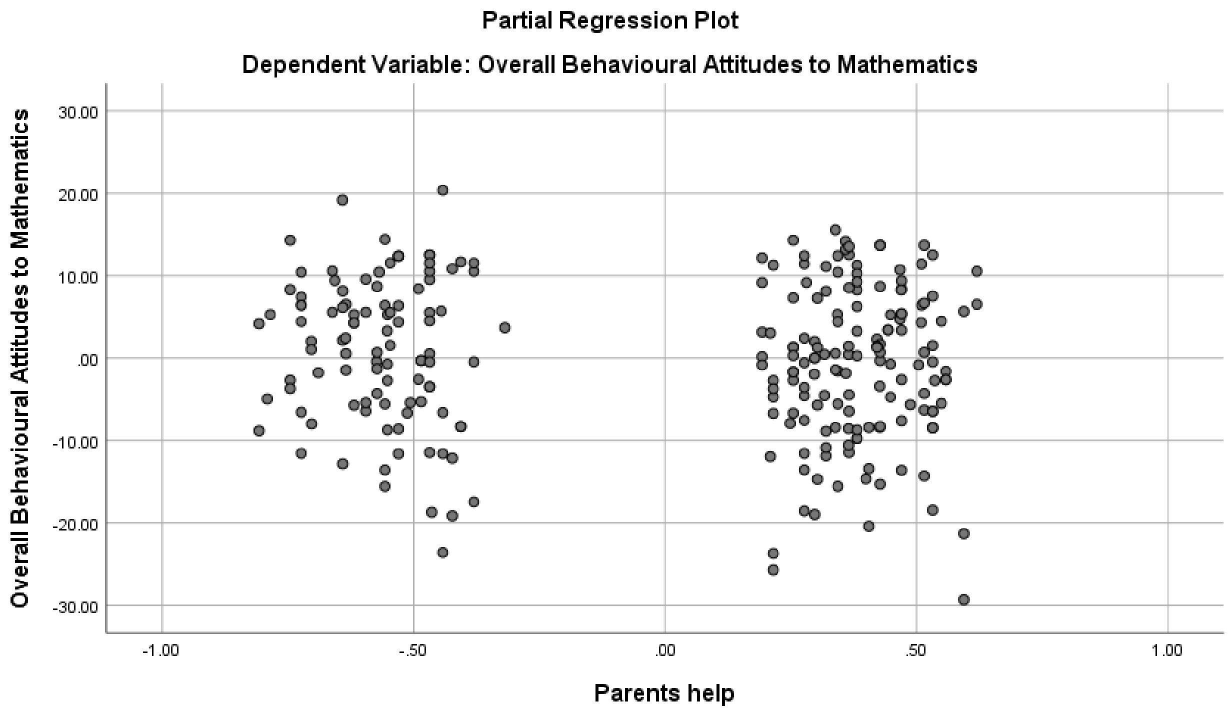

Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
Pupil Gender
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.00
-.50
.00
.50
1.00

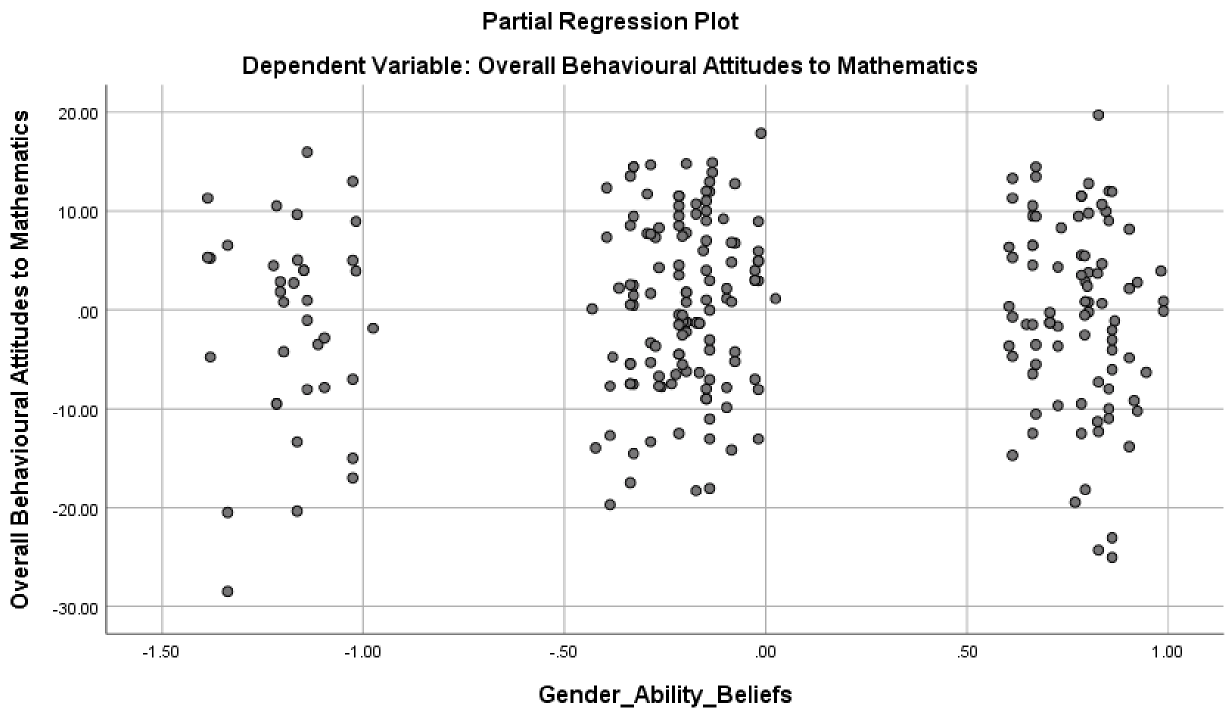

Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.00
-.50
.00
.50
1.00
Pupil Favourite Subject


Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.00
-.50
.00
.50
1.00
Ethnicity (White = 1 and BME = 0)


Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
30.00
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.00
-.75
-.50
-.25
.00
.25
I am good at maths


Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
20.00
10.00
.00
-10.00
-20.00
-30.00
-40.00
-1.50
-1.00
-.50
.00
.50
1.00
I do maths at home


Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
30.00
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.00
-.50
.00
.50
1.00
Parents help


Partial Regression Plot
Dependent Variable: Overall Behavioural Attitudes to Mathematics
Overall Behavioural Attitudes to Mathematics
20.00
10.00
.00
-10.00
-20.00
-30.00
-1.50
-1.00
-.50
.00
.50
1.00
Gender_Ability_Beliefs

Model1.1.1: Model 1.1 without Self-Confidence

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Gender_Ability_Beliefs, I do maths at home, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Favourite Subject, Pupil Gender[b]	.	Enter

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.456[a]	.208	.192	10.53899

a. Predictors: (Constant), Gender_Ability_Beliefs, I do maths at home, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Favourite Subject, Pupil Gender

b. Dependent Variable: Overall Behavioural Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8758.800	6	1459.800	13.143	.000[b]
	Residual	33321.083	300	111.070		
	Total	42079.883	306			

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, I do maths at home, Parents help, Ethnicity (White = 1 and BME = 0), Pupil Favourite Subject, Pupil Gender

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	42.761	1.867		22.898	.000	39.086	46.436					
	Pupil Gender	-2.936	1.287	-.125	-2.282	.023	-5.468	-.404	-.123	-.131	-.117	.877	1.141
	Pupil Favourite Subject	3.661	1.290	.153	2.839	.005	1.123	6.199	.229	.162	.146	.911	1.098
	Ethnicity (White = 1 and BME = 0)	-.360	1.323	-.014	-.272	.786	-2.964	2.245	-.046	-.016	-.014	.961	1.040
	I do maths at home	10.477	1.437	.388	7.291	.000	7.649	13.305	.380	.388	.375	.932	1.072
	Parents help	-2.098	1.301	-.086	-1.613	.108	-4.658	.461	-.101	-.093	-.083	.930	1.075
	Gender_Ability_Beliefs	.433	.903	.025	.479	.632	-1.345	2.211	.045	.028	.025	.973	1.027

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

Assumptions and Collinearity Diagnostics of Model 1.2 (Multiple Regression EAM)

Regression

Notes

Output Created		20-APR-2020 13:50:46
Comments		
Input	Data	\\staffhome\staff_home0\55115237\Documents\PhD\Data\Condensed Full Dataset.sav
	Active Dataset	DataSet1
	Filter	<none>
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	N of Rows in Working Data File	508
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA COLLIN TOL ZPP /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT Total_Emotional /METHOD=ENTER Gender Fav_Sub Eth_R S6Q1R S6Q2R S6Q3R Gender_Ability_Beliefs /PARTIALPLOT ALL /SCATTERPLOT=(*ZRESID ,*ZPRED).
Resources	Processor Time	00:00:01.00
	Elapsed Time	00:00:00.86
	Memory Required	8032 bytes
	Additional Memory Required for Residual Plots	1768 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
Overall Emotional Attitudes to Mathematics	19.8086	3.86113	256

Pupil Gender	.4688	.50000	256
Pupil Favourite Subject	.4688	.50000	256
Ethnicity (White = 1 and BME = 0)	.6836	.46598	256
I am good at maths	.9492	.21998	256
I do maths at home	.7734	.41943	256
Parents help	.6094	.48885	256
Gender_Ability_Beliefs	.2070	.67454	256

Correlations

		Overall Emotional Attitudes to Mathematics	Pupil Gender	Pupil Favourite Subject	Ethnicity (White = 1 and BME = 0)	I am good at maths	I do maths at home	Parents help	Gender_Ability_Beliefs
Pearson Correlation	Overall Emotional Attitudes to Mathematics	1.000	-.055	.337	.058	.501	.237	-.189	-.010
	Pupil Gender	-.055	1.000	-.161	-.068	-.032	.097	.223	-.161
	Pupil Favourite Subject	.337	-.161	1.000	.100	.182	.134	-.146	.013
	Ethnicity (White = 1 and BME = 0)	.058	-.068	.100	1.000	.034	-.168	-.063	-.040
	I am good at maths	.501	-.032	.182	.034	1.000	.087	-.076	-.035
	I do maths at home	.237	.097	.134	-.168	.087	1.000	.102	.028
	Parents help	-.189	.223	-.146	-.063	-.076	.102	1.000	.068
	Gender_Ability_Beliefs	-.010	-.161	.013	-.040	-.035	.028	.068	1.000
Sig. (1-tailed)	Overall Emotional Attitudes to Mathematics	.	.191	.000	.179	.000	.000	.001	.435
	Pupil Gender	.191	.	.005	.140	.303	.061	.000	.005
	Pupil Favourite Subject	.000	.005	.	.054	.002	.016	.010	.415
	Ethnicity (White = 1 and BME = 0)	.179	.140	.054	.	.295	.004	.159	.260
	I am good at maths	.000	.303	.002	.295	.	.082	.113	.291
	I do maths at home	.000	.061	.016	.004	.082	.	.051	.329
	Parents help	.001	.000	.010	.159	.113	.051	.	.140
	Gender_Ability_Beliefs	.435	.005	.415	.260	.291	.329	.140	.
N	Overall Emotional Attitudes to Mathematics	256	256	256	256	256	256	256	256

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Gender_Ability_Beliefs, Pupil Favourite Subject, Ethnicity (White = 1 and BME = 0), Parents help, I am good at maths, I do maths at home, Pupil Gender[b]	.	Enter

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.603[a]	.363	.345	3.12478

a. Predictors: (Constant), Gender_Ability_Beliefs, Pupil Favourite Subject, Ethnicity (White = 1 and BME = 0), Parents help, I am good at maths, I do maths at home, Pupil Gender

b. Dependent Variable: Overall Emotional Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1380.088	7	197.155	20.192	.000[b]
	Residual	2421.533	248	9.764		
	Total	3801.621	255			

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, Pupil Favourite Subject, Ethnicity (White = 1 and BME = 0), Parents help, I am good at maths, I do maths at home, Pupil Gender

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	10.833	1.024		10.583	.000	8.817	12.849					
	Pupil Gender	.086	.414	.011	.208	.835	-.730	.902	-.055	.013	.011	.893	1.120
	Pupil Favourite Subject	1.606	.412	.208	3.895	.000	.794	2.418	.337	.240	.197	.901	1.110
	Ethnicity (White = 1 and BME = 0)	.384	.430	.046	.894	.372	-.463	1.232	.058	.057	.045	.953	1.049
	I am good at maths	7.626	.909	.434	8.390	.000	5.836	9.417	.501	.470	.425	.958	1.044
	I do maths at home	1.772	.486	.192	3.646	.000	.815	2.729	.237	.226	.185	.922	1.085
	Parents help	-1.153	.418	-.146	-2.755	.006	-1.977	-.328	-.189	-.172	-.140	.915	1.093
	Gender_Ability_Beliefs	.058	.296	.010	.195	.845	-.526	.641	-.010	.012	.010	.959	1.043

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Pupil Gender	Pupil Favourite Subject	Ethnicity (White = 1 and BME = 0)	I am good at maths	I do maths at home	Parents help	Gender_Ability_Beliefs
1	1	5.302	1.000	.00	.01	.01	.01	.00	.01	.01	.00
	2	.944	2.370	.00	.05	.00	.00	.00	.00	.00	.84
	3	.662	2.831	.00	.21	.35	.02	.00	.00	.08	.05
	4	.370	3.784	.00	.27	.33	.36	.00	.02	.02	.02
	5	.327	4.029	.00	.39	.00	.18	.00	.04	.49	.08
	6	.252	4.590	.01	.06	.30	.05	.01	.35	.35	.00
	7	.122	6.596	.05	.01	.01	.34	.14	.56	.02	.00
	8	.023	15.199	.94	.01	.00	.04	.84	.02	.03	.01

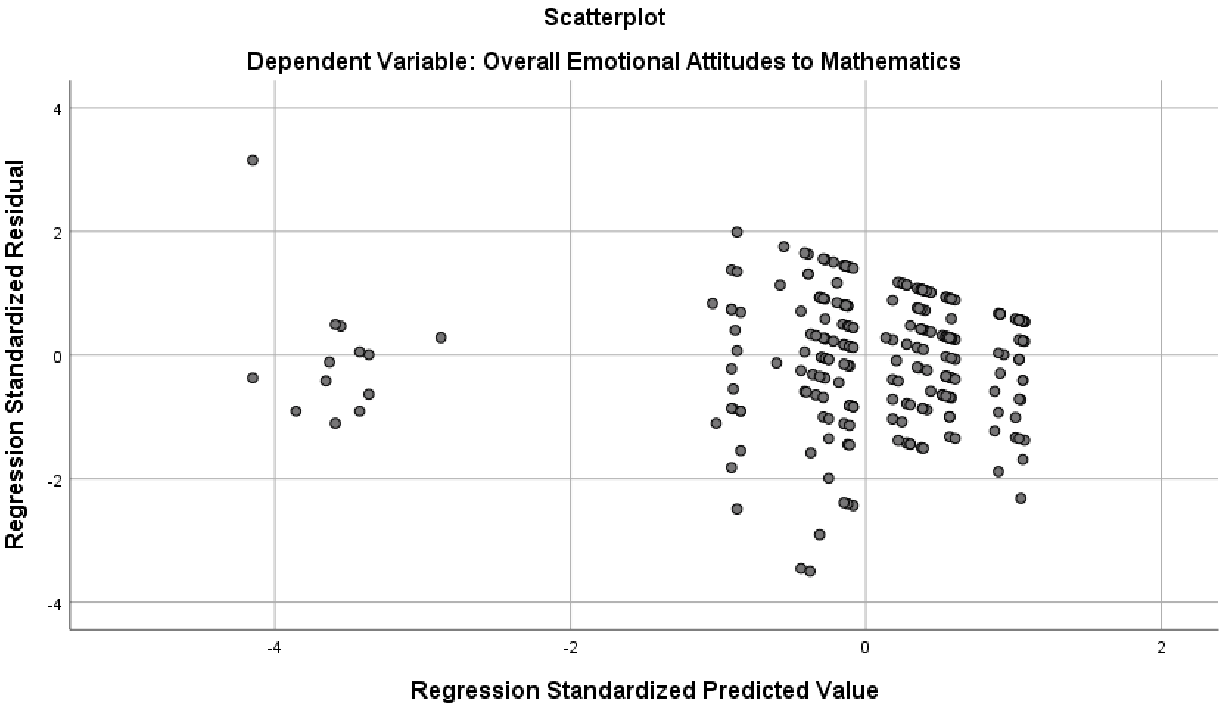
a. Dependent Variable: Overall Emotional Attitudes to Mathematics

Residuals Statistics[a]

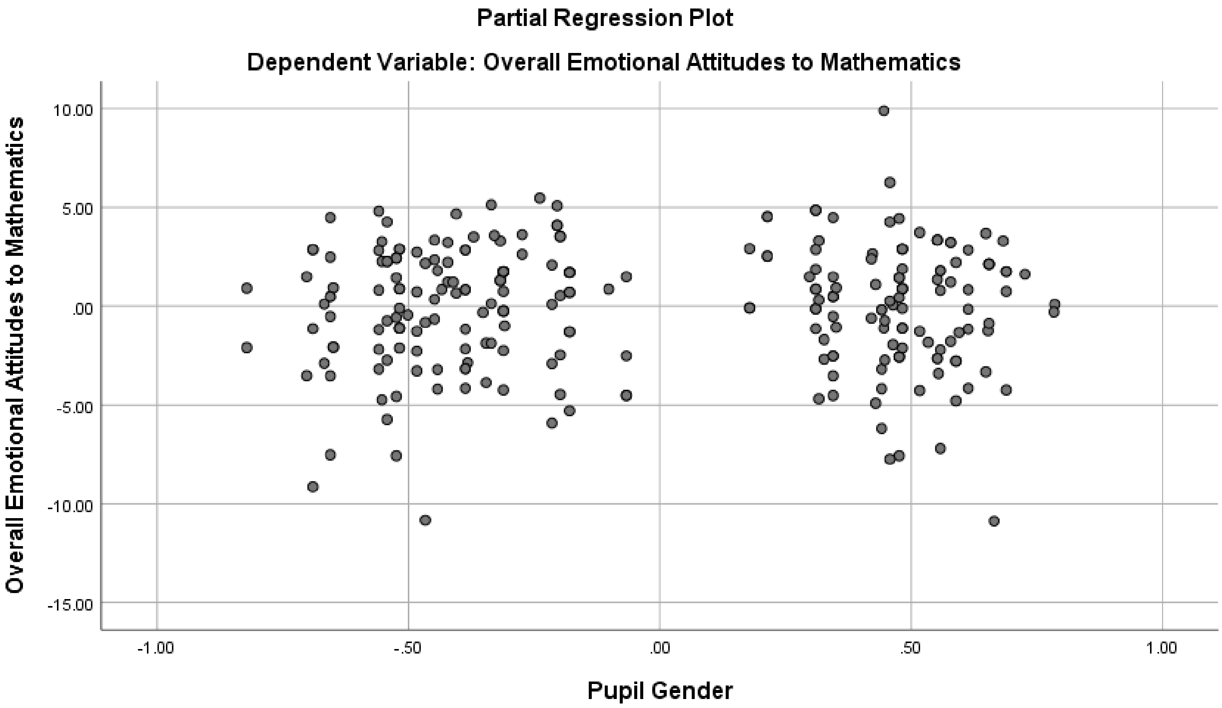
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	10.1514	22.3083	19.8086	2.32639	256
Residual	-10.93020	9.84863	.00000	3.08159	256
Std. Predicted Value	-4.151	1.075	.000	1.000	256
Std. Residual	-3.498	3.152	.000	.986	256

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

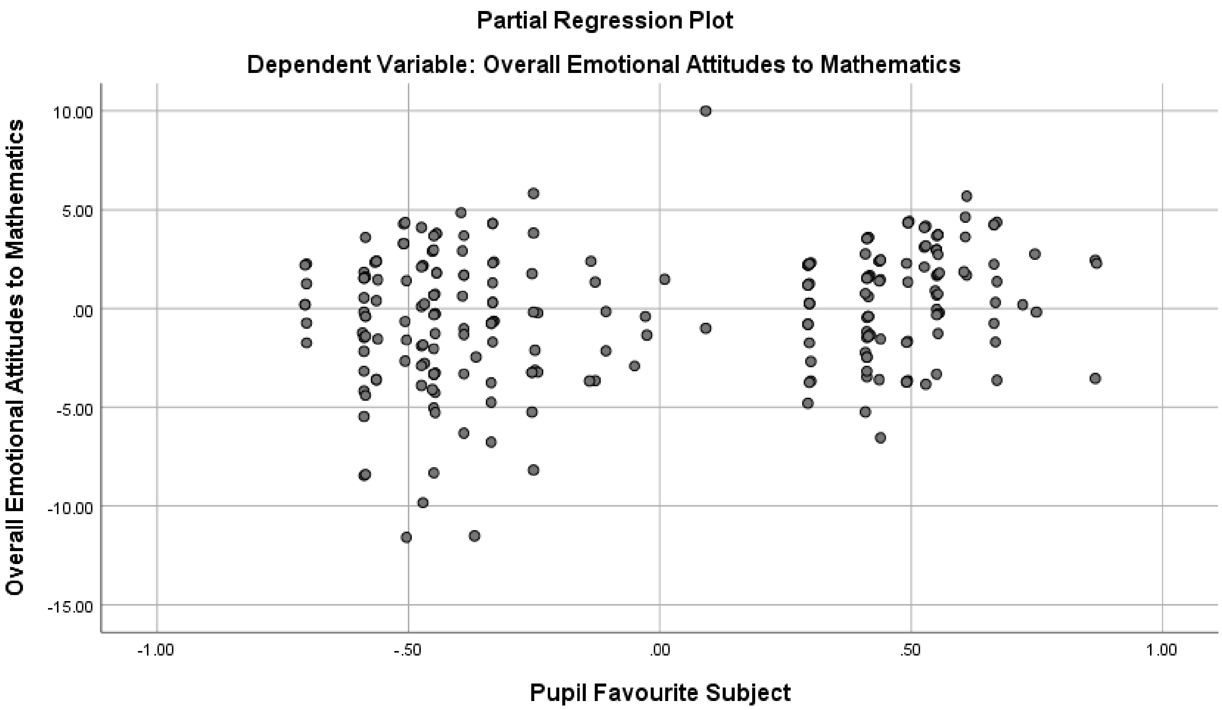
Charts

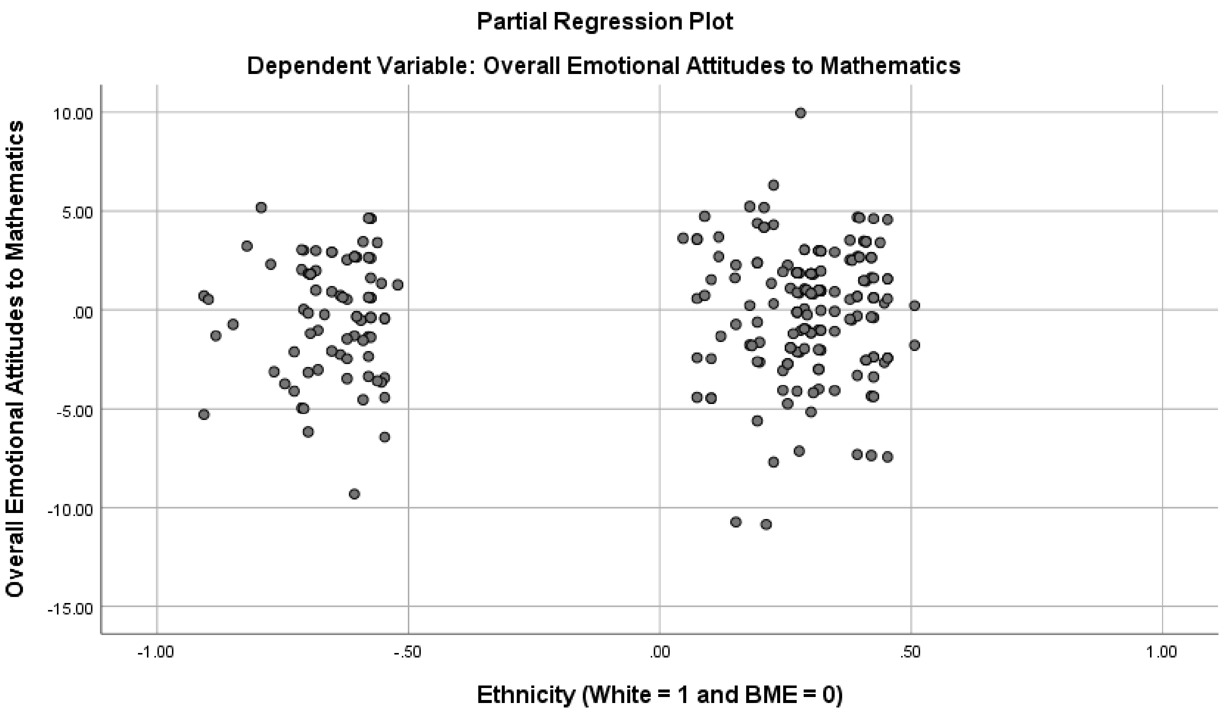


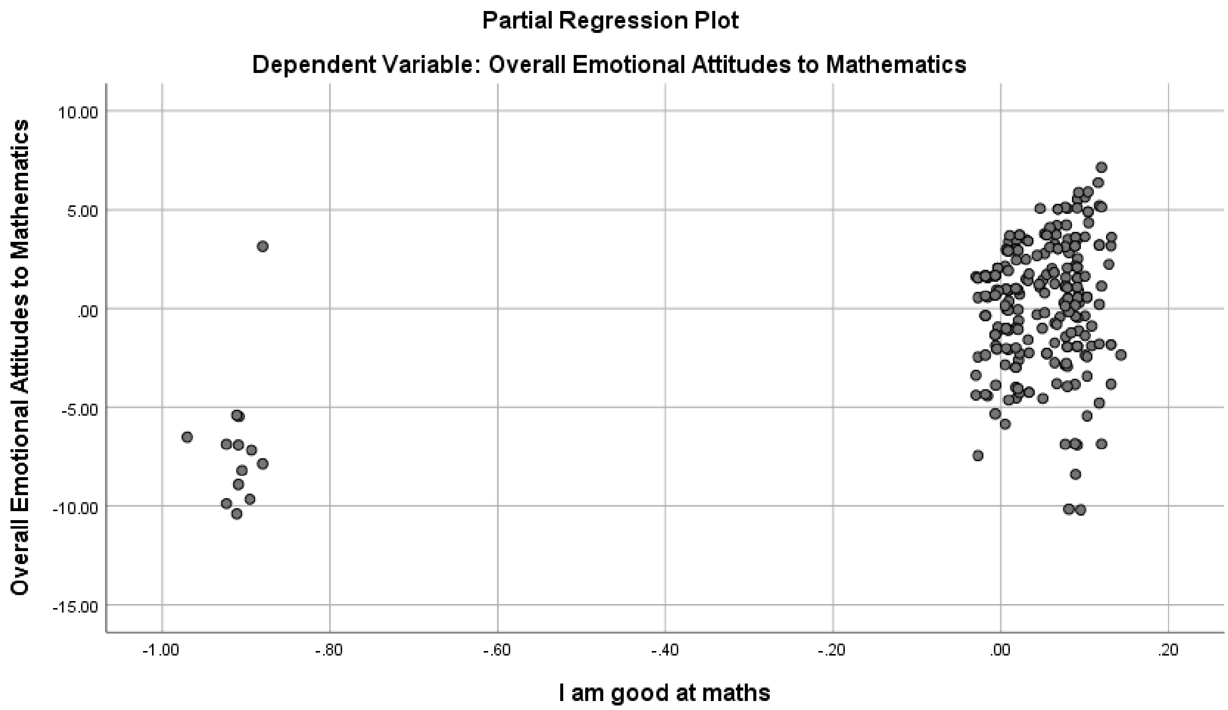
Scatterplot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Regression Standardized Residual
4
2
0
-2
-4
-4
-2
0
2
Regression Standardized Predicted Value

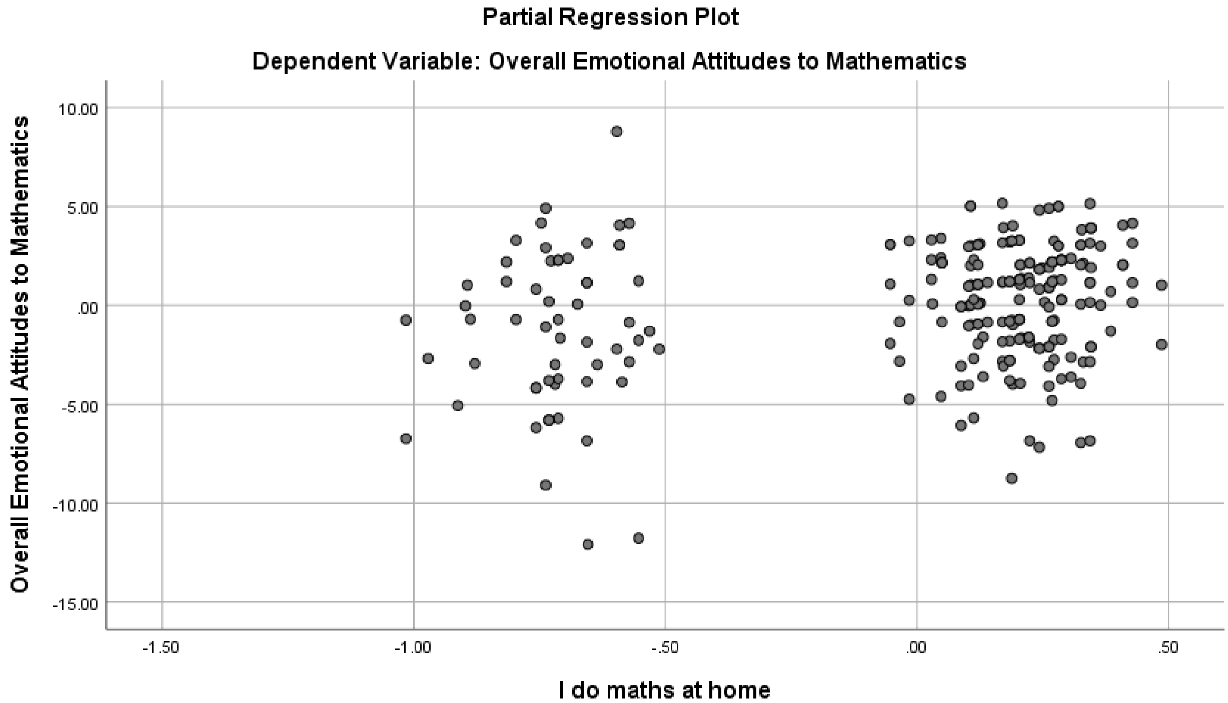


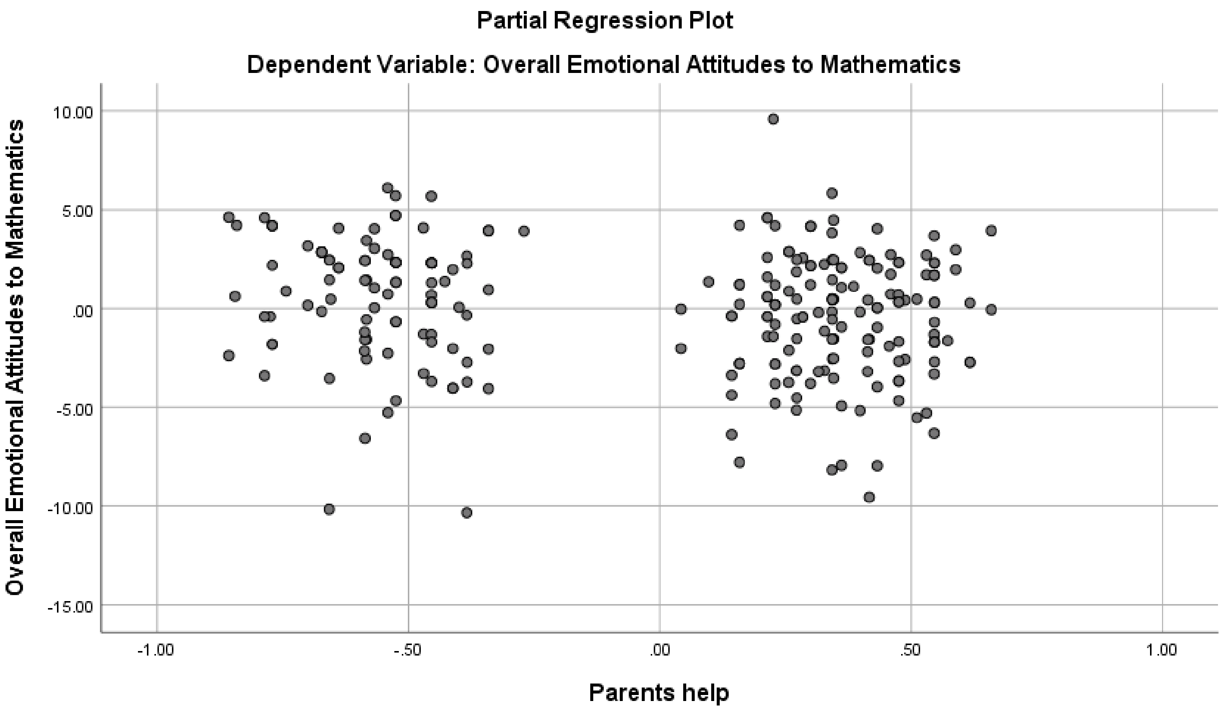
Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.00
-.50
.00
.50
1.00
Pupil Gender

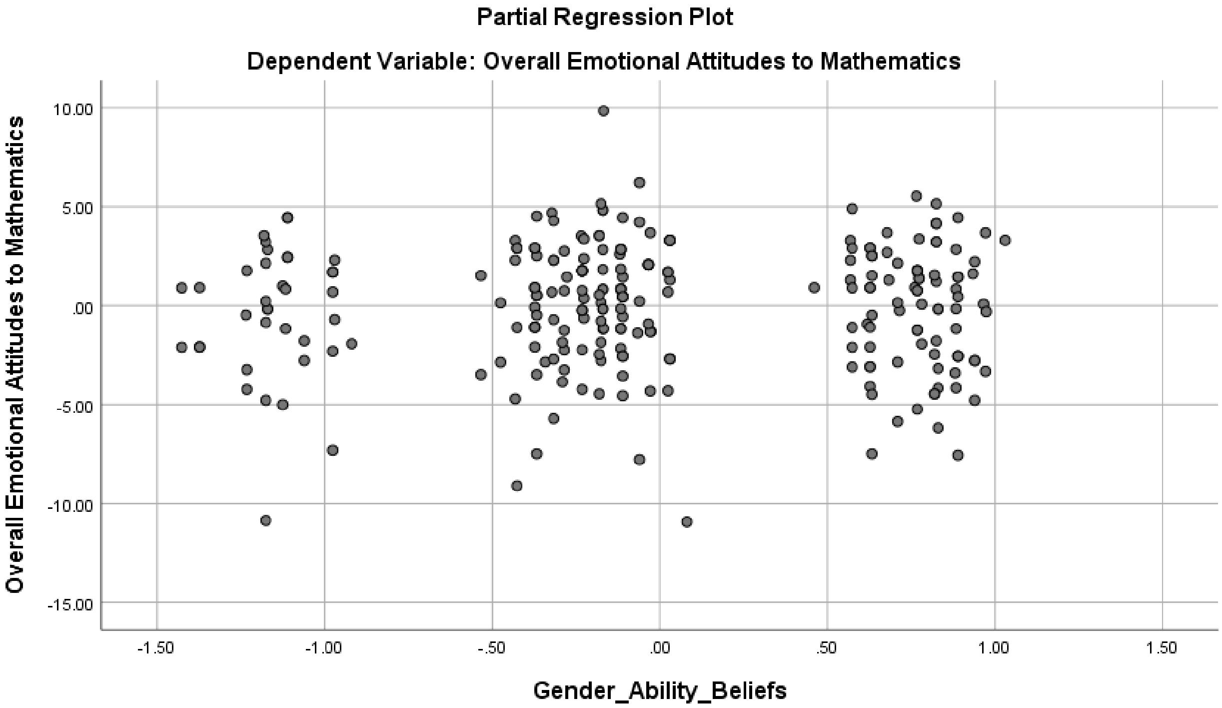

Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.00
-.50
.00
.50
1.00
Pupil Favourite Subject


Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.00
-.50
.00
.50
1.00
Ethnicity (White = 1 and BME = 0)


Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.00
-.80
-.60
-.40
-.20
.00
.20
I am good at maths


Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.50
-1.00
-.50
.00
.50
I do maths at home


Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.00
-.50
.00
.50
1.00
Parents help


Partial Regression Plot
Dependent Variable: Overall Emotional Attitudes to Mathematics
Overall Emotional Attitudes to Mathematics
10.00
5.00
.00
-5.00
-10.00
-15.00
-1.50
-1.00
-.50
.00
.50
1.00
1.50
Gender_Ability_Beliefs

Model 1.2.1: Model 1.2 without Self-Confidence

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Gender_Ability_Beliefs, Ethnicity (White = 1 and BME = 0), Parents help, I do maths at home, Pupil Favourite Subject, Pupil Gender[b]	.	Enter

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.456[a]	.208	.193	3.91091

a. Predictors: (Constant), Gender_Ability_Beliefs, Ethnicity (White = 1 and BME = 0), Parents help, I do maths at home, Pupil Favourite Subject, Pupil Gender

b. Dependent Variable: Overall Emotional Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1227.576	6	204.596	13.376	.000[b]
	Residual	4665.039	305	15.295		
	Total	5892.615	311			

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. Predictors: (Constant), Gender_Ability_Beliefs, Ethnicity (White = 1 and BME = 0), Parents help, I do maths at home, Pupil Favourite Subject, Pupil Gender

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	17.078	.715		23.884	.000	15.671	18.485					
	Pupil Gender	-.468	.471	-.054	-.993	.322	-1.396	.460	-.143	-.057	-.051	.883	1.132
	Pupil Favourite Subject	2.978	.465	.338	6.397	.000	2.062	3.893	.393	.344	.326	.931	1.074
	Ethnicity (White = 1 and BME = 0)	.618	.486	.066	1.273	.204	-.338	1.574	.085	.073	.065	.954	1.048
	I do maths at home	1.678	.544	.162	3.083	.002	.607	2.749	.155	.174	.157	.942	1.062
	Parents help	-1.493	.488	-.163	-3.060	.002	-2.454	-.533	-.220	-.173	-.156	.910	1.099
	Gender_Ability_Beliefs	.184	.337	.028	.546	.585	-.479	.847	.040	.031	.028	.963	1.039

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

Single Level Model with School ID (Dummy Coded) for BAM

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, Parents help, School_ID=2.0, School_ID=5.0, School_ID=10.0, Pupil Gender, School_ID=4.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0[b]	.	Enter

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.505[a]	.255	.217	10.37660

a. Predictors: (Constant), School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, Parents help, School_ID=2.0, School_ID=5.0, School_ID=10.0, Pupil Gender, School_ID=4.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0

b. Dependent Variable: Overall Behavioural Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10746.821	15	716.455	6.654	.000[b]
	Residual	31333.061	291	107.674		
	Total	42079.883	306			

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

b. Predictors: (Constant), School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, Parents help, School_ID=2.0, School_ID=5.0, School_ID=10.0, Pupil Gender, School_ID=4.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	43.630	2.828		15.428	.000	38.064	49.196					
	Pupil Gender	-3.084	1.288	-.131	-2.394	.017	-5.618	-.549	-.123	-.139	-.121	.848	1.179
	Pupil Favourite Subject	4.129	1.286	.172	3.210	.001	1.597	6.661	.229	.185	.162	.888	1.127
	Ethnicity (White = 1 and BME = 0)	-2.086	1.814	-.083	-1.150	.251	-5.657	1.485	-.046	-.067	-.058	.496	2.017
	I do maths at home	9.530	1.497	.353	6.366	.000	6.583	12.476	.380	.350	.322	.833	1.201
	Parents help	-2.169	1.298	-.089	-1.671	.096	-4.724	.386	-.101	-.097	-.085	.905	1.105
	Gender_Ability_Beliefs	.195	.922	.011	.212	.832	-1.619	2.009	.045	.012	.011	.906	1.103
	School_ID=2.0	2.234	2.458	.066	.909	.364	-2.605	7.072	.023	.053	.046	.491	2.035
	School_ID=3.0	8.223	4.103	.112	2.004	.046	.148	16.299	.102	.117	.101	.821	1.218
	School_ID=4.0	.818	2.653	.021	.308	.758	-4.404	6.040	.043	.018	.016	.549	1.822
	School_ID=5.0	-.188	2.601	-.005	-.072	.942	-5.307	4.931	-.033	-.004	-.004	.513	1.948
	School_ID=6.0	-2.793	3.440	-.048	-.812	.418	-9.563	3.977	-.058	-.048	-.041	.731	1.368
	School_ID=7.0	5.604	2.402	.172	2.333	.020	.876	10.332	.183	.135	.118	.469	2.133
	School_ID=9.0	.240	2.574	.006	.093	.926	-4.827	5.307	-.088	.005	.005	.537	1.861
	School_ID=10.0	-1.596	2.917	-.042	-.547	.585	-7.337	4.144	-.095	-.032	-.028	.442	2.265
	School_ID=11.0	-1.746	2.945	-.045	-.593	.554	-7.543	4.051	-.019	-.035	-.030	.445	2.246

a. Dependent Variable: Overall Behavioural Attitudes to Mathematics

Single Level Model with School ID (Dummy Coded) for EAM

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, School_ID=5.0, Parents help, School_ID=10.0, School_ID=4.0, Pupil Gender, School_ID=2.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0[b]	.	Enter

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.541[a]	.293	.257	3.75230

a. Predictors: (Constant), School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, School_ID=5.0, Parents help, School_ID=10.0, School_ID=4.0, Pupil Gender, School_ID=2.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0

b. Dependent Variable: Overall Emotional Attitudes to Mathematics

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1725.011	15	115.001	8.168	.000[b]
	Residual	4167.605	296	14.080		
	Total	5892.615	311			

a. Dependent Variable: Overall Emotional Attitudes to Mathematics

b. Predictors: (Constant), School_ID=11.0, Gender_Ability_Beliefs, Pupil Favourite Subject, School_ID=3.0, School_ID=6.0, I do maths at home, School_ID=5.0, Parents help, School_ID=10.0, School_ID=4.0, Pupil Gender, School_ID=2.0, School_ID=9.0, Ethnicity (White = 1 and BME = 0), School_ID=7.0

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	19.144	1.037		18.468	.000	17.104	21.184					
	Pupil Gender	-.462	.459	-.053	-1.007	.315	-1.366	.441	-.143	-.058	-.049	.857	1.167
	Pupil Favourite Subject	3.056	.455	.347	6.711	.000	2.160	3.952	.393	.363	.328	.895	1.117
	Ethnicity (White = 1 and BME = 0)	-.276	.652	-.030	-.423	.673	-1.560	1.008	.085	-.025	-.021	.487	2.054
	I do maths at home	1.412	.550	.136	2.568	.011	.330	2.493	.155	.148	.126	.850	1.177
	Parents help	-1.546	.472	-.169	-3.278	.001	-2.475	-.618	-.220	-.187	-.160	.896	1.116
	Gender_Ability_Beliefs	.029	.334	.005	.088	.930	-.627	.686	.040	.005	.004	.903	1.107
	School_ID=2.0	-1.279	.881	-.099	-1.452	.148	-3.013	.455	-.002	-.084	-.071	.509	1.964
	School_ID=3.0	.940	1.416	.036	.664	.507	-1.847	3.728	.072	.039	.032	.803	1.245
	School_ID=4.0	-2.048	.936	-.143	-2.187	.029	-3.891	-.205	-.054	-.126	-.107	.559	1.788
	School_ID=5.0	-1.659	.922	-.123	-1.800	.073	-3.473	.155	-.017	-.104	-.088	.508	1.968
	School_ID=6.0	-.588	1.229	-.027	-.479	.632	-3.006	1.830	.048	-.028	-.023	.749	1.336
	School_ID=7.0	1.023	.861	.083	1.187	.236	-.673	2.718	.183	.069	.058	.484	2.067
	School_ID=9.0	-2.150	.905	-.158	-2.377	.018	-3.931	-.370	-.091	-.137	-.116	.540	1.851
	School_ID=10.0	-3.089	1.070	-.206	-2.886	.004	-5.195	-.982	-.184	-.165	-.141	.467	2.140
	School_ID=11.0	-2.564	1.041	-.181	-2.463	.014	-4.613	-.515	-.077	-.142	-.120	.440	2.272

a. Dependent Variable: Overall Emotional Attitudes to Mathematics