"It's maths! Emotions don't come into it": Parents' modelling of mathematical affect

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A thesis submitted for the degree of

Master of Arts

at the University of Otago, Dunedin, New Zealand

2015
Abstract

Mathematical confidence has become increasingly important in our society because of the connection mathematics has with science and technology. Accordingly, the influence of affective factors in mathematics has become a significant focus in mathematics education research and within this, understanding the relationship between affective factors such as self-efficacy and mathematics anxiety. Social Cognitive Theory (Bandura, 1986) is a useful framework for understanding these factors. In this theory, learners do not learn in isolation but reflect and assimilate observed actions and interactions that are presented in their environments. Parents are a significant component of a learner’s environment and as such, play an important role in children’s learning and the development of self-efficacy (Anthony & Walshaw, 2007; Bandura, 1997). Research suggests that parental modelling of affective factors may relate to the development of maths self-efficacy and levels of emotional arousal of children (Jameson, 2014; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Vukovic, Roberts, & Green Wright, 2013).

This mixed method study aimed to explore the relationship between parents’ maths self-efficacy and emotional arousal to mathematics and their children’s maths self-efficacy and emotional arousal to mathematics. Reports of interactions and actions around the activity of mathematics homework provided opportunities to explore the transference of these affective factors through the act of modelling.

84 parent and child pairings from seven schools in the Otago/Southland region of New Zealand were represented in the study. The children in this study were 12-13 years old. A sequential explanatory design allowed for three phases of analysis: a quantitative, integration, and qualitative phase. No significant correlations were found when the parent’s variables maths self-efficacy and emotional arousal to mathematics, were correlated with the children’s variables maths self-efficacy and emotional arousal to mathematics. However, as a result of more in-depth analysis and consideration of emerging qualitative findings in the interactive research process, a significant positive correlation was found between fathers’ emotional arousal to mathematics and their children’s maths self-efficacy. Furthermore, for pairings who reported that the parent assisted with their children’s mathematics homework, a significant positive correlation was found between parents’ maths self-efficacy and children’s emotional arousal to mathematics. The findings from the qualitative phase suggested that the parents’ level of emotional arousal to mathematics affected their willingness to assist their children with homework. Parents who did assist were generally calm, and predominantly assisted by using techniques associated with positive engagement. Findings also suggested that fathers
were calmer and more likely to express more readiness to assist with mathematics homework. Implications from the study suggest directions for future research into possible intervention programs to increase the confidence and capability of parents in the area of mathematics activities in the home.
Acknowledgements

First of all, thank you to the students and parents who participated in the survey and shared their time, feelings and experiences. Their willingness to share, in many cases, painful experiences in mathematics has enriched both my thesis and my journey as a teacher. Many thanks also to the schools for taking part and to the teachers who enthusiastically encouraged participation.

Thank you to Naomi Ingram, my supervisor, whose tireless enthusiasm and support has steered me through this thesis. I am grateful for Naomi’s meticulous feedback and patience as I grappled with the intricacies of research. I have been so fortunate to have such a champion of the mathematics cause as a role model.

Thank you to Lisa Smith and Keryn Pratt for being available and willing to help me use and understand SPSS and statistical analysis. They have opened my eyes to an exciting world of statistics. To my comrades on the fourth floor, Lara, Keely, Sylvia, Kim, Lien, Byron and Rafaela. Their insight, support and friendship has been invaluable. Thank you also to Megan Anakin and Professor John Tarter whose pragmatism, humour and direction meant I was able to start my thesis with a flourish. Their questions kept me on my toes and I am so appreciative that they took an interest and cared to ask. Thank you also to Fiona Stuart who was a gem at the end of the thesis when I was faced with the daunting task of formatting.

Thank you to my parents, Ngaire and Denis Bartley, whose encouragement, support and love has propped me up throughout this thesis with opportunities for timeout, loving care and endless proofreading. To my sister Jessica for her encouragement and sense of humour, which has often had me in tears of laughter when I was too deep in seriousness. Thank you to Michael, Cerys, Jason, Dylan, Seren, James and Harry for all your support and love. Thank you to my dear friends and extended family for their interest and care.

Finally, a big thank you to the Renfrew-White Trust who so generously bequeathed the funding for the scholarship I was so privileged to receive.
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Chapter One – Introduction

Mathematics is a powerful social entity (Anthony & Walshaw, 2007). An individual’s perception and experience of mathematics can influence their engagement in activities that integrate mathematical concepts. As society recognises the increasing reliance and influence of mathematics in the areas of science and technology, thinking mathematically in the 21st Century has become essential. Succeeding in mathematics, and becoming a numerate member of society has been associated with both economic and social growth and prosperity in a landscape of neoliberal ideals (Ministry of Business Innovation and Employment & Ministry of Education, 2014). The mathematics community has recognised that succeeding at mathematics is not just about the classroom exercise involving pencil, paper, number lines and an infinite set of word problems. It is the confidence to explore and learn about the relationships in quantities, space, and data which help individuals to make sense of the world around them (Ministry of Education, 2007).

Mathematics is an affective process that has both social and emotional factors that are continually interacting. “Mathematics is often thought of as a purely intellectual and unemotional activity. Recently, researchers have begun to question the validity of this approach, arguing that emotions and cognition are intertwined” (Else-Quest, Hyde, & Hejmadi, 2008, p. 5).

In this introduction the New Zealand (NZ) mathematics education landscape will be described. This will include a brief exploration into government policies and initiatives that resonate with the growing emphasis on mathematics. The current rhetoric around mathematics in media will also be explored to emphasize the growing interest in mathematics and pedagogical practises beyond the domain of educators. Following this my own experience of mathematics, both as a learner and a teacher, will be shared to begin to illustrate how affective factors, especially emotional arousal to mathematics and mathematics self-efficacy, influences mathematics learning. Finally, a framework of the current study will be presented, along with some key definitions and the layout of the thesis.

Mathematics in the New Zealand Landscape

Mathematics, which includes Statistics, is a core learning area in the New Zealand Curriculum and a compulsory school subject up to and including Year Eleven (approximately 15 years of age), with many students continuing to take Mathematics and/or Statistics throughout senior secondary school. The rationale behind the inclusion of mathematics and statistics in the New
Zealand (NZ) curriculum is illustrated in the following statement from the NZ curriculum document:

Mathematics is the exploration and use of patterns and relationships in quantities, space, and time. Statistics is the exploration and use of patterns and relationships in data. These two disciplines are related but different ways of thinking and of solving problems. Both equip students with effective means of investigating, interpreting, explaining, and making sense of the world in which they live. (Ministry of Education, 2007, p. 26)

Away from the context of the classroom, the perceived importance of mathematics within the New Zealand (NZ) societal context led to the subject’s inclusion in the STEM (science, technology, engineering and mathematics) tetrad which has been connected both nationally and internationally to economic growth and prosperity (Ministry of Business Innovation and Employment & Ministry of Education, 2014). The NZ government has acknowledged this association particularly in its document A Nation of Curious Minds, “Internationally, it is recognised that STEM skills underpin the development of new practices and technologies, the application of existing technologies and the development of new high-value products and services” (Ministry of Business Innovation and Employment & Ministry of Education, 2014, p. 16).

In a survey conducted by the Ministry of Business, Innovation and Employment, 90% of participants recognised the importance of studying STEM subjects at school, and reported the importance of science and technological innovation in being internationally competitive (Joyce & Parata, 2014).

The New Zealand government has supported the growth in participation in STEM subjects through fiscal initiatives. For example in 2013, $10 million was given to projects to increase the mathematics and science skills of teachers (Johnstone, 2013). Along with nurturing mathematics and the other STEM subjects through increased funding, the government has also put significant funding into financial literacy. In December 2014, $500,000 was given to initiatives to develop financial literacy in youth under the assumption that increased understanding of financial skill would drive the country to be more prosperous (Kaye, 2014). Headlines like Financial literacy way out of poverty (The New Zealand Herald, 03/08/2014) and Teaching Kids how to Manage Money (Manawatu Standard, 03/09/2014) echo the rhetoric espoused by the government and tertiary institutions.
Indeed, so great has been the interest in developing financial literacy skills that recommendations have been made to schools for the inclusion of financial skills in the curriculum (Parker & Mason, 2014; Townsend, 2014). At primary school level, recommendations include fostering the concept of earning and spending, and wants and needs. The concept of consumer choice is also included within recommendations for primary aged children (Townsend, 2014). Carpena, Cole, Shapiro and Zia (2013) argue that financial literacy has three dimensions, numeracy, basic financial awareness, and attitudes toward financial decisions. They define numeracy in the context of financial literacy “as those skills that involve calculating interest rates, adding income, and similar computations” (Carpena et al, 2013, p.8). In this line of argument, numeracy skills are an essential dimension of financial literacy.

The performance of NZ students in mathematics has increasingly come under the spotlight. One such example is the Organisation of Economic Cooperation and Development’s (OECD) PISA assessment program. The OECD Programme for International Student Assessment (PISA), in which NZ participates, gives an indication of how 15 years old students are achieving in mathematics, science and reading. Testing occurs tri annually and in 2012, a special focus was placed on mathematical literacy. PISA scores are used internationally to drive policy and curriculum change but they are not without criticism. Kreiner and Afdeling (2010), for example, questions the use of the Rasch model in determining plausible student average scores. However, the PISA results are dissected and often become the focus of significant media comment.

The PISA results for 2012 concluded that the NZ average in mathematics performance had dropped, continuing a declining trend that began in 2003. The NZ average summed score in 2003 was 523 but this dropped to an average summed score of 500 in 2012. The greatest decline was experienced between 2009 and 2012 (May, Cowles, & Lamy, 2013). This result in 2012 placed NZ in 23rd position across the participating OECD countries, still above the OECD average of 494, but down eleven places from the previous study in 2009. Significantly, in 2012, 23% of NZ students scored below level two on the PISA scale. Level two is the level deemed necessary for an individual to have the mathematical skills to function successfully in everyday tasks (May et al., 2013).

Other notable findings from PISA 2012 connected to the current discussion, are the findings related to student behaviour. In 2012, 40% of all NZ students reported disruptive behaviour (significant noise during lessons, disorder and inattention) in most or every mathematics
lesson (Lamy & May, 2014). Significantly, 12% of students also reported skipping one to two
classes in the two week period prior to the administration of PISA (Lamy & May, 2014). New
Zealand stood out from other participating countries because of a strong association between
lower achievement and skipping classes.

Unsurprisingly, NZ media reported these findings in an alarming fashion with headlines such
as The New Zealand Herald ‘NZ kids slip in world maths rankings’ (Carnegie, 2014), and the
Sunday Star Times headline ‘Time to panic over maths?’ (Dudding, 2013). Criticism has been
directed at teaching practices and new initiatives such as the NZ Numeracy Project. The
Numeracy Project, a Ministry of Education initiative that began in 2002, is a significant
component of the primary schools mathematics program and is part of the Number/Algebra
strand of the NZ mathematics curriculum. Emphasis in the Numeracy Project is placed on
both the strategies and knowledge used to build mathematical competence. A diverse range of
the population has weighed into the debate about the state of mathematics education in NZ.
For example, the following statement by celebrity chef Allyson Gofton, “Learning seven
strategies takes valuable time away from getting the answers right” (Gofton, 2013), or the
following statement reported prominently in the Manawatu Standard.

The report released by the Education Review Office (ERO) into children’s
mathematics education has found that New Zealand schools lag internationally and
nearly half could improve their numeracy teaching of Years 4 to 8 pupils, labelling 50
percent of schools “partially effective”. (Shadwell, 2013, p. 5)

One area of mathematics education research that is infrequently reported in the public arena
when compared to the attention given to mathematics performances, is affect. This is in spite
of research directly linking disengagement and avoidant behaviour to aspects of the affective
domain such as anxiety and self-efficacy (Grills-Taquechel, Fletcher, Vaughn, Denton, &
Taylor, 2013; Hirvonen, Tolvanen, Aunola, & Nurmi, 2012; Pajares & Kranzler, 1995;
Tobias, 1993). Indeed, my own mathematical journey anecdotally typifies the mathematical
journey of many with periods of avoidant behaviour and anxiety.

My Own Mathematical Journey

My primary school years were a blissful journey of open plan classrooms, mathematics
lessons in make-shift shops in the classroom and Cuisenaire rods. I remember as I approached
the end of primary school, the book ‘Family Maths’ (Stenmark, Thompson, & Cossey, 1986)
coming home with my father after a school committee meeting. Dad, being an engineer, was
always enthusiastic about mathematics and eager to assist whenever he could. Soon we had
camera film canisters filled with dried beans everywhere. I remember one activity being called ‘Three Bean Salad’ which my younger sister worked through with Dad. Until I went to boarding school when I was 16, Dad always assisted with mathematics homework, and I remember the joy he would get from working out questions, whilst explaining it to me in relation to oil tanks and pipelines.

The only significant memory of mathematics at intermediate school (Years Seven and Eight) was the daily timed multiplication grids which I felt I was terrible at, and Mum’s endless efforts with me to learn my times tables. I remember charts on walls in the kitchen, quick-fire rounds in the car, and rewards for learning each set. Unfortunately, none of these efforts resulted in better results in the dreaded daily grids.

My lasting memories of secondary school mathematics are few and far between by choice. However, two vivid and perhaps seminal memories involved two different teachers which provoked a dichotomy of feelings and responses in my teenage self. In my fifth form year (Year 11, aged 15) I had a teacher who was passionate about mathematics who, although being traditional in methods, engaged me in mathematics. The previous year I had spent my time in mathematics class gossiping, pontificating and avoiding mathematics activities at all cost because I had lost my way with the learning, and became bored. My fifth form teacher (Year 11) often referred to separating the sheep from the goats when describing the examination questions. I realised on some level that this referred to student achievement and it struck a competitive cord in me but I also remember half expecting to see a perimeter problem featuring a pen with sheep and goats. I got through School Certificate and was a solid student. Mathematics didn’t scare me but it didn’t enthral me either. I was a sheep with some hidden aspirations to be a goat but I wasn’t going to work hard at it because I was not sure if it was attainable.

In Sixth Form (Year 12) I shifted to a private school in the city. On the first day of school the Head of Mathematics gathered the whole form on the cricket field and then got us to line up according to our school certificate examination mark. At somewhere in the 60-70% mark I didn’t think I was doing too badly until I realised that at the far end of the field, at the opposite end from the scholars, were my peers. The scholars were marched off followed by the average achievers and then last and definitely least my cohort, the “mathematically challenged”, the “dumb kids”, the “strugglers”. Fortunately, the mathematically challenged class were blessed with a sensitive and responsive mathematics teacher and after six weeks I
was promoted to the average stream. This was the beginning of a new chapter in my mathematics career which was turbulent to say the least.

My new teacher had a PhD in mathematics. When asked, he happily confided that he had got 100% in both School Certificate and University Entrance examinations. His success in school mathematics did not translate to his teaching. He taught by talking to the blackboard about what he considered to be the most exciting calculation that was occupying our attention or not. His enthusiasm for formulas and calculations were not contagious and I struggled. My avoidant behaviours re-emerged with vengeance. It started with gossiping and other in-class avoidance strategies, but then it ramped up a notch to mathematics truancy. I was occupying the stair wells and skipping mathematics class to visit the office, the library, my smoking friends, the noticeboard – anything was more appealing than mathematics and the drowning feeling that went with copying copious examples and notes, which could have been a foreign language to me. At the end of sixth form he wrote … “It is illogical for Sarah to continue with maths”. Although anticipated, this was a blow to me – the sheep who once had aspirations to be a goat, and who still felt the importance of ‘doing’ mathematics. In spite of this, I choose to take Statistics in the seventh Form, and found myself once more in the same teacher’s class.

One day, my teacher displayed our results from a mathematics test to the class to demonstrate normal distribution. I was discussing with the “rugby heads” at the back of the class which of us was the left tail, when my mathematics teacher asked the question that redirected my attention for the rest of the year and beyond. “If anyone can suggest a better way of teaching this, please put your hand up?” Unsurprisingly, I had a few inappropriate suggestions at the time, but this question was the unconscious beginning of my journey to be a teacher.

My memories of learning mathematics are vivid and the feelings of inadequacy, of frustration and of drowning are potent as I reflect on these experiences. In some way these feelings have deepened and matured with distance. The feelings returned when I was faced with the prospect of sitting the entry mathematics test for primary teacher training. This time the stakes were higher. If I did not pass it would restrict my choices. My anxiety was very real. To be a primary teacher I had to teach mathematics and being a perfectionist, I had to do it well and love it, or at least pretend too.

As a teacher, when I discussed a student’s progress in mathematics in parent interviews, I would often hear from parents “our family isn’t good at mathematics. It isn’t our thing” or “I was terrible at the subject and I always hated it”. This was often followed by a recollection of
a humiliating experience in a mathematics class or a description of the “worst maths teacher in the world”. I could relate to this but what bemused me was that it was often said in front of their children. This view was so different from my own experience of mathematics at home with my parents as I could not imagine my mother or father saying this to a teacher in front of me.

At one stage in my teaching career, I was the middle school co-ordinator of mathematics at a private school in London. This meant I was a full time mathematics specialist responsible for the students who struggled in mathematics. On my first day in this role, in the store room that had been converted into the remedial mathematics room, I was faced with eight very pale and worried looking ten year olds. As I started my lesson any remaining hope drained from their little faces and was replaced with sheer terror. In that year there were tears, temporary facial paralysis, lots of heads on tables and dizziness, along with cries of “I just can’t do this”, “my brain just shuts off” and “this is just horrible”. During the year I began to suspect that the students did not struggle purely because of a cognitive processing issue, they were also dealing with something deeper. There was something psychological in the way the students responded with such anxiety and fear. Over the next five years I regularly saw varying degrees of this response and noticed the frequency of visits to the bathroom, rescheduled music lessons, and the sudden desperate need to go to the school sickbay, or school counsellor. I knew these signs well because of my own experiences. These were avoidance and disengagement responses associated with anxiety towards mathematics.

Affect in Mathematics Education

The affective domain was described in the 1950’s as one of the three domains in Bloom’s taxonomy of thinking behaviours (Forehand, 2010). Variables within affect have included attitudes, beliefs, emotions, valuations, and motivations. Clear definitions are essential when researching aspects of the affective domain. However, literature in the field of the affective or affect, as it will be referred to in this discussion, is fraught with debates around definitions and boundaries (Hannula, 2014; Hart, 1989; Leder & Grootenboer, 2005). One view of the debate around definition stems from how these variables are recognised as independent or dependent variables. The interwoven nature of the affective variables leads to ambiguity. For this discussion, the following generic definition of affect will be used as it accommodates a more inclusive range of affective variables. “Affect relates to and/or encompasses a wide range of concepts and phenomena including feelings, emotions, moods, motivation, and certain drives and instincts” (Corsini, 1994 p. 36).
Regardless of how affect in mathematics is defined, the need for research into how this is connected to the mathematical learning is warranted (Leder & Grootenboer, 2005). Furthermore, the factors which contribute to the development of specific variables within affect that may increase/decrease mathematics engagement need to be explored.

Albert Bandura’s Social Cognitive Theory (Bandura, 1986) provides a framework that demonstrates how environments, behaviours and personal factors interact and influence each other. Within this framework, school and home environments interact through engagement in activities such as homework (behaviour) and is mediated by participants’ affective variables, such as mathematics self-efficacy (Mathematics self-efficacy will be shortened to maths self-efficacy from here onwards) and emotional arousal to mathematics (personal factors). The nature of this interaction is what is being explored in this thesis. The school environment and particularly the interactions of the teacher within the mathematics class are crucial components of this triadic system. There has been significant research into the relationship between school environment and student engagement and mathematics self-concept, identity, and mathematics self-efficacy (e.g. (Boaler, 2012; Fast et al., 2010; Griggs, Rimm-Kaufman, Merritt, & Patton, 2013; Ingram, 2008; Skovsmose, 2012)). There has been less research into the relationship between the home environment factors, such as parental attitudes to mathematics and children’s affective factors, such as maths anxiety, which in turn may affect mathematics engagement (Else-Quest et al., 2008; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). The aim of the current study is to explore one aspect of this relationship. Specifically, this study will explore the relationship between parental modelling of maths self-efficacy and emotional response to mathematics (the home environment) and their children’s maths self-efficacy and emotional response (personal factors).

The two specific affective variables explored in this study are mathematics self-efficacy and emotional arousal to mathematics, specifically anxiety. A broad definition of these two variables will be presented here, but a more in depth description will be provided in Chapter two.

Self-efficacy is a construct that was initially theorised by Bandura who defined self-efficacy as “people’s belief about their capabilities to exercise control over events that affect their lives” (Bandura, 1989, p. 1175). Identifying self-efficacy levels in students can be used to predict the persistence in challenging subjects, a category mathematics frequently falls under (Griggs et al., 2013). Specifically, in this study, we will explore perceived mathematics self-efficacy which Bandura defines as “a person’s judgements of their capabilities to organise and
execute courses of action required to attain designated types of performance” (Bandura, 1986, p. 391).

Anxiety is an “unpleasant emotion of fear which is directed towards an expected outcome in the future” (Hannula, 2014, p. 1). An anxious response to mathematics can be defined as a state rather than trait response, in that it is an acute emotional response of fear to a perceived specific threat (Hannula, 2014; Hart, 1989), that threat being mathematics. The definition of mathematics anxiety, or maths anxiety (MA) as it is commonly referred to, is contested as are other aspects of affect. Ashcraft defines MA as “a feeling of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002). However, an earlier definition constructed by Richardson and Suinn (1972) will be used in this discussion as it gives a broader context that is inclusive of everyday activities: “Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551).

MA was initially measured using mathematical assessment tools with attitudinal questions around liking or disliking mathematics (Hart, 1989). In this regard MA was considered a variant of attitude. However, a more evolved understanding of the nature of MA suggests that it is an affective or emotional response (Hart, 1989) and this is how MA will be classified in this discussion.

**Research Question and Hypotheses**

The overarching research question for the current study is:

- How does parental modelling of maths self-efficacy and emotional arousal to mathematics relate to the perceived maths self-efficacy and emotional arousal of their children?

The specific hypotheses explored in the quantitative section are:

1. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ maths self-efficacy.
2. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ emotional arousal to mathematics.
3. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ emotional arousal to mathematics.
4. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ maths self-efficacy.

The design for this study is sequential explanatory mixed methods, so quantitative and qualitative data were collected. The sequential explanatory mixed methods design aims to “use a qualitative strand to explain initial quantitative results” (Creswell, 2011, p. 82). One of the advantages of sequential explanatory mixed methods is the integrative nature demonstrated through the second phase, the integration phase, which allows for the exploration of anomalies found within the quantitative data. A full description of the methodology is presented in chapter three. However, as a result of the quantitative findings, the following questions were explored in the third phase of analysis, the qualitative phase, which explore in more depth the nature of parental modelling in the context of mathematics homework.

1. Why do some parents not assist with mathematics homework?
2. How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?

**Organisation of the Thesis**

In Chapter Two the literature in the fields of parental beliefs and involvement in mathematics, mathematics anxiety and mathematics self-efficacy will be discussed in relation to Social Cognitive Theory and Self-Efficacy Theory, the underpinning theories in this study. In Chapter Three, pragmatism is presented as the underpinning philosophical approach which has driven the methodological design choices in the study. A description of the current research follows and includes the participant determination pre-study and the pilot study. Chapter Four is made up of three sections of results. The first section is the quantitative phase, the presentation of the quantitative findings from the study. The second section is the integration phase, which discusses the quantitative findings in relation to literature, presents the anomalies within the data, and suggests some explanations for further exploration in the third phase. The third and final section is the qualitative phase. During this phase qualitative responses will be analysed, in relation to the questions identified in the integration phase, and discussed in relation to literature. Finally, in the concluding chapter, the findings are summarised, the limitations of the study are discussed, and future directions presented.
Chapter Two – Literature Review

Meaningful engagement in mathematics is the inducement for affective research in mathematics education, as discussed in Chapter One. In the current study, Social Cognitive Theory and its emphasis on the triadic interaction between environmental factors, personal factors and behaviour, is the vehicle to explore specific interactions which facilitate or hinder engagement, with the child, as mathematics learner, placed at the centre. A child’s maths self-efficacy and emotional response to mathematics are the specific factors considered within personal factors. Parent maths self-efficacy and emotional arousal to mathematics are the specific factors within the child’s home environment. The actions and interactions associated with doing mathematics homework are the behavioural contexts that also provide a point of interaction between the parent and child. In this chapter each of these factors will be explored in relation to research and literature, and where apparent, gaps will be described that justify the direction of the current study.

Social Cognitive Theory

Social Cognitive Theory (SCT) recognises the reciprocal influence of the environment and an individual’s personal agency, in regard to control over internal cognitive and affective processes on behaviour. Furthermore, SCT theorises that people learn through observing, imitation and modelling:

Social Cognitive Theory suggests that people are not merely products of their environment, nor are they simply driven to behave as they do by internal forces. It suggests that behaviour results from reciprocal influences among the environment (both social and physical), personal factors (thoughts, feelings, perceptions), and the individual’s behaviour itself. (Kauffman & Landrum, 2013, p. 86)

Personal factors can be described as the cognitive and affective processes that filter and direct the intent of the individual (Bandura, 2001; Kauffman & Landrum, 2013). Cognitive processes include the knowledge and skills utilised by an individual, such as acquisitional skills, working memory and spatial awareness. Affective processes or variables include the beliefs, attitudes, values and expectations that amongst other things motivate behaviour. In the current study the specific personal factors examined are maths self-efficacy and emotional arousal to mathematics, with a particular focus on maths anxiety.

Environmental factors can be described as the external influences and variables that are attributed to varying settings and circumstances (Bandura, 1986). The school environment in
all its multifaceted complexity provides many variables that influence and are influenced bidirectionally within an individual’s triadic system. The home environment is another complex system that makes a similar contribution to an individual’s triadic system. Examples of specific environmental variables include classroom climate, teachers’ personal factors, parental personal factors and school curriculum priorities and policies. In the current study the specific environmental factors explored are parental maths self-efficacy and emotional arousal to mathematics.

Behaviour is the way an individual acts or conducts themselves in response to environmental factors. This can include mathematics performance, mathematics avoidance, and classroom behaviour.

Bandura describes the interaction and influence on, and between the individual, and the social system that they function in, as reciprocal determinism (Bandura, 1977, 1986, 1997). Figure 1 illustrates this interacting triadic model.

Figure 1. Bandura's triadic model of reciprocal causation.

Bandura coined this structure of causation ‘triadic reciprocal causation’. However, it is not to be assumed that all factors are given equal footing. The strength of influence and effect is determined by the situation and circumstance at any particular time (Bandura, 1997).

Within the current study the interaction between specific personal affective variables relating to mathematics and the home environment, specifically parents and their own system of affective variables, will be explored and discussed in relation to actions and interactions associated with doing mathematics homework the behavioural variable. Figure 2 illustrates the model in relation to the current study.
There are a multitude of factors within the environmental and personal components that have been explored in mathematics education research, especially with consideration to engagement (e.g., (Griggs, Rimm-Kaufman, Merritt, & Patton, 2013; Hannula, 2014; Ingram, 2008, 2011; Lee, 2009; Mason & Davis, 2013; Skovsmose, 2005, 2012)). In the following sections a description of each factor, specific to this study is given with a discussion around theory, literature and research.

**Maths Self-Efficacy**

Maths self-efficacy is one of the personal factors in the triadic model that is relevant to the current study. It is also one of the environmental factors when a parent’s mathematics self-efficacy is considered. This discussion will begin with an outline of Bandura’s Self-Efficacy Theory.

**Self-efficacy theory.**

Self-efficacy (SEFF) is an individual’s sense of control over the circumstances of their life. (Bandura, 1986), or more specifically “people’s judgements of their capabilities to organise and execute a course of action required to attain designated types of performances” (Bandura, 1986, p. 391). SEFF is a variable that functions under personal factors in the SCT triadic model. SCT holds the view that self-reflection is a fundamental aspect of personal agency.
(Bandura, 1997). Through the process of self-reflection, people can challenge and alter their thinking patterns and behaviour.

Efficacy expectations influence the time commitment given to a task and the effort exerted. Higher efficacy expectations result in greater exerted effort. Efficacy expectations differ from outcome expectations which are the conviction that a particular behaviour will lead to a certain outcome (Bandura, 1977; Schunk & Pajares, 2009). Within a school context, efficacy expectations also influence the choices made and interest in particular school subjects (Bandura, 1977; Schunk & Pajares, 2009). Efficacy expectations vary in strength and magnitude depending on the task at hand and the nature of the development of the expectation. For example, children may feel a lack of confidence about approaching new learning around fractions despite successfully completing a division task or, an adult might baulk at the prospect of having to solve an algebra equation that they were expected to have learnt at high school.

Efficacy expectations are task specific, and affective scales that use generalised self-efficacy questions to determine self-efficacy across a school subject such as mathematics for example (i.e. items such as *I feel confident in maths*), are argued to be inappropriate and not rigorous when determining levels of self-efficacy (Pajares & Miller, 1995; Schunk & Pajares, 2009). This will be discussed later in the Section *Maths Self-efficacy Research* when discussing Mathematics Self-efficacy Research. Efficacy expectations are established and nurtured through the cognitive processing of four components; mastery experiences, vicarious experiences, verbal persuasion, and emotional arousal (Bandura, 1977, 1989, 1997; Pajares & Kranzler, 1995a; Schunk & Pajares, 2009).

**Mastery experiences.**

A mastery experience refers to the successful performance of a task (Bandura, 1977). For example, within the mathematical domain of measurement, a mastery experience could be the successful completion of a task which asks the student to work out the distance between two points on a map. The successful completion of this task or mastery experience increases the student’s self-efficacy and this success will be retrieved when they are faced with a similar task in the future. It is argued that mastery experiences have the strongest influence on self-efficacy (SEFF) (Schunk & Pajares, 2009).

Indeed, the significance of the failure on the individual’s self-efficacy is dependent on the timing and the patterns of experiences (Bandura, 1977). If the failure comes during the development of a specific efficacy expectation and it follows a series of failures, then this will
lower SEFF. If on the other hand it is a one off and the student works through the task to establish where they made the error, then this can have the reverse effect on SEFF as the student has made a self-correction which reinforces higher SEFF. When efficacy expectations are low for a particular task this can lead to avoidance that in turn may perpetuate a vicarious cycle as without successful mastery experiences, SEFF cannot develop and increase.

**Vicarious experiences (modelling).**

Vicarious experiences or modelling refers to individual’s observing others perform tasks successfully (Bandura, 1977, 1997). The person performing the task could be a peer with similar abilities or age, or someone with a significant connection to the individual, such as a family member.

Seeing others perform threatening activities without adverse consequences can generate expectations in observers that they too will improve if they intensify and persist in their efforts. They persuade themselves that if others can do it, they should be able to achieve at least some improvement in performance. (Bandura, 1977, p. 197)

Modelling is a powerful factor in learning new behaviours. Chosen models, whether chosen consciously or unconsciously, influence the beliefs of the individual as new information and responses can be observed that are outside the current repertoire of the individual (Bandura, 1997). Students observe the behaviours and outcomes of peers, teachers and parents and these serve as models, which the students interpret according to their own sets of beliefs (Ingram, 2011). In the field of phobia and other specific anxiety disorders modelling is seen as an effective treatment (Al-Kubaisy et al., 1992; Bandura, 1977). However, modelling can be both a positive influence and a negative influence. Experience in the classroom and literature in the area of teaching fractions shows fear approaching fractions, even when it is the first exposure to the more complex concepts such as adding mixed numerators (Wu, 2008).

**Verbal persuasion.**

Verbal persuasion is the direct encouragement to and support of completing a task successfully, from others such as peers and teachers (Lopez & Lent, 1992). Persuasion has a moderate influence on SEFF (Bandura, 1977). Persuasion has a significant role in both the classroom and home environment, “People are led, through suggestion, into believing they can cope successfully with what has overwhelmed them in the past” (Bandura, 1977, p. 198). Negative persuasion has just as much influence on SEFF as positive persuasion. Peer and societal beliefs around mathematics may play a role in the nature of persuasion, such as the
myth about mathematics being an innate ability or individual’s being born with a mathematics mind (Tobias, 1993).

Parents, especially parents of girls, often expect their children to be nonmathematical. If the parents are poor at math, they had their own sudden-death experience; if math was easy for them, they do not know how it feels to be slow. In either case, they will unwittingly foster the idea that a mathematical mind is something one either has or does not have. (Tobias, 1993, p. 53)

Parents who foster this myth are more likely to negatively persuade their children with comments such as “we are not a maths family” or “all of us struggle with maths so don’t worry about that algebra” (also illustrated in the Section Maths Self-efficacy).

**Emotional arousal.**

Emotional arousal is often referred as physiological arousal; the physiological responses such as a racing heart and increased sweating that effect SEFF. However, the other side of this argument is that these physical responses only have an impact on SEFF when they are evaluated in terms of emotions, “People can gauge their self-efficacy by the emotional state as they contemplate an action” (Schunk & Pajares, 2009, p. 37). For example, a racing heart and sweating before a mathematics test or when a new concept is taught, is a sign of increased arousal and it could be evaluated by the individual as a sign of excitement or on the flipside, as a sign of fear. If the individual interprets it in terms of excitement it can increase their SEFF. “I am excited; the adrenaline is pumping which means enhanced performance. I can do this”. Alternatively, if it is interpreted as fear, it can lower their SEFF. “I am scared; my heart is racing and my hands are sweating. I can’t do this”. The recognition of the emotion can intensify the physiological response and trigger more responses, “Many forms of physiological arousal are generated cognitively by arousing trains of thought” (Bandura, 1977, p. 199). In the current discussion and subsequent study the debated phenomenon will be referred to as emotional arousal.

A person’s evaluation of the emotion relating to the physiological arousal is what influences SEFF. This can be described as the informative function of physiological arousal (Bandura, 1997). Emotional arousal can occur without noticeable physiological signs. In the day to day experience of new learning and tasks, an individual may not be conscious of physiological arousal but emotional arousal may be heightened. Some maths anxiety related responses are examples of this and are relevant to the current study. Maths anxiety will be discussed in greater depth in the section Emotional Arousal to Mathematics. Emotional arousal can have
both informative and motivational effects and these are interdependent. Negative emotional arousal such as anxiety, can lower efficacy expectations and in turn the motivation to engage and the individual may employ avoidance behaviours. This again feeds into a vicious cycle of restricted opportunities for mastery experiences. Social cognitive theory holds the view that “… potential threats activate fear largely through cognitive self-arousal” (Bandura, 1977, p. 200). Strong negative emotional arousal also strengthens anticipatory self-arousal. Anticipatory self-arousal is when the fear of the experience is worse than the actual threat. This fear provokes thoughts of ineptitude which lowers SEFF dramatically.

**Development of self-efficacy.**

The development of self-efficacy is determined by an individual’s interactions with the environments that they are part of. The home and school environments are important environments that help shape self-efficacy as they provide opportunities to participate in mastery experiences, to observe others as models, and to receive feedback and encouragement. In this section the influence of home and school will be briefly discussed in relation to the development of self-efficacy.

In infancy, an individual learns through observations of the environment that surrounds them, the mother being a central focus in their environment. As the social environment expands and interactions increase, self-knowledge increases and the child becomes more aware of their capabilities. The more opportunities the child is given to explore, the more linguistic and cognitive processes develop, and in turn self-efficacy develops (Bandura, 1997; Schunk & Pajares, 2009). At this point the influence of others on self-appraisal becomes apparent.

Once children can understand speech, parents and others express judgements of children’s capabilities to guide them in foreseen situations where parents may not be present. To the extent that children’s appraisals of their capabilities are partly shaped by the efficacy appraisals of others, they can affect their rate of personal development by influencing whether and how they approach new tasks. (Bandura, 1997, p. 169)

siblings and peers play an increasingly significant role in the development of self-appraisals. This begins with siblings and then age related peers. “Family members also are important models. Those who model ways to cope with difficulties, persistence, and effort strengthen their children’s self-efficacy” (Schunk & Pajares, 2009, p. 43). This influence may interact with significant transitions such as starting preschool, formal education, or even new topics within the mathematics curriculum, such as algebra, whereby the perceived appraisals of
others, namely family members, influence how children approach new learning. This influence warrants further exploration and is a significant attribute in the current study. Whilst research exists that explores the influence of parents attitudes to mathematics on their children’s mathematics performance (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Tiedemann, 2000; Vukovic, Roberts, & Green Wright, 2013), there appears to be a gap that explores the direct relationship between parent’s maths self-efficacy and their children’s maths self-efficacy. The current study aims to bridge this gap.

The school environment also cultivates self-efficacy. Instructional practices in schools significantly influence the development of children’s self-efficacy through the provision or lack of provision of opportunities for autonomous mastery experiences and opportunities to learn beside with peers. Three particular instructional practices are seen as negatively affecting self-efficacy. The first is what is described as lock-step sequences of instruction. Lock-step instructions are the practices of teaching a new concept in sequence methodically without revising earlier steps, a common practice in the mathematics classroom. The lock-step approach does not accommodate for children who take a little longer to consolidate new learning (Bandura, 1997; Tobias, 1993).

Another common practice which may affect the development of self-efficacy is ability grouping. When students are grouped solely according to ability, less able students have low expectations as they are only able to observe the actions and responses of students with similar abilities. As discussed earlier efficacy expectations can only be increased when students can observe others achieving a slightly harder task, and then they may be persuaded to lift their expectations because a peer already has achieved the task (Bandura, 1997; Schunk & Pajares, 2009).

The third practice which affects the development of positive self-efficacy is when teachers over-encourage students when the students do not possess the necessary skills (Bandura, 1997; Schunk & Pajares, 2009). When a student overestimates their ability based on teacher encouragement, the consequences to self-efficacy can be dire. “Self–efficacy judgements that slightly exceed what one can do are desirable because such overestimation can raise effort and persistence. But recurring overestimation can lead to continued failure with resulting decrements in student’s motivation to learn”(Schunk & Pajares, 2009, p. 42).

Teacher self-efficacy also plays a role in the self-efficacy of students. “Social cognitive theory predicts that teacher self-efficacy should influence the same types of activities that student self-efficacy affects: choice of activities, effort, persistence and achievement” (Schunk &
Pajares, 2009, p. 38). Teachers with high self-efficacy will choose more challenging activities that in turn means their students will have more opportunities for mastery experiences and the development of knowledge and skills. Whilst the school environment is not the focus of the current study, its significance to self-efficacy development can be appreciated through the extensive coverage in literature and research.

**Maths self-efficacy research.**

The relationship between self-efficacy (SEFF) and performance has been the focus of a plethora of research since Bandura conceptualised self-efficacy. Of particular interest has been the direct effect of maths self-efficacy (MSEFF) on children’s achievements and persistence in mathematics (Bandura & Schunk, 1981). Pajares and Kranzler (1995b), for example, explored the influence of both mental ability and MSEFF on mathematics performance. The findings showed that MSEFF had “a powerful and independent contribution to the prediction of performance” (Schunk & Pajares, 2009, p. 39). Researchers in SEFF, particularly MSEFF, have been careful to separate the construct of self-efficacy from the more global and collective construct of self-concept: “Self-efficacy also is not the same as self-concept, which refers to one’s collective self-perceptions formed through experiences with and interpretations of the environment and influenced by reinforcements and evaluations by others” (Schunk & Pajares, 2009, p. 39).

Betz and Hackett (1983) explored the relationship between MSEFF and course choices in college level students. In the study Betz and Hackett (1983) identified three behaviours relevant to maths self-efficacy; - problem solving, mathematics behaviour that relates to the application of mathematics in everyday situations, and the capability of satisfactory performance in college courses (satisfactory performance being deemed as a B grade or better). The findings from this study highlight that students with high maths SEFF were more likely to choose mathematics and mathematics related science courses than those with low MSEFF. Two further significant findings relevant to the current study was a moderate negative correlation between MSEFF and maths anxiety. This substantiates Bandura’s argument “that anxiety is an inverse co-effect of SEFF expectations” (Bandura, 1977 as cited in Betz &Hackett, 1983, p.343). Secondly, Betz and Hackett (1983) reported findings relating to variance in MSEFF in relation to gender. Betz and Hackett (1983) noted that women in the study had lower self-efficacy and underestimated their capabilities in mathematics.

The findings that females’ self-efficacy expectations were equivalent to those of males when the tasks involved stereotypically feminine activities had both theoretical and
practical importance.... It is likely that many young women are not aware that they are successfully using math in ordinary activities and, thus, fail to acknowledge the ‘successful performance accomplishments’ that would increase their expectations of mathematics related self-efficacy. (Betz & Hackett, 1983, p. 344)

Pajares and Miller (1995) explored the role of MSEFF and self-concept beliefs in mathematical problem solving. Their findings showed that students’ judgements about capability (MSEFF expectations) to solve mathematical problems were more predictive than other variables such as maths anxiety and mathematics self-concept.

Pajares and Miller (1995) went on to explore Bandura’s conjecture relating to the necessity for specificity when measuring SEFF. “Ill-defined global measures of perceived self-efficacy or defective assessments of performance will yield discordances” (Bandura, 1986, p. 397).

The findings from Pajares and Miller (1995) confirmed Bandura’s caution about ill-defined measures and mismatched assessments of performance. Pajares and Miller (1995) propose that “measures of self-efficacy should be specifically tailored to the criterial task being assessed and the domain of functioning being analysed” (Pajares & Miller, 1995, p. 190). Predictions are more enhanced if self-efficacy measures match closely or replicate the performance task. More recent research that explores SEFF has thrown Bandura’s caution to the wind and moved towards more globalised measures of MSEFF that do not match the performance task (Fast et al., 2010; Griggs et al., 2013). Thus the resulting findings showed weak correlations between SEFF and performance in the case of Fast et al. (2010). When performance was not considered, as in the case of Griggs et al. (2013), then the validity of the findings need to be examined in light of miscalibration especially when the young age of the participants (Year 6) is considered. These findings and recommendations, in relation to the construction of maths self-efficacy measures, and miscalibration, are very relevant to the current study and will be discussed further in Chapter Three.

The final piece of research that is relevant to the current study is Pajares and Kranzler (1995a). Pajares and Kranzler (1995b) hypothesised that MSEFF mediates other predictors of behaviour such as gender, general mental ability, and maths anxiety on mathematical problem solving tasks. In this study, 329 high school students from grades 9-12 (14 -18 years of age) were assessed on four measures, general ability, maths self-efficacy, maths anxiety, and a maths problem solving task which constituted the mathematics performance measure.

Findings from this study pointed towards SEFF having a strong direct effect on maths anxiety and on mathematics problem solving performance. Findings also showed that students in the
sample tended to overestimate their mathematics capabilities. The results showed that “students with better calibration reported higher self-efficacy and lower anxiety” (Pajares & Kranzler, 1995a, p. 15). Finally, findings suggested a gender difference in relation to maths anxiety. Whilst this is not the focus for the current study it is interesting to note that while there was no difference between the SEFF of boys and girls, there was a difference for maths anxiety. In Pajares and Kranzler (1995a) research, girls had more pronounced maths anxiety.

**Emotional Arousal to Mathematics**

Emotional arousal to mathematics is one of the personal factors within the triadic model presented for the current study. General emotional arousal has been discussed in the section *Emotional Arousal* within the discussion of Self-Efficacy theory. However, in this section emotional arousal is specific to mathematics. In this discussion maths anxiety is focused on as a significant arousal response in the field of mathematics education. This discussion begins with an outline of the effects and possible causes of maths anxiety (MA).

**Maths anxiety.**

Richardson and Suinn’s (1972) definition of MA was initially presented in the introduction chapter in the section *Affect in Mathematics Education*, MA is therefore defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551). Very little quantitative research exists around the prevalence of maths anxiety (MA) in the New Zealand school student population (May, Cowles, & Lamy, 2013). The current study proposes the following definition of MA which is an adaption of Richardson and Suinn’s (1972) definition, maths anxiety is the reoccurring emotion of anxiety aroused by thinking about and performing mathematics either in the classroom or in everyday activities.

In Self-Efficacy theory, MA fits within the contributing component of Emotional Arousal when it is experienced by an individual, but also under Vicarious Experience/Modelling when an individual witnesses another individual’s experience, or account of MA, and integrates it into their own repertoire of responses as outlined in the section *Vicarious Experiences* within the discussion of Self-Efficacy theory. As discussed in the section *Emotional Arousal*, the emotions aroused in a specific domain or situation significantly affects an individual’s Self-Efficacy Expectation. *Figure 3* illustrates the presence of MA in the development of Self-Efficacy.
As discussed in Chapter One, the definition of maths anxiety has been contested and its validity as an anxiety disorder has been challenged. In early studies of the phenomena, fear of mathematics was subsumed into Test Anxiety and that in turn was absorbed within General Anxiety. Studies have shown a close correlation with test anxiety (Ashcraft, 2002). However, it can be argued that the anticipatory nature of MA (Bandura, 1997; Ramirez, Gunderson, Levine, & Beilock, 2013) can justify this correlation, but the fear associated with carrying out non-threatening mathematics tasks means that the similarities stop there.

**Etiology of maths anxiety.**

The causes and theories behind the onset and development of Maths Anxiety are discussed in depth in literature (e.g. (Ashcraft, 2002; Hembree, 1990; Jameson, 2014; Ramirez et al., 2013; Richardson & Suinn, 1972; Tobias, 1993; Wigfield & Meece, 1988)). In the current study, this will be discussed from the perspective of Social Cognitive Theory with reference to Bandura’s theory of anxiety.

Anxiety has a reciprocal relationship with an individual’s self-efficacy. Self-efficacy influences anxiety and vice versa. Bandura recognised this reciprocal interaction. “Efficacy beliefs create attentional biases and influences whether life events are construed, cognitively represented, and retrieved in ways that are benign or emotionally perturbing” (Bandura, 1997, p. 137).
When the beliefs/thoughts are cognitively recognised as emotionally perturbing, it sets off physiological arousal which in turn helps define the emotion associated with the event or object of stimulation (Bandura, 1997). Tobias (1993) explains that in the passage to MA an individual will come to a point where they can go no further, an insurmountable wall which metaphorically signals the end of their mathematics journey and the extent of their perceived mathematical ability (Tobias, 1993). From this point the intrusive thoughts and worry kick in and irrational associations lead to aversion. In extreme cases this could be feeling anxious just walking into a classroom where mathematics has been taught, or feeling physically sick hearing the words “long division”. This interaction is described by Bandura in Conditional Theory, “Conditional theory assumes that formerly neutral events acquire anxiety provoking properties by association with painful experiences. If a neutral event is paired with one that is painful, the formerly neutral one is said to become aversive” (Bandura, 1997, p. 140).

It is not the external stimuli which cause the feeling of anxiety and tension but its association with judgements of connections to a painful experience that elicit beliefs of inability and lack of control (Bandura, 1997; Tobias, 1993).

Whilst MA has a reciprocal deterministic relationship with self-efficacy, it can at the same time be regarded as a contributing component of self-efficacy. Anxiety is an emotion that is identifiable by the individual during emotional arousal. As with all other aspects of SCT the development of MA can be attributed to the interaction of personal factors, environmental factors with the behaviours being the associated effects of MA i.e. avoidance and low performance which is discussed in the section Effects of Maths Anxiety. Literature in the field of MA recognise and relate these factors to explain the development of MA (Boaler, 2012; Harari, Vukovic, & Bailey, 2013; Jameson, 2014; Tobias, 1993; Whyte & Anthony, 2012). Jameson (2014) explored the contributing factor to MA in Second grade children (7-8 year olds). In this study mathematics self-concept, gender, MSEFF, parental maths anxiety, and the frequency and accessibility of mathematics activities in home were examined in relation to MA. Findings illustrated that mathematics self-concept was the strongest indicator of MA. MSEFF and frequency of mathematic activities made minimal contributions to the prediction of MA (Jameson, 2014). However, Jameson (2014) stated that the relationships found were correlational and not causal. Furthermore, recommendations were made that more research was required to explore the relationship between parental MA and child MA. These recommendations are pertinent to the current study as they support the argument that there is a need to explore the relationship between parents’ and children’s emotional arousal to mathematics, which is a key component of the current studies focus.
The environmental factors that may contribute to the development of MA are societal attitudes and cultural norms relating to mathematics, the attitudes and behaviours of parents and families around mathematics, the classroom climate and the attitude of the teacher towards math. The personal factors revolve around the background and experiences of the individual, the mathematics journey, and their judgements and beliefs (Ingram, 2011; Skovsmose, 2005, 2012; Tobias, 1993).

The home environment, especially the attitudes and beliefs of parents and other family members may contribute to the development of MA (Tobias, 1993). Familial influence is similar to self-efficacy in this regard (Jameson, 2014). Parental disappointment and despair around mathematics can give a clear message to a child who is encountering mathematics in early education (Maloney et al., 2015). Parents who communicate that mathematics is unimportant, or is of low status, provide reason for their child to avoid mathematics, often unconsciously providing excuses not to engage with mathematics by saying things such as “Don’t worry I was never good at maths either” or “We are more of an languages family and our brains aren’t tuned into maths” (Whyte & Anthony, 2012). In this regard, parents are also providing verbal persuasion, a necessary contributor to the development of self-efficacy, but to a negative effect. Cultural norms also influence the engagement and communication of parents (Tobias, 1993). A commonly held misconception in western culture is that mathematics is an aptitude (Ashcraft, 2002). In contrast, in Asian cultures parents recognise that achievement in mathematics is the result of hard work and application (Tobias, 1993).

Societal messages around mathematics may also influence how an individual feels about maths. Mathematics norms such as that it is cool to hate mathematics, mathematics is for geeks, and that it is a “Men’s turf” (Tobias, 1993) suggest to an individual that it is not socially acceptable to be seen to try in mathematics. However, as science and technology become more and more important in the world around us, the importance of mathematics is becoming more acknowledged. A juxtaposition exists between the negative maths norms and the growing necessity for mathematical skills. A new pressure exists for children to achieve in mathematics.

The classroom and its culture around mathematics may also contribute to the development of MA. The teachers who are anxious about mathematics themselves, may restrict activities, or may be more reliant on traditional instrumental methods such as drills, flashcards, timed tests, and textbooks (Whyte & Anthony, 2012). Timed tests emphasise correct answers, put unnecessary stress on the individual which in turn inhibits access to working memory (Boaler, 2012; Tobias, 1993). Research has shown that the fear region of the brain is activated during
Timed tests detrimentally effecting the individual and, in turn, achievement. The use of these traditional instrumental methods are empirically uninformed (Boaler, 2012). Other aspects of classroom culture may also contribute to the development of MA. Rigid and highly structured classrooms where discussion and debate are not encouraged stifles reflection and thinking about alternative ways in problem solving (Tobias, 1993; Whyte & Anthony, 2012). Heavily structured classroom environments also perpetuate the notion that the role of the student is to perform rather than to learn (Boaler, 2012).

Personal factors can also be attributed to the development of MA. Tobias (1993) presents several variables within personal factors that may be attributed to the development of MA. The Dropped Stitch concept is described in MA literature as an individual’s aversion to go further or engage in mathematics because they have missed a self-determined ‘crucial’ component which means they can go no further (Tobias, 1993; Whyte & Anthony, 2012). This could be through absence through illness, or changing schools. Fear of being exposed as either too dumb or too smart also may contribute to the development of MA “Everyone knows, that I don’t understand this. The teacher knows. Friends know. I’d better not make it worse by asking questions. Then everyone will find out how dumb I really am” (Tobias, 1993, p.51). This can lead to a fear of risk-taking in mathematics and trust issues. Being seen to ask questions or to volunteer answers can be revealing and can challenge an individual’s standing both socially and academically. In a subject that is haunted by myths that it is “uncool to excel” this pushes an individual’s boundaries. Another personal factor that is described in literature around the topic of MA is the concept of “faking maths”. An individual questions their ability if it comes too easily, “If it's easy for me, it can’t be maths” (Tobias, 1993, p. 66). Often an individual intuitively is able to solve a problem. However, the individual doesn’t recognise intuition as a tool of problem solving and does not trust their response. They then may question their solution. All these personal factors equate to self-doubt and feeling uncertain.

**Effects of maths anxiety.**

Participation and performance are the two areas that are most significantly affected by MA (Ashcraft & Kirk, 2001; Ashcraft & Moore, 2009; Frankcom, 2006; Gierl & Bisanz, 1995; Harari et al., 2013; Hembree, 1990; Maloney et al., 2015; Ramirez et al., 2013; Sheffield & Hunt, 2006; Tobias, 1993; Wigfield & Meece, 1988). However, individuals with MA do not necessarily have a general deficit in mathematics competence (Ashcraft, 2002). Students with MA, though, are more likely to espouse negative views of mathematics and hold very negative self-perceptions about their capabilities in mathematics (Ashcraft, 2002; Hembree,
1990; Maloney et al., 2015). They might be the students who vocalise the opinion that ‘maths is a waste of time' and ‘ridiculously hard, without a purpose'.

Avoidance is one of the most significant effects of MA which has profound impact on both short term mastery and long term life choices (Ashcraft & Moore, 2009; Boaler, 2012; Frankcom, 2006; Hembree, 1990; Ramirez et al., 2013; Sheffield & Hunt, 2006; Suinn & Winston, 2003). Bandura (1997) describes avoidant behaviour as being “motivated by an anxiety drive” (p.323). In Social Cognitive Theory, an individual is seen as driven to avoid mathematics in the hope of reducing the feelings of anxiousness, tension and ultimately the underlying perception that they are incapable of coping with the threat (Bandura, 1997). In the immediate future this may have a spiral effect on both math’s self-efficacy and levels of anxiety. Figure 4 illustrates this cyclic pattern.

![Diagram](image)

*Figure 4. The cyclic nature of maths anxiety and avoidance.*

Avoidant behaviour can appear in many different guises. A student may avoid university courses that include mathematics and statistics papers thus limiting future career choices (Hembree, 1990; Richardson & Suinn, 1972). A school student may opt to have music lessons, frequent the counsellor’s office, school sick bay, and bathroom rather than being in mathematics class. Within class, a student may rapidly respond to questions inaccurately to just get it over and done with (Tobias, 1993). Some literature suggests that MA is more prevalent in the female population (Ashcraft, 2002; Hembree, 1990; Pajares & Kranzler, 1995a; Tobias, 1993) and it could be argued that avoidance in relation to this prevalence may account for the disproportionate representation of females in the STEM subjects as females have avoided these areas because of their reliance on mathematics (Wigfield & Meece, 1988). However, conflicting with this is Hembree’s (1990) findings which showed that males at
junior and senior high school who reported high MA were less likely to take more mathematics in the future in comparison to females with high MA. Ma and Cartwright (2003) analysed gender differences in affective outcomes in mathematics during middle and high school, and found that “female anxiety toward mathematics grew significantly faster than male anxiety towards mathematics” (Ma & Cartwright, 2003, p. 428).

Lower achievement as a direct effect of MA has been contested amongst researchers in the field of MA. Meece, Wigfield, and Eccles (1990) argue that MA has only an indirect effect on performance, and that expectancy outcomes, which they defined as “the subjective probability of success on a task” (Meece et al., 1990, p. 61), and the importance placed on mathematics had the greatest influence on performance. In contrast, findings from Hembree (1990) found that there was a negative relationship between maths anxiety and performance, the more anxious a student is the poorer they performed. This was described in the effect size of -0.61. Findings from more recent research such as Sheffield and Hunt (2006), Vukovic, Kieffer, Bailey, and Harari (2013), and Ramirez et al. (2013) are all consistent with these findings.

MA, like other anxiety disorders, has a direct impact on the autonomic nervous system. MA is classed as state anxiety because anxious arousal is triggered by an object of fear, in the case of MA the presentation or anticipation of mathematics (Baloglu, 1999; Frankcom, 2006; Whyte & Anthony, 2012). State anxiety is situational and not a general characteristic of the individual. During an episode of anxiety, emotional arousal hormones are released and may trigger elevated heart beating, sweating, shaking hands, to name but a few physiological responses (Ashcraft, 2002; Sheffield & Hunt, 2006). Some attention has been given to the increased cortisol response in individuals with MA (Mattarella-Micke, Mateo, Kozak, Foster, & Beilock, 2011; Ramirez et al., 2013).

The interaction between MA and the Working Memory is another area that has been documented in literature. The basic premise is that distress blocks the Working Memory (WM) and prohibits the retrieval of known facts and mathematics procedures (Ashcraft & Kirk, 2001; Ramirez et al., 2013; Sheffield & Hunt, 2006). This is often vocalised when an individual says “my mind had gone blank”, “Maths Anxiety may negatively impact mathematics performance by co-opting the limited Working Memory resources that are crucial for successful math problem solving, which we refer to as ‘Working Memory disruption’” (Ramirez et al., 2013, p. 189).

Sheffield and Hunt (2006) explored the interaction between the MA and working memory. Their first study looked at the accuracy of individuals to carry out dual tasks; perform one and
two digit addition with and without carrying numbers whilst remembering six random letters. This replicated the studies of Ashcraft and Faust (1994), and Ashcraft and Kirk (2001). Participants first carried out the mathematics performance task only, then the letter recall task, and then both tasks in tandem. Sheffield and Hunt (2006) found that highly maths anxious participants responded correctly less frequently to both the primary task (the mathematics performance task) and the secondary task (the letter recall task) when the activity was a dual task. Eysenck and Calvos (1992) theorised the Processing Efficiency Theory in relation to anxiety. They claimed that the resources of the Working Memory are exhausted by the intrusive thoughts and worry that is provoked by the perceived threat i.e. mathematics tasks (Eysenck & Calvo, 1992). Sheffield and Hunt (2006) further illustrate this point, “In the case of maths anxiety worry could pre-empt actual task processing, consequently inhibiting the effectiveness of the working memory […] Failure to inhibit worrisome thoughts loading working memory and detrimentally affecting performance” (pp. 21-22).

Ramirez et al. (2013) looked at the relationship between MA, Working Memory, and mathematics achievement in early elementary students (Years 2 & 3) and found a negative correlation between maths anxiety and mathematics achievement in students with high levels of working memory. They went on to suggest that students with higher levels of working memory (WM) are more likely to use more sophisticated problem solving strategies that rely more heavily on the WM. However, if these students are afflicted with MA, retrieval efficacy and cognitive processing is disrupted by interference from intrusive thoughts and worry (Ramirez et al., 2013). Those with the most potential may be the most vulnerable to the effects of MA on the WM.

The long term effects of MA into adulthood are weighty and have an impact on an individual’s everyday functioning. “Among non-students, MA may be a contributor to tensions doing routine or everyday activities such as handling money, balancing bank accounts, evaluating sale prices or dividing workload” (Richardson & Suinn, 1972, p. 552). For example, Suri, Monroe, and Koc (2013) explored consumers’ preferences for the presentation of discounts. Their findings suggest that maths anxious individuals will prefer dollar saving discounts over percentage savings, even when the percentage was the optimum saving. They account for this by suggesting that accuracy and cognitive processing loads influence the choice of the individual, “Interestingly, even those with mathematics skills and superior intellectual abilities … were made vulnerable to the co-opting influence of math anxiety leading them to prefer the easier to compute dollars-off price promotions” (Suri et al., 2013, p. 280).
Interestingly, Feng, Suri, and Bell (2014) explored the remediation of this through playing classical music in shops as “slow tempo classical music has been shown to relax consumers and enhance sales” (Feng et al., 2014, p. 489). Another practical effect of MA is around a nurse’s competence to calculate and administer correct drug dosage. McMullan, Jones, and Lea (2012) explored the relationship between nursing students with MA and drug calculation competence. In this study they found that the students who had failed the numerical and/or drug calculation ability test were more anxious and less confident about performing drug calculations than those that passed. Obviously, the administration of correct dosage of drugs is crucial for a career in nursing.

Preservice teaching education is another area where an individual’s level of MA can affect their performance and long term effectiveness in their vocation (Frankcom, 2006). Frankcom (2006) examined the levels of maths anxiety reported by 29 third year primary student teachers. The findings pointed to a strong negative correlation between high MA and low MSEFF. Significantly, the level of school mathematics achieved by the student teacher had no effect on MSEFF or MA. Hembree (1990) observed this trend as well during a comparison of tertiary courses.

Maths anxiety is a multifaceted personal affective variable in regard to etiology and effects. As with maths self-efficacy it would be impossible to explore all contributing factors in one thesis. However, recommendations from researchers in the field of MA (Jameson, 2014; Maloney et al., 2015; Vukovic, Roberts, et al., 2013), and the direction of research points to further inquiry in relation to the influence of parental attitudes and the level of maths anxiety in their children. In the next section parents’ affective factors, specifically those related to emotional arousal to mathematics and maths self-efficacy will be outlined.

Parents’ Affective Factors

Parents’ affective factors fit under environmental factors within our triadic model (Figure 2). This section will begin with a brief discussion about parental involvement in mathematics education. Parents’ views of mathematics will then be explored in relation to perceptions of the nature of mathematics and gender expectations. Finally, research around the influence of parent self-efficacy and levels of maths anxiety on children will be outlined.

Parents play an important role in students’ academic well-being and mathematical success (Anthony & Walshaw, 2007). The partnerships between school and home in nurturing students’ mathematical progressions are crucial and as such need significant consideration.
Some parents have their own recollections of negative experiences of mathematics learning (Anthony & Walshaw, 2007), or are strongly attached to the methods used when they learnt mathematics (Muir, 2012b). Negative recollections and strong attachment to their own experiences of mathematics methods can have an effect on their confidence to be involved with their own children’s mathematical education and can create conflict (Anthony & Walshaw, 2007; Ingram, 2011; Lange & Meaney, 2011; Muir, 2012b; Onslow, 1993). Peressini (1998) argued that mathematical reforms have disempowered parents and created a disconnect between school and home as parents are uninformed of pedagogical methods in mathematics. This argument is also reiterated in more recent research (Muir, 2012a, 2012b; Pritchard, 2004):

Many parents tend to value their own forms of doing mathematics over ‘school mathematics’, while many children value schools’ form of knowledge over parents’ knowledge hence demonstrating the potential tensions that may arise when engaging in mathematical tasks and assignments at home (Muir, 2012b, p. 2).

Pritchard (2004) explored the views held by parents about mathematics education. The three aims of the study were to explore mathematics beliefs commonly held by parents, the extent of how informed the parents were of teaching methods and practices and the role of the parent in their children’s mathematics education. In this study 33 participants responded to a survey from one urban school. From this sample a subsample was chosen based on their agreement and interest in being part of a focus group that shared their beliefs about the nature of mathematics, the level of understanding of current teaching practices in mathematics and their experience of interactions with children around mathematics in the home. Pritchard (2004) noted that the parents who chose to be participants were the parents who were already engaged in the school and an absence of the ‘hard to reach’ parents, a limitation frequently cited in research involving parents (Maloney et al., 2015; Onslow, 1993; Toomey, 1996). This may have had an effect on data as it limited the variety of responses and perhaps put a positive spin on the findings.

Findings showed that nearly all of the participants voiced a positive view of mathematics and saw achievement in mathematics as an important factor in their children’s education and future. The focus group also hoped their children would experience enjoyment and understanding in mathematics. Participants in the study defined mathematics broadly as being “seen as pervasive in society involving practical, meaningful, investigative, and creative aspects” (Pritchard, 2004, p. 483). However, findings suggested that the parents felt they
lacked knowledge about curriculum content and current teaching methods and reported a desire to know more in this respect.

Pritchard’s findings proposed that some parents tend to hold views of mathematics that relate to the procedural nature of mathematics. This procedural understanding focuses on learning procedures before understanding when to apply the procedure (Boaler, 2012; Schoenfeld, 1994). Doing mathematics, from this perspective, is characterised as using the correct methods and procedures to solve problems (Ingram, 2011; Muir, 2012b; Onslow, 1993; Pritchard, 2004).

Muir (2012a) also conducted research that explored the perceptions of mathematics education held by parents. The research uncovered that there was high agreement to statements such as “maths is the correct procedures to solve problems” and “worksheets and textbooks are a good way to learn mathematics” (Muir, 2012a, p. 30). In this study only 36 percent of parents felt they had a good grasp of how their child was taught numeracy (Muir, 2012a). Parents’ uncertainty about mathematical pedagogy and their expression of this suspicion may play a role in their children’s mathematics beliefs and may contribute to tension and conflict between parent and children when mathematics is explored in the home. Exploration into this effect, a focus in the current research, is warranted.

Parent’s beliefs around gender and subsequent expectations may also contribute to the attitudes and beliefs held by a child. Parent’s academic aspirations for their children, and the parents’ beliefs in their own efficacy to assist with their children’s learning, affected children’s academic achievements (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). “By providing guidance through standards and supportive efficacious action, parents serve as enabling influences in their children’s academic lives” (Bandura et al., 1996, p. 1217).

Gender stereotype biases also have an effect on parent expectations for their children’s mathematical ability (Tiedemann, 2000). Findings showed that parents who believed that men where innately more suited to mathematics assigned lower ability to their daughters (Tiedemann, 2000), and this in turn had a small effect on children’s self- perception. Else-Quest, Hyde, and Hejmadi (2008) also found gender bias in their study of mother and child emotions during mathematics homework. Else-Quest et al. (2008) studied the emotions expressed by mothers and their eleven year old children during a homework task. A high correlation between mothers’ emotions and children’s emotions reflecting the social aspect of homework. Else-Quest et al. (2008) found that mothers comforted their daughters more than their sons after failing to successfully complete a pre-algebraic task (Else-Quest et al., 2008).
Parents are a significant source of verbal persuasion and vicarious experience/modelling which contribute to the development of self-efficacy. “Parents’ beliefs in their efficacy to promote their children’s intellectual development and the educational aspirations they hold for them were both influential factors in the academic process” (Bandura et al., 1996, p. 1217).

Jameson (2014) suggests that it may be that the verbal persuasion and vicarious experience witnessed by the child in their environment (school and home) contributes most to the development or detriment of a child’s self-efficacy. Parents, in this regard, are prominent models and persuasive communicators. The influence of parental modelling on children’s maths self-efficacy is seldom researched. This has significant implication for the current study which aims to explore the relationship between parents’ maths self-efficacy and children’s maths self-efficacy. Furthermore, exploration of the nature of parent modelling of maths self-efficacy is necessary to understand the actions of the parents that the child observes. The activity of doing homework is a natural point of interaction to explore and constitutes the behavioural aspect in the current study and this will be discussed further in the section Actions and Interactions Associated with Homework.

Vukovic, Roberts, et al. (2013) explored the extent parents’ involvement in mathematics activities at home reduces maths anxiety in children and substantially positively influences achievement. Home involvement in mathematics includes parental expectations and aspirations, parent-child communication, and encouragement for learning mathematics (Vukovic, Roberts, et al., 2013). Vukovic, Roberts, et al. (2013) hypothesised that parental involvement would be negatively related to MA and that MA would be negatively related to maths achievement. There were 78 parent (primarily mothers 85.9%) and child pairings in the study. The children were aged between 7-8 years old (second grade). Results suggested that parents, through home involvement and expectation, “exert an indirect influence on higher order mathematics by reducing MA” (Vukovic, Roberts, et al., 2013, p. 459). This influence was specifically apparent to algebraic reasoning and not whole number arithmetic. Causation was precluded. However, the findings suggested that positive parent communication styles may contribute to this negative correlation. More research is needed to explore how parents communicate their attitudes and demonstrate their emotional response to mathematics and whether this is observed and then internalised by their children.
Actions and Interactions Associated with Homework

The nature of interactions around homework are a natural situation to explore the interactions between parents and their children to determine the prevalence of modelling of beliefs and attitudes to mathematics. Within the triadic model, actions and interactions associated with homework constitute the behaviour in the current study (see figure 2). This section will begin with a brief discussion around the debate relating to mathematics homework. Following this an outline of research relevant to the current study will be presented.

The relevance of homework and its effect on academic achievement has been debated in the education sector, particularly in mathematics. Findings from Cooper, Lindsay, Nye, and Greathouse (1998) suggest that the time spent completing homework has close to zero correlation on the achievement of students aged 7-10 years old when correlated with standardized testing ($r = -.04$). However, there was a negative correlation when time spent on homework was correlated with class grades ($r = -.19$). The negative correlation between time spent on homework and class grades could be attributed to the significance the teacher places on homework practice as a demonstration of student effort. Inglis (2007) argues that homework is a controlled activity that takes the school environment and places it in the home where complex interactions and relations between the child and parents are not considered. Furthermore, Lange and Meaney (2011) suggest that children and parents are artificially assigned the roles of teacher and student through traditional homework practices which cause conflict and tension. Mathematics, in particular, is a subject where the ways of the school may be enforced through homework practises that are teacher directed and enforce procedural approaches to mathematics (Lange & Meaney, 2011). “This colonisation of what constitutes mathematics into the home situation not only reinforces school-instigated mathematical trauma but also exacerbates it by taking over the situations where other mathematical learning could take place” (Lange & Meaney, 2011, p. 49).

Furthermore, it may reinforce social inequities associated with a student’s access to resources in the home, such as computers and internet access for homework tasks that rely on mathematics programs such as Mathletics. Parents’ knowledge and confidence with mathematics is another factor that may contribute to social inequity (Kralovec & Buell, 2001).

Homework is the activity that most frequently necessitates interaction between children and parents around mathematics. The child can be described as a mediator between the two environments, home and school (Inglis, 2007; Ingram, 2011; Lange & Meaney, 2011). The mediator role becomes crucial and more complex during homework sessions as both
environments intersect (Inglis, 2007). When this interaction occurs homework can be characterised by frustration and conflict as expectations from the two environments clash, for example the procedural methods employed by parents against the strategies taught in school (Díez-Palomar, Ortín, & Roldán, 2012; Lange & Meaney, 2011; Muir, 2012b). This frequently may result in the cessation of homework interactions because of conflicting understandings of methods and strategies, or a parent lacking the knowledge to assist. Parents have been misplaced as a result of mathematics reforms (Díez-Palomar et al., 2012; Muir, 2012a; Peressini, 1998). 31% of participants in Díez-Palomar et al. (2012) study strongly felt that they wanted to help with their child’s homework but could not because of a lack of understanding. Frequently parents had to resort to external tutoring to support their child’s learning (Díez-Palomar et al., 2012). These findings are important as they suggest mathematics homework is a point of demonstration of emotionality, “the effective component of anxiety, including feelings of nervousness, tension, and unpleasant physiological reactions to testing situations” (Wigfield & Meece, 1988, p. 210), between parents and children, and that further exploration into the interactions around mathematics homework is required.

Else-Quest et al. (2008) explored the relationship between mothers’ emotions and their children’s emotions when interacting over mathematics homework. Positive emotions and tension were the most frequently observed emotional responses. However, the correlation between child and mother anger was the strongest ($r = .93$), with positive interest and contempt correlating moderately at $r = .46$ and $r = .35$. Else-Quest et al. argue that “mothers may be able to shape their children’s emotional experience of mathematics homework by carefully choosing and regulating their own emotions” (Else-Quest et al., 2008, p. 27). One of the limitations of this study is that it only explored the relationship between mothers and children when doing mathematics homework. Fathers’ interactions were not considered, based on the assumption that mothers were predominantly the parent to assist with homework. This has implications for the current study because if women are more prone to maths anxiety (Ashcraft, 2002; Beilock, Gunderson, Ramirez, & Levine, 2010; Hembree, 1990; Ma & Cartwright, 2003; Tobias, 1993), and are therefore more likely to avoid mathematics tasks as suggested in literature (Hembree, 1990; Ramirez et al., 2013; Sheffield & Hunt, 2006), then mothers may avoid assisting with mathematics homework and rely on their husbands/fathers to assist.

Maloney et al. (2015) explored the effects of parents’ maths anxiety on children’s mathematics achievement. Specifically they tested whether parents’ MA predicted their child’s mathematics achievement. Their findings showed that parental MA was negatively
related to mathematics achievement, but only when the parent frequently assisted with homework (Maloney et al., 2015). Homework, again appears to be a significant opportunity to measure emotionality around mathematics:

If parents themselves have a high fear of failure in mathematics, then they may be more likely to express negativity when their child is struggling, which in turn could cause their children to also learn to fear failing in mathematics and to avoid engaging in challenging situations (Maloney et al., 2015, p. 6).

Maloney et al. (2015) express the need for more research around the homework environment. Specifically the difference in environments created by highly anxious and low maths anxious parents. This is an important factor in the current study.

Parents who model a strong and positive interest in mathematics, even if it contrasts with their own experience of mathematics, are linked to students with strong confidence in their mathematical ability (Muir, 2012a, 2012b; Pritchard, 2004). Jameson (2014) goes further and suggests that research is needed to explore the effect of parent’s modelling of maths attitudes and beliefs on the development of MA in children as very little literature currently exists. It is this gap in the research literature that this thesis is attempting to address.

**Conclusion**

In conclusion, Bandura’s triadic model provides a framework for understanding the reciprocity between a child’s personal factors, such as maths self-efficacy and emotional arousal to mathematics and the environmental factors of parental maths self-efficacy and emotional arousal to mathematics. Actions and interactions associated with mathematics homework (behaviour factors) may provide an opportunity for children to observe parental modelling of these two affective factors, and facilitate interaction between the personal and environmental factors. This model of exploration hopes to fill a gap in the literature which is signalled in recent research (Else-Quest et al., 2008; Jameson, 2014; Maloney et al., 2015). Further exploration is recommended into the relationship between parental and child responses to mathematics, and the mathematical activities in the home environment because of the relationship with mathematics affect, engagement and performance. Therefore the research question for the current study is: Does parental modelling of maths self-efficacy and emotional arousal to mathematics relate to the perceived maths self-efficacy and emotional arousal of their children?
The four hypotheses, below, will be explored in the quantitative phase of the study.

1. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ maths self-efficacy.
2. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ emotional arousal to mathematics.
3. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ emotional arousal to mathematics.
4. There is a significant positive correlation between Years Eight children’s emotional arousal to mathematics and parents’ maths self-efficacy.
Chapter Three – Research Methodology

Following on from Chapter Two, which outlined the literature and rationale for the current study, this chapter outlines the underpinning theory, the design of the study and presents a description of the measures and procedures used. Pragmatism is the theory underpinning the current study. In line with the philosophy of pragmatism, ultimately the practical implications resulting from the findings of the study are the driving force behind the research methodology. In the section *My Own Mathematical Journey*, my background as both a learner and teacher in the area of mathematics was discussed. My experiences as a teacher have driven this line of inquiry. As a teacher I witnessed anxiety in mathematics which was explained by parents and students as a family thing. My research is to inform teachers and educators, as well as families, about the possible relationship between how parents respond to mathematics and how their children respond to mathematics, and how parents model this response to the children in mathematics activities in the home such as homework. The motivation is to fill a gap in the literature, a gap signalled in the conclusion of the previous chapter, which recommends the exploration of the relationship between parents’ maths self-efficacy and their emotional arousal to mathematics and their children’s maths self-efficacy and emotional arousal to mathematics. The application of an explanatory sequential mixed methods design allows for the exploration of the relationship in depth, utilising the strengths of both quantitative and qualitative methods to provide an explanation for the findings through abduction which will feature in the integrative phase of the design.

**Pragmatism**

**Definition of pragmatism.**

In this discussion pragmatism will be discussed as an approach rather than a paradigm in line with Morgan’s (2007) argument that pragmatism is anti-dualistic. Pragmatism does not require a choice between one thing and another, in the case of research methodology, qualitative or quantitative methods (Johnson & Onwuegbuzie, 2004). Pragmatism is seen as focusing on getting the questions answered rather than accepting “the either or choices and the metaphysical concepts associated with the paradigm wars” (Punch, 2009, p. 291). Kuhn argues that there can be no absolute truth. Furthermore, obedience to one paradigm, or another, may limit curiosity and intellectual creativity (Feilzer, 2010).

Pragmatism, when regarded as an alternative paradigm, sidesteps the contentious issues of truth and reality, accepts, philosophically that there are singular and multiple
realities that are open to empirical inquiry and orients itself toward solving practical
problems in the real world. (Feilzer, 2010, p. 8)

Influenced significantly by Darwinism and evolutionary theories, pragmatism is change and
outcome oriented (Johnson & Onwuegbuzie, 2004; Shannon-Baker, 2015). Pragmatism
recognises the organic nature of organisms and systems, and the need for adaptation and
flexibility. In this sense human beings are seen as primarily actors or agents of change rather
than knowers. Seeking knowledge comes secondary to action. This contrasts with idealism
and realism that sees knowledge as the primary function of human beings. Dewey, a
historically significant pragmatist espoused this fundamental principle and he “upheld the idea
that knowledge is a state of the human organism which consists in the settling of beliefs,
understood as habits of behaviour that have proven successful in action” (Stokes, 2002, p.
131).

The essence of pragmatism is the workability of knowledge, the outcome or consequences of
identifying and using knowledge to solve a problem. This workable knowledge is tentatively
treated as the ‘truth’ at any given moment or situation. William James, another pragmatist,
insists, “All knowledge is pragmatic – in other words, something is either true or right insofar
as it has a successful application to the world” (Stokes, 2002, p. 129).

**Methodological implications of pragmatism.**

Pragmatism requires a perspective that is flexible and open ended. It requires logic and
consideration of the ethical implications of an action (Morgan, 2007; Stokes, 2002). Human
inquiry is crucial but social considerations and democracy are also paramount. The questions
“what is it for” and “who is it for” and “how do the researchers” own values and beliefs
influence the study are quintessential questions within the pragmatic approach (Feilzer, 2010).
In this regard, mixed methods is a natural fit with pragmatism as the strengths of both
qualitative and quantitative methods can be exploited to answer the given question and in
relation to the current study, the best methods to explore the relationship between parents’
maths self-efficacy and their emotional arousal to mathematics, and their children’s maths
self-efficacy and emotional arousal to mathematics.

**Pragmatism and mixed methods.**

Pragmatism and mixed methods share a natural connection. Mixed methods allow for
integration of methods to best fit the research question. It is argued that the research question
is more important than the philosophy of the methodology or theory of knowledge, within
pragmatism (Shannon-Baker, 2015). The integrative nature of mixed methods allows the strengths of qualitative and quantitative methods in design, data collection and analysis to be incorporated in the best way to answer the question of identified problems or social phenomena. Qualitative methods add deeper descriptions of the numbers and patterns, whilst quantitative methods add precision and generalisability to words and narratives (Johnson & Onwuegbuzie, 2004; Morgan, 2007; Onwuegbuzie & Leech, 2005). Within the field of mathematics education research there is a need to explore the affective nature of mathematics learning, especially the emotional aspect of learning (Leder & Grootenboer, 2005) so it is appropriate to incorporate both quantitative and qualitative methods to explore the relationship between parent maths self-efficacy and emotional arousal to mathematics, and children’s maths self-efficacy and emotional arousal to mathematics. Maths self-efficacy and emotional arousal to mathematics being the two specific affective variables.

It can be argued that a deeper and more varied range of answers to the research question is more attainable through the employment of a mixed methods approach (Johnson & Onwuegbuzie, 2004). Transferability, generalisability and triangulation (both at the methodological and data level) are three of the significant strengths of mixed method approaches (Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2009). The combination of both empirical and descriptive precision and the holistic view allows the researcher to have both a macro and micro view of the phenomenon are other strengths attributed to the mixed methods (Teddlie & Tashakkori, 2009).

Mixed methods research has its critics. Purists argue that mixing methods is inappropriate due to the incompatible nature of the epistemological underpinnings of the paradigms. This theory is called the Incompatibility Thesis (Onwuegbuzie & Leech, 2005; Teddlie & Tashakkori, 2009). Purists hold the view that the “assumptions associated with both paradigms are incompatible regarding how the world is viewed and what it important to know” (Onwuegbuzie & Leech, 2005, p. 376). Critics also argue that mixed method designs are time consuming in the regard that they often have several phases and require the researcher to learn multiple methods. The infancy of mixed methods is also of concern within the methodological research world (Teddlie & Tashakkori, 2009). The need for a mixed methods specific language is one such need that has arisen. Development and research around true integration at all stages of mixed method research is also warranted within this new tradition. However, in the current study, the strengths of adopting a mixed methods approach in exploring the relationship between parents’ maths self-efficacy and their emotional arousal to mathematics and their children’s maths self-efficacy and emotional arousal to mathematics, outweighs the
precautions. The current study necessitates breadth and depth that can be achieved successfully through the use of integrative mixed methods. The interface between these methods is important, and is characterised by the logic of abduction.

The logic of abduction is a specific component which is characteristic of mixed methods research. Theorised by Peirce, abduction is the movement between induction and deduction (Feilzer, 2010; Teddlie & Tashakkori, 2009). Abduction allows for the generation of hypotheses when a surprising event or anomaly arises out of the data (Teddlie & Tashakkori, 2009). Abduction facilitates explanations for anomalies and then provides the opportunity for further testing. Abduction is characteristic of the integrative nature of mixed methods and is a key feature of the integrative stage of the explanatory sequential design.

**Sequential Explanatory Design**

Sequential mixed method designs are designs that have two distinct phases (Punch, 2009). Explanatory and exploratory are the two variants of this design. Both share similar characteristics but the exploratory design begins with the qualitative phase of the research and is then followed by the quantitative phase (Creswell, 2011). In this design priority and weighting is predominantly given to the qualitative phase. In contrast, in the explanatory design, priority and weighting is given to the initial quantitative phase, with the qualitative phase explaining and describing the relationships, trends and anomalies that are uncovered in the quantitative stage (Ivankova, Creswell, & Stick, 2006). Sequential designs do not necessarily ascribe to any theoretical perspective so they naturally fit with a pragmatic approach.

The strengths of using a sequential explanatory design is that it is straightforward in its two phase process. Furthermore, the use of both qualitative and quantitative methods allows for greater triangulation because there are more opportunities to explore and explain surprising results and anomalies (Creswell, 2011). The weaknesses of using this design are that using two phases is time consuming both for the researcher and the participants, ethical approval can be harder to obtain as the second phase of the research is not predetermined, and the weighting given to the quantitative and qualitative phases and analysis can be problematic (Creswell, 2011; Ivankova et al., 2006; Plano Clark & Creswell, 2008).

The point of interface (Creswell, 2011) where the two phases collide is called the integration stage. It is at this point that abduction is most evident, and where new questions arise from the
quantitative analysis. This process illustrates the emergent nature of the design (Creswell, 2011).

The current study used an explanatory sequential design because of the design’s strengths and the emergent qualities associated. Figure 5. shows a visual model of the sequential explanatory model used. A description of the procedure can be found in the procedure section that comes later in this chapter. The current study digresses slightly from the traditional sequential explanatory design. The initial design afforded time to carry out interviews on a possible subsample participants. However, the timeline of the master’s thesis did not allow for the inclusion of interviews. In this regard, the questions arose from the quantitative findings but responses were collected from the survey, which included predetermined open questions. The analysis was emergent and true of the nature of sequential explanatory design.

![Figure 5. Flow chart of research.](image_url)

**Participants**

Parent and child pairings were required for the current study. These pairings were necessary to explore the relationship between the two affective variables, maths self-efficacy and emotional arousal to mathematics. Parent was the broad term used to describe a primary carer.
which may have included grandparents or extended members of the family or whanau depending on individual family situations.

**Participant determination study.**

A preliminary study was deemed necessary during the design stage of the research to determine the year level of participants. Literature in the area of self-efficacy suggests that miscalibration between self-efficacy and performance is evident in younger children (Bandura, 1997; Schunk & Pajares, 2009). Researchers argue that the development of self-efficacy parallels other cognitive developments. As children become more aware of the success criteria of a task, their ability to accurately determine their level of efficacy increases (Bandura, 1997). Miscalibration occurs when there is a misjudgement of the demands of the task and the efficacy expectation is either overestimated or underestimated (Klassen, 2002; Schunk & Pajares, 2009). Children have an inability to simultaneously attend to multiple sources of efficacy information, so immediate attention goes to the most recent experience (Bandura, 1997). This leads to unstable self-appraisals. However, stability comes with age. “As they get older, they begin to use inference rules or heuristics in processing efficacy information” (Bandura, 1997, p.171), in other words, children begin to draw conclusions from their observations of and interactions with their environment more efficiently.

In the current study the two considered year groups were Year Four (approximately Eight years old) and Year Eight (approximately 12 years old). These two groups were chosen because they correspond with the year levels focused on by the National Monitoring Study of Student Achievement in New Zealand (NMSSA), previously known as the National Education Monitoring Project (NEMP). NMSSA is a national study that assesses the achievement of New Zealand primary students across the New Zealand curriculum. This collaboration provided the current study opportunities to validate the sample group to national population in linked tasks and in providing tasks within the assessment measures that accurately linked to the New Zealand curriculum.

The preliminary study consisted of two tasks, a self-efficacy task and a performance task, given to Year Four and Year Eight students (see appendix 1 for examples of the tasks at Year Eight that were replicated in the wider study). Two classes were used for the study. The Year Four class was a co-educational composite class in an integrated urban school. There were 18 students in the Year Four class. The 25 students in the Year Eight class were from a single sex integrated urban school.
In the self-efficacy task the students were asked to read through each of the eight tasks. After reading the question they were asked to circle either very confident, confident, not very confident or not very confident at all. This scale matches the Program of International Student Assessment (PISA) mathematics self-efficacy scale (Organisation for Economic Cooperation & Development, 2005). PISA is a tri-annual assessment of 15 year old students administered by the Organisation for Economic Cooperation and Development (OECD). A 1-4 scale was used to correlate with the confidence scale: 1 being not at all confident through to 4 being very confident. The questions were tasks taken from NEMP Mathematics Assessment 2009 (Crooks, 2010). Figure 6 shows an example the questions asked in the task.

**Figure 6.** Self-efficacy question Year Eight (task adapted from p. 31, National Education Monitoring Project - Mathematics Assessment Results, 2009 (Crooks, 2010).

The questions included relate to the areas of numeracy, algebra, measurement and statistics. This again matched the areas covered in the PISA mathematics self-efficacy scale, which was used to measure self-efficacy in the parent population. The questions have been constructed by the National Education Monitoring Project to fit with the New Zealand mathematics curriculum. In the first task the students were only asked to consider how confident they would feel answering the question. They were not at this point asked to answer the mathematics question (the performance task).

The students were then presented with the performance task, which asked the students to solve the mathematical tasks given earlier. This decision follows recommendations for measuring self-efficacy as suggested by Schunk and Pajares (2009) which stipulate that self-efficacy measures must assess the same or similar skills required for the performance task. The performance task meant that a statistical correlation could be determined between self-efficacy and performance. Again the answers were coded from 1-4. 1 equated to no attempt of
the question, 2 some attempt with no accurate answers, 3 attempted with some accurate answers and 4 being all correct and explanations provided, if requested. In two questions a 1-4 scale was not possible so a 1, 2, 4 scale was used. 1 equating to no attempt, 2 attempted but wrong and 4 correct. This exception allowed the two scales to match. For example, if a child had circled 1 (not confident at all) in the self-efficacy scale and then had not attempted the question in the performance task it can be argued that there was a match between the individual’s estimation of their ability to successfully perform the problem solving task and their actions. They may have decided they were not confident at all about successfully completing the task and so then did not have a go at the task. The self-efficacy task was administered first, followed by the performance task. The self-efficacy task was collected so participants could not adjust their estimation after completing the performance task.

Results from the preliminary study suggested that there was a stronger correlation between the two variables (self-efficacy and performance) at Year Eight (0.69) than Year Four (0.37). The results at Year Eight was $r = .70$, $p < .001$, $r^2 = .49$. There was no statistical significance at Year Four. These results support the literature that suggests that the younger the child the more miscalibrated self-efficacy is to actual performance (Bandura, 1997). This led to the decision to use Year Eight students in the wider study as their maths self-efficacy is more likely to predict performance because of the strong correlation between the maths self-efficacy task and the performance task.

**Participating schools.**

The participating schools were located in the Otago/Southland area. Three of the schools were high schools/colleges with junior departments within them (Years 7-13). One was an intermediate school (Years 7-8), and three were full primary schools (Years 0-8). The schools ranged in socio-economic decile from three through to ten, and from semi-rural through to city schools. Schools were either state schools or state integrated schools (schools with special character, often religious based). Six of the schools were co-educational and one was single-sexed. All Year Eight students at the participating schools were invited to participate. The total possible pool of Year Eight students invited to participate was 544. The response rate for the study was 16%. Pairings of parents and their child were sought, and this may have reduced the response rate.

**Sample.**

The sample consisted of 86 Year Eight – parent pairings who agreed to participate in the study and completed the accompanying surveys. Two pairings were removed from the study,
in one case because of authenticity of consent, and in the other case because of too many missed responses on the scales. The parents’ mean age across the sample was \( n = 81 \) 45.4 years with a range of 34 (34-68 years). The Year Eight students ranged between twelve years old and thirteen years old. The Year Eight sample consisted of 63 females and 21 males. The accompanying parent sample consisted of 62 females (mothers) and 22 males (fathers). The collection of ethnicity data was strongly encouraged by the Ngāi Tahu Research Committee during consultation for Ethical approval. Only the ethnicity of the Year Eight students was collated and reported. 72 students identified as being Pakeha/NZ European, five identified as Māori, one identified as Asian, two identified as other ethnicities not directly named as an option, two as Pakeha/NZ European/Māori, one as Pakeha/NZ European Asian, and one as Pakeha/NZ European Pasifika. The reporting of ethnicity reflects the choices of the individuals. Where individuals have chosen two ethnicities, this has been recorded to respect the choice of the individual.

**Instruments**

The construction of the instruments, the operational constructs, is driven by the conceptual definitions of the variables. For the current study two conceptual constructs have been established.

**Conceptual definition of perceived maths self-efficacy –**

Perceived self-efficacy is an individual’s estimation of their capability to successfully perform a problem-solving task in the mathematical domains of arithmetic, measurement, algebra and statistics (Bandura, 1977). This definition is conceptualised using the literature and research discussed in the section *Maths Self-Efficacy* in Chapter Two.

**Conceptual definition of emotional arousal to mathematics in this study –**

An emotional arousal to mathematics is an individual’s evaluation of the emotional state they experience when they are performing a problem-solving task in the domain of mathematics either in the classroom or in everyday activities (Schunk & Pajares, 2009). This definition is conceptualised using the literature and research discussed in the section *Emotional Arousal to Mathematics* in Chapter Two. In this study the anxious-calm dichotomy is the construct that will solely be explored. The scales, in this regard, will be symmetrical and include only variations of intensity of anxiety and calm.
Child Emotional Arousal to Mathematics Scale (CEAMS).

The Child Anxiety in Math Scale (CAMS) (Jameson, 2013) was adapted for the current study to form the Child Emotional Arousal to Mathematics Scale. This instrument in its original form consisted of 16 items with three factors arriving out of exploratory factor analysis from the original study; General Math Anxiety (GMA), Math Performance Anxiety (MPA) and Math Error Anxiety (MEA). Jameson (2013) used this instrument with 438 child participants ranging from 1st grade (6-7 year olds) to 5th grade (10-11 years old). A subset of 134 of these participants were also given the Wide Range Achievement Test (WRAT-4) (Wilkinson & Robinson (2006) cited in Jameson, 2013) so a correlation could be established between maths anxiety (MA) and performance. The Cronbach alpha for internal consistency for the CAMS was $\alpha = 0.86$. A small effect size was found between the two instruments when a correlation score was determined, $r = -.189$, $p = .032$, $r^2 = .036$.

Five other instruments were considered in the adaption of the CAMS. These were the Mathematics Anxiety Rating Scale MARS (Richardson & Suinn, 1972), the Suinn Mathematics Anxiety Rating Scale for Elementary Students (MARS-E) (Suinn, Taylor, & Edwards, 1988), the Mathematic Anxiety Questionnaire (MAQ) (Wigfield & Meece, 1988), the Mathematic Anxiety Scale for Children (MASC) (Chiu & Henry, 1990) and the mathematic anxiety scale for young children (Harari, Vukovic, & Bailey, 2013). Each instrument will be discussed in terms of its features, and how each of these instruments informed the design of the current instrument, the CEAMS.

The Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972) was one of the original and most influential instruments in the study of maths anxiety (MA) (e.g. (Ashcraft, 2002; Ashcraft & Kirk, 2001; Ashcraft & Moore, 2009; Beilock, Gunderson, Ramirez, & Levine, 2010; Gierl & Bisanz, 1995; Hembree, 1990)). The study and findings that provided the context for the construction of this instrument, along with the other studies and findings for the other instruments, have been discussed in detail in the literature review. The MARS was a 98 item Likert type scale. The items covered both academic and everyday contexts where MA could arise. Although constructed and administered for students it was claimed to be appropriate for non-students as well (Richardson & Suinn, 1972). The scale was a 5 point scale, ranging from 1 – very much anxious to 5 – not at all. The Cronbach alpha for internal consistency was $\alpha = .97$, and the Pearson’s product-moment coefficient was .85 when the initial test was compared to a retest. Similar to a number of the other measures the instrument had a negative valence and a correlation between maths anxiety and performance was tested.
Valence is the term used to define emotions which are evoked by an event, situation, or object, as being either intrinsically attractive (positive) or aversive (negative) (Viinikainen et al., 2010). In the case of the MARS, a negative correlation was found between the two variables. A high score in the MARS correlated with a low score in performance, $r = -0.64$, $p < 0.01$.

The Suinn Mathematics Anxiety Rating Scale for Elementary Students (MARS-E) (Suinn et al., 1988) is an instrument that was adapted from the MARS to investigate MA in elementary aged students. Shortened significantly from the original 98 item instrument, this 26 item Likert type scale also used a 5 point scale but in this case, ‘nervous’ replaced ‘anxious’ in the wording. So 1-very, very nervous to 5–not at all nervous. The Cronbach alpha for internal consistency was $\alpha = 0.88$. Again with the MARS-E a correlation with performance was established through the administration of the Stanford Achievement Test (SAT) in mathematics which is made up of three subtest; mathematics concept, mathematics application and mathematics computation. The correlation between MA and the three subtests ranged from $r = -0.26$ and -0.29 with a total of $r = -0.31$, $p < 0.01$.

The Mathematics Anxiety Questionnaire (MAQ) (Wigfield & Meece, 1988) was administered as part of a battery of instruments in a two year longitudinal study that explored the attitudes, beliefs and values towards mathematics of 564 students in grades 6-12. Initially the MAQ dimension of this battery had 22 items but this was reduced to 19 and then 11 during the analysis phase. This reduction was because of disparity with the conceptual construct of maths anxiety, particularly around dislike of mathematics and perception of ability. Again this instrument had a negative valence and used a 7 point Likert type scale.

The Mathematics Anxiety Scale for Children (MASC) (Chiu & Henry, 1990) was a 22 item Likert type scale which also used ‘nervous’ as a child relevant synonym for anxiety. The scale was a four point scale ranging from very, very nervous to not nervous at all. The MASC was adapted from the Mathematics Anxiety Rating Scale – shortened version (MARS-S), which in turn was adapted from the original MARS. The MARS-S was created for college and high school students so was not appropriate for elementary (primary) age students. This scale had a high correlation with MARS ($r = .97$). The Cronbach alpha for internal consistency was $\alpha = 0.92$.

The fifth instrument that was considered in the adaption of the CAMS for the current study was the Mathematics Anxiety Scale for Young Children (MASYC) (Harari et al., 2013). This instrument was also a Likert type scale. Harari et al (2013) used a four point scale to reduce
cognitive overloading as supported by Beasley, Long, and Natali (2001). The responses being Yes! Agree a lot, yes agree a little, no disagree a little and No! Disagree a lot. The MASYC was constructed of 12 items which included physiological responses commonly associated with state anxiety for example, *When it is time for maths my head hurts* and *When it is time to do maths my heartbeats fast.* The instrument was titled ‘Feelings about Maths’ on the survey sheets and, unlike many of the other instruments, was both positive (attractive) and negative (aversive) in valence. The Cronbach alpha for internal consistency was $\alpha = .70$. The explanatory factor analysis suggested that MA is a multidimensional construct.

Five instruments each offered considerations for the choice and possible adaptions for the current study. The specific features are listed below;

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MARS</strong> (Richardson &amp; Suinn, 1972)</td>
<td>Use of the word ‘anxiety’ in the scale Use of both every day and academic contexts for items</td>
</tr>
<tr>
<td><strong>MARS-E</strong> (Suinn et al., 1988)</td>
<td>Use of the word ‘nervous’ in place of ‘anxiety’ Inclusion of test related questions</td>
</tr>
<tr>
<td><strong>MAQ</strong> (Wigfield &amp; Meece, 1988)</td>
<td>Inclusion of test related questions and correlation with test anxiety tools</td>
</tr>
<tr>
<td><strong>MASC</strong> (Chiu &amp; Henry, 1990)</td>
<td>Use of maths content questions Inclusion of test related questions and correlation with test anxiety tools Four point scale and use of the word ‘nervous’</td>
</tr>
<tr>
<td><strong>MASYC</strong> (Harari et al., 2013)</td>
<td>MA instrument used last in administration Positive and negative valence Four point scale</td>
</tr>
<tr>
<td><strong>CAMS</strong> (Jameson, 2013)</td>
<td>Positive and negative valence Use of both every day and academic contexts for items Inclusion of test related questions</td>
</tr>
</tbody>
</table>

*Figure 7. Summary of contributing instruments for the child emotional arousal scale.*

The CAMS was chosen to be the base of the current study and was adapted accordingly. Permission to adapt the CAMS was granted by the author Assistant Professor Molly Jameson (personal communication, March 3rd, 2015). This instrument was chosen because it included items that facilitated both positive and negative valence in their responses, as also described in
the MASYC (Harari et al., 2013) instrument. This focus on the positive and negative valence also gives justification for the name of the current instrument, the Child Emotional Arousal to Mathematics Scale. Jameson’s study and consequentially, the tool constructed for her study, focused specifically on the identification of MA. The current study has a broader focus of identifying both anxious and non-anxious responses, the calm-anxious dichotomy. Another reason for the choice of the CAMS was that the items covered classroom and home contexts for the application of mathematics instruction, but not specific content related questions, such as items relating to mathematics operational strategies as used in the MASC (Chiu & Henry, 1990) and the MARS-E (Suinn et al., 1988). These items are very specific to the American school context and some of the content does not fit with the numeracy framework of New Zealand. Furthermore, one item was removed from the CAMS inventory as it referred to taking a maths test. The inclusion or exclusion of test related items is debated in literature and research as discussed in the earlier literature review (Harari et al., 2013). Test anxiety within the current discussion is regarded as a separate type of anxiety (Hembree, 1990), which obscures the boundaries of MA. The remaining 15 items are illustrated below. Four further items were adjusted for the NZ context; these adjustments included changing math to maths, changing blackboard to whiteboard, and changing the phrase ‘calling on’ to asking’. The final wording in the instruments is below:

When I solve maths problems, I feel:
When I think about doing maths, I feel:
When I am working on maths problems that are difficult and make me think hard, I feel:
Compared to other school subjects, maths makes me feel:
When I solve maths puzzles, I feel:
When I have a hard maths question, I feel:
When the teacher calls on me to answer a maths question, I feel:
When the teacher is showing the class how to solve a maths problem, I feel:
If I had to add up numbers on the whiteboard in front of the class, I feel:
When I make a mistake in maths, I feel:
Thinking about working on maths in class makes me feel:
Working on maths at home makes me feel:
When the teacher gives the class a maths problem I don’t understand, I feel:
When my teacher says that he or she is going to give me a maths question on the whiteboard, I feel:
When I know that my class will be working on maths at school, I feel:

The original version included five facial icons which represented a five point Likert type scale. In the adapted version these icons have been removed because it was deemed inappropriate to get Year Eights to use the facial icons, as they were able to understand and identify with the words that they represented. This adaption was validated during the pilot study which is discussed in the procedure section. They are replaced with the following scale,

Very Anxious/Nervous, Anxious/Nervous, Calm, and Very Calm.

The inclusion of the synonyms nervous and anxious is supported by their presence in the MASC (Chiu & Henry, 1990), MARS (Richardson & Suinn, 1972) and MARS-E (Suinn et al., 1988). The other adjustment that was made in relation to the scale was the removal of the neutral third point. This use of a four point scale instead of a five point scale is supported by its presence in the MASC (Chiu & Henry, 1990) and the MASYC (Harari et al., 2013). Harari et al. (2013) justify this choice so as to reduce cognitive demand. A neutral point was avoided to limit cognitive overload and to focus the participants to commit to a more descriptive response. Recommendations to administer the emotional arousal scale after the maths self-efficacy scale was also incorporated to avoid the possibility that completing the emotional arousal to mathematics scale would influence performance on the maths self-efficacy scale (Gierl & Bisanz, 1995; Harari et al., 2013). The Cronbach alpha for the CEAMS was \( \alpha = .94 \). The Cronbach alpha was used to determine the internal consistency of the scales, and was calculated using the IBM statistical package, Statistical Package for Social Sciences (SPSS). If the Cronbach alpha is over seven it is considered that the internal consistency of the scale is good.

Parent Emotional Arousal to Mathematics Scale (PEAMS).

The Parent Emotional Arousal to Mathematics Scale (PEAMS) was adapted from the CEAMS. There is a gap in the research of instruments that explore adult emotional arousal to mathematics in relation to everyday contexts, and in relation to being a parent. The items were constructed using everyday contexts and situations that would have been familiar to adults. If parents were asked to respond to items about their experience of school mathematics, their memories of these events may have been unreliable because of the time lapse. An everyday context was therefore used (Gardner, 2001; Loftus, 2003).
Jameson (2013) identified three significant factors that arose out of the CAMS factor analysis, General Mathematics Anxiety, Mathematics Error Anxiety and Mathematics Performance Anxiety. The construction of the 16 items that made up the CEAMS matched the CAMS factors where possible. The 16 items are listed below.

- When I am faced with everyday problems that involve maths, I feel:
- When I know I have to use maths, I feel:
- If a bank consultant was explaining interest rates to me, I would feel:
- If I was asked to work out a 65% discount on a jacket before I reached the checkout, I would feel:
- Working out quantities when I need to double a recipe makes me feel:
- When I know it is time to check my tax return using maths calculations, I feel:
- Working out the area and volume of paint I need for a fence makes me feel:
- When my child asks me to help with maths homework, I feel:
- If I was asked to run the sausage sizzle at the school fair and I make a mistake giving the change I would feel:
- If I had to use some of the maths I learnt at school like algebra I would feel:
- When I am helping my child with maths, I feel:
- When my child’s teacher is discussing maths strategies with me, I feel:
- When someone asks me the answer for a times table like 7 x 9, I feel:
- If I was asked to be the treasurer for a sports club I would feel:
- If a new job or course required me to take a maths paper or course I would feel:
- If I was asked to work out the average electricity used in our home over a year for a price comparison website I would feel:

The response scale for the PEAMS matched that of the CEAMS with the only variation being the removal of the word ‘nervous’. ‘Nervous’ was removed as its inclusion was deemed superfluous for adult participants. A four point Likert type scale with options including, Very Anxious, Anxious, Calm and Very Calm was used. The Cronbach alpha for the PEAMS was \( \alpha = .93 \). Again, this alpha suggests the internal consistency for this measure was good.

**Child Maths Self-Efficacy Scale (CMSEFF).**

Bandura argued that self-efficacy instruments need to be domain and task specific by nature, and that global measures are not effective in predicting accurate self-efficacy (Bandura, 1977; Pajares & Miller, 1995; Schunk & Pajares, 2009) “To be both explanatory and predictive self-efficacy measures should be tailored to the domain(s) of functioning being analysed and reflect the various task demands within the domain” (Schunk & Pajares, 2009, p. 50).
In determining the tasks that combine to make an instrument, a good understanding of the domain and required capabilities and applications is necessary (Bandura, 1993; Pajares & Kranzler, 1995; Pajares & Miller, 1995). Multon, Brown, and Lent (1991) meta-analysis of research around self-efficacy measures argued that strongest effects on accurate prediction are made when the instrument used compares efficacy judgements to specific domain tasks that relate to specific measures of performance. These considerations were made when examining significant research in the domain of maths self-efficacy.

Betz and Hackett (1983) constructed the Mathematics Self Efficacy Scale (MSES) to study the self-efficacy levels of undergraduate college students in relation to behaviours relevant to mathematics. One of the behaviours that Betz and Hackett identified as being significant to the domain of mathematics was problem solving, so this was one of the three subscales that they introduced when constructing the MSES. Betz and Hackett used preliminary questions from Dowling’s Problem subscale from the Mathematics Confidence Scale (as cited in Betz & Hackett, 1983) for this component of the MSES. The MSES was made up of three subscales, mathematics tasks, mathematics problem solving, and college course completion. 52 items were included in the instrument (18 problem solving, 18 tasks and 16 relating to college courses). The scale used a 10 point Likert type scale with 0 - no confidence through to 9 - complete confidence. An example of a problem solving questions is, “Determine how much interest you will end up paying on a $695 loan over 2 years at 14.75% interest?” (Betz & Hackett, 1983, p. 335).

The coefficient alpha for internal consistency was .96 over the 52 items. This suggests strong internal consistency for this instrument, in relation to all items relating to the operational construct maths self-efficacy.

Pajares and Miller (1995) revised the MSES by reducing the scale from a 10 point scale to a 5 point and using different questions taken from the Problems subscale in Dowling (1978) Mathematics Confidence Scale. The Mathematics Self Efficacy Scale – Revised consisted of three subscales similar to the original MSES. The three subscales, like the MSES, were solving maths problems, completion of mathematics tasks in everyday contexts, and satisfactory performance in college courses. The coefficient alpha for internal consistency was .90 for Problems, .91 for Tasks and .92 for Courses. These signal strong internal consistency for these three subscales. Pajares and Miller (1995) noted that, in an earlier study by Langenfeld and Pajares (as cited in Pajares & Miller, 1995), the reduction from a 10 point scale to a 5 point scale had no loss in internal consistency.
Fast et al. (2010) incorporated a four question subscale for maths self-efficacy in their Student Motivation Questionnaire (SMQ). This small subscale was considered in the current study as the participants for the study ranged between 4th and 6th grade so were close to the participant age in the current study. The subscale used a 5 point Likert type scale, 1 = not at all true, 3 = somewhat true, and 5 = very true. The coefficient alpha for internal consistency across the four items was .84. This suggests strong internal consistency that all four items are measuring one construct, maths self-efficacy. However, criticism can be made in relation to the validity of the subscale because of its’ globalised nature. The four questions measure generalised self-efficacy in the domain of mathematics, and are not task specific as recommended by Bandura (1977) and argued by Pajares and Miller (1995), Schunk and Pajares (2009), and Betz and Hackett (1983). For example, one of the questions is “I am sure I can learn everything in maths”. This question does not refer to a specific behaviour with a measurable outcome, the most significant criteria for accurately predicting a participant’s self-efficacy (Bandura, 1977). The maths self-efficacy subscale was not considered for the current study because of this discrepancy.

Griggs, Rimm-Kaufman, Merritt, and Patton (2013) investigated correlations between self-efficacy and anxiety in the domains of science and mathematics. This study had a significant sample population of 1,561 5th graders (10-11 years old). The instrument, the Self Efficacy and Anxiety Questionnaire (SEAQ) was made up of two subscales, one being for anxiety (10 questions) and one being for self-efficacy (10 questions). The two subscales were then evenly divided between science and math, containing five questions about anxiety in mathematics and five questions about self-efficacy in mathematics. The scale used a 4 point Likert type scale ranging from 1 - almost never, through to 4 - almost all the time. The coefficient alpha for internal consistency across the scale was $\alpha = .82$ meaning internal consistency was strong and the scales items appeared to measure the operationalised construct of maths self-efficacy. Again, this instrument, like the self-efficacy in mathematics subscale in the SMQ (Fast et al., 2010), measured globalised self-efficacy in the domain of mathematics and not the more empirically vigorous task specific measures. An example of this generalised nature is the question, “I know I can learn the skills taught in maths this year”.

The four instruments discussed above offered considerations for the choice and possible adaptations for the current study. These are summarised in Figure 8 below.
The Maths Self-Efficacy items (MATHEFF) (OECD) from PISA 2012, originally included in the 2003 PISA assessment program, provided 8 items that were purposefully designed to be task specific in the domain of mathematics (OECD, 2005). Although the PISA instrument was designed for 15 year olds, the tasks were deemed necessary tasks for the individual to operate successfully in the world around them. For this reason they were chosen as the instrument for predicting maths self-efficacy in parents. Specific details of the instrument are found in the following section. However, the most significant aspects of the instrument that relate to the construction of the child self-efficacy instrument is the wording used on the 4 point scale and domain specific areas covered in the items. The MATHEFF (OECD) scale is a 4 point Likert type scale and uses the following range, Very confident, Confident, Not very confident, and Not very confident at all. The areas of mathematics covered in the task specific items include measurement, statistics, and algebra. These areas were included in the construction of the instrument used in the current study. For the child instrument, tasks were selected from the National Education Monitoring Project 2009 (Crooks, 2010). The tasks, which are graduated in levels of difficulty, were selected to reflect the content of the NZ mathematics curriculum at Year Eight. The rationale behind the task selection is illustrated in the following statement from the National Education Monitoring Project Assessment Results 2009 report, “Tasks are chosen because they provide a good representation of important knowledge and skills, but also because they meet a number of requirements to do with their administration and presentation” (Crooks, 2010, p. 9).

The instrument used was the same instrument used in the participant determination stage, as described in the section Child Emotional Arousal to Mathematics. A full copy of the

instrument is in appendix 1. The Cronbach alpha for the CMSEFF was strong for internal consistency, $\alpha = .81$.

**Parent Maths Self-Efficacy Scale (PMSEFF).**

The PISA Mathematics Self-efficacy questions were used as the parent instrument. Permission to use these items was granted by PISA NZ. The eight items were task specific and their construction echoes the recommendations of Bandura and Pajares in relation to avoiding general measures of self-efficacy (Bandura, 1977; Pajares & Miller, 1995). In 2003, when these items were first included in the PISA battery, the coefficient alpha for internal consistency across the scale was $\alpha = .86$ for the NZ sample, and $\alpha = .82$ across the whole OECD. In 2012 the coefficient alpha for internal consistency across the scale was $\alpha = .88$ for the NZ sample and $\alpha = .85$ across the whole OECD. The questions used were graduated in relation to difficulty and included both linear equations and more challenging problems that involved the application of rates and proportions in real life situations. These questions covered a diverse range of everyday situations that involved the application of mathematical problem solving. The 8 items used are listed below.

*How confident would you feel answering the following mathematics tasks?*

- Using the train timetable to work out how long it would take to get from one place to another
- Calculating how much cheaper a TV would be after a 30% discount
- Calculating how many square metres of tiles you need to cover a floor
- Understanding graphs presented in newspapers
- Solving an equation like $3x + 5 = 17$
- Finding the actual distance between two places on a map with a 1:10 000 scale
- Solving an equation like $2(x +3) = (x+3)(x-3)$
- Calculating the petrol consumption rate of a car

The Cronbach alpha for the PMSEFF was $\alpha = .91$.

**NMSSA attitude to mathematics scale and open questions.**

The National Monitoring Study of Student Achievement (NMSSA) is a program of assessment that is administered to Year 4 and Year 8 students from across New Zealand. NMSSA is administered on a five year cycle and is designed to assess and understand student achievement across the NZ Curriculum. Mathematics and statistics was assessed in 2013 and one component of the student questionnaire was the Attitude to Mathematics Scale. In this
scale students were asked to “show how much they agreed with a number of statements related to their general self-efficacy in mathematics and statistics and their level of engagement and interest in mathematics learning” (Education Assessment Research Unit, 2015, p. 21). Measuring general maths self-efficacy goes against cautions in constructing and measuring maths self-efficacy (Bandura, 1986; Pajares & Miller, 1995), which warn that measuring general self-efficacy in a domain is not an accurate measure of an individual’s self-efficacy, as outlined in the section Child Maths Self-Efficacy. The NMSSA Attitude Scale is also weighted heavily to the positive. For example, the students can respond to each item with one of the following responses: Do not agree at all, Agree a little, Agree quite a lot, and Totally Agree. Three of the statements are in agreement (positive) and only one is in disagreement (negative). There is an imbalance in the nature of the possible responses. However, regardless of these two criticisms the NMSSA Attitude to Mathematics Scale was included as a tool to measure the study sample against the general NZ population for purposes of generalisability. The scale is presented in sample Year Eight survey in the Appendices, but the eight items are also described below.

- I usually do well in maths.
- I am good at maths.
- My parents think I am good at maths.
- I think maths is interesting.
- I like doing maths at school.
- I would like to do more maths at school.
- I want to keep learning about maths when I grow up.
- I learn useful things in maths at school.

The final part in each survey was the open questions. The questions were directed by literature in the field of maths self-efficacy and maths anxiety. This is a variation away from pure sequential explanatory design, as questions are usually determined after analysis of quantitative analysis. However, because of pragmatic reasons associated with the timeframe, the questions were determined and administered at the same time as the other scales. The first question was the same for both the Year Eight students and Parents:

1. Describe your emotional response to maths. List all the words or phrases you can think of that you could use.

Then the questions differed. The questions specifically for the parents are presented first followed by the questions that were specifically for the students.
2. How did you feel about maths when you were at school?
3. If you have a significant memory of maths at school that shaped how you feel about maths today, please describe that memory?
4. Do you help your child with maths homework? Yes/No (circle one)
   If yes, describe how you help your child with their maths homework?
   Describe a recent experience if possible.
   If no (or only sometimes), what prevents you from helping your child with maths?

Year Eight questions
2. How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?
3. Do you think the parent who has agreed to participate in this study is good at maths? Yes/No (Circle one)
   Why do you think this? (If you can think of examples to support your reason please include e.g. Mum loves working out the savings when we go shopping or Dad often says 'he is rubbish at maths')
4. Is maths important in your family? Yes/No (Circle one)
   How do you know this?
5. Has the parent who has agreed to participate in this study ever talked about their experiences of maths when they were at school? Yes/No
   What have they told you?
6. Does the parent who has agreed to participate in this study help you with maths homework? Yes/No (circle one)
   If they do help, how do they help you?
   If they don’t help, why do think they don’t help you?

**Procedure**

**Pilot study.**

Both the Year Eight survey and the Parent survey was piloted on appropriately matched samples (e.g. a group of postgraduate students who were also parents of school aged children). The Year Eight sample consisted of a class of 24 Year Eight students. This class was the Year Eight group of students used in the Participant Determination study (see the section Participant Determination). They were not therefore recruited in the larger study because of pre-exposure to the nature and design of the study. The pilot study group were asked to complete the survey by the researcher during a mathematics class. The time taken for the first student to complete the survey was recorded along with time taken for the last
At the completion of the survey the group was asked for feedback around the design of the survey.

One of the questions in the maths self-efficacy scale was noted as being ambiguous, the clarity of the response boxes and their link to each question was noted, and the choice of wording for the emotional arousal scale was discussed. In each of these cases revisions were made. On analysis the open questions needed to specify that the student had to think of the parent who agreed to participate in the study, when responding. The pilot study also gave an opportunity to establish an answer rubric for the wider study which followed the 1-4 marking scale established in the Participant Determination study. In all scales 1 was the most negative option and 4 was the most positive.

The pilot sample for the parent/guardian survey consisted of six postgraduate students who identified as being parents. The pilot group were asked to complete the survey in their own time, but with a deadline of a week after distribution. This mimicked the timeline for the wider study. Eight surveys were distributed and six were returned. In following up the two who didn’t return the survey, one reported that they did not because they had discussed it with their husband and then forgot it at home, and the other reported that they had lost the survey. Using an online survey was recommended to account for this, but it was decided not to pursue this as relying on this method would limit possible participants to those who had access to computers and the internet. Other recommendations from the pilot parent sample were to remove the word nervous from the Parent Emotional Arousal Scale, leaving just the word anxious, and to adjust the wording of the first open question. Both of these recommendations were accepted with the first question being adjusted to match the first open question in the Year Eight survey. The final set of surveys can be found in the appendices.

**Recruitment and administration.**

A list of full primary, intermediate, and high school/colleges with junior departments from the Otago and Southland region was constructed, and all schools were invited to participate in the study. A letter to either the Principal and/or Dean, which outlined the study and the level of school involvement was sent, and a consent form was included with a self-addressed envelope for its return (See appendix 3 for a copy of this letter). Schools were offered a day of teacher relieving to acknowledge their participation in the study, and this was authorised by the University of Otago Ethics committee. Seven schools agreed to participate and all were included in the study. An initial recruitment session with all Year Eight students in each school, that agreed to participate, was then scheduled.
In five of the schools the research and invitation to participate was presented on a class by class basis. In the other two schools the Year Eight students were gathered into one area for the presentation. The delivery of information about the research was consistent across the classes and schools. All Year Eight students were given an information and consent package which included the information sheet for parents, the information brochure for Year Eight students, the consent form parent/guardian participants, the consent form for the Year Eight students, along with the parent survey and a returning envelope. Parents/guardians in this study were defined as anyone who was the permanent primary carer of the child and could include grandparents and other members of the extended family/whanau. It was made clear in the recruitment that only the Year Eight students whose parent/guardian agreed to participate could take part in the study. All information sheets and brochures, and consent forms were ratified by the University of Otago Ethics committee. Examples of the information sheets are included in the appendices (see appendix 4 & 5).

As mentioned in the section *Child Emotional Arousal*, the order of the scales within the survey was important, particularly for younger participants. The Year Eight survey followed this order but, unfortunately, in the process of printing the parent survey, the PEAMS was first and was followed by the PMSEFF. The resulting implications of this will be discussed in the final chapter. The Year Eight students were asked to return the envelopes containing the completed consent forms and parent surveys to either the school office, or a special box placed in each class.

Between four and six weeks was allowed between the initial recruitment session and the Year Eight survey session. This delay was designed to mitigate the influence of possible discussions between parents and Year Eight students and the possibility of increased focus on homework interactions that may have influenced the responses given by students in the subsequent session. During the Year Eight survey session participants gathered in a quiet area of the school such as the library. All schools opted for the students to be removed from class rather than the session taking place within the mathematics class. The participating schools chose an area and a time which was convenient to them. At the beginning of the session the students were given an identification code, which was given to each Year Eight–parent pairing. In filling in their own survey, the students were asked to think of the parent who had filled in the survey. The students were given up to 45 minutes to complete the survey. In the pilot study the survey had taken on average 22 minutes to fill out, so an extra 23 minutes was allowed for instructions to be given at the beginning and for slower writers to complete the survey. On completion the surveys were collected and the students returned to class.
Phase one – quantitative analysis.

The scales were marked according to the 1-4 rubric confirmed during the pilot study. The item responses for each participant were recorded on a SPSS data field. Each row corresponded to one Year Eight – parent pairing. Figure 9 illustrates how the data was recorded in SPSS. The pairing codes are missing for anonymity.

<table>
<thead>
<tr>
<th>Pairing Code</th>
<th>School</th>
<th>P_Gend</th>
<th>Yr8_Gend</th>
<th>Yr8_Eth...</th>
<th>P_Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>57</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>49</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>39</td>
</tr>
</tbody>
</table>

Figure 9. An example of a spss data field coding.

Once all responses were recorded on SPSS and systematically checked, a random cross check of 12% of the sample was carried out between numbers recorded on SPSS and the responses given on survey returns. The research supervisor assisted with this cross check. The ten pairings were determined using the random function on a calculator. This accounted for 12% of the sample and with 100% accuracy with the sample of ten it was agreed that the recording of responses was accurate. All the items for each scale were summed to establish a score for each scale. These were used for classification purposes during analysis.

The measures of central tendency and variability for maths self-efficacy and emotional arousal to mathematics were determined and reported. An independent t-test was used to explore any difference between ethnicities and gender. The effect size was determined using Cohen’s d. Reliability and variability were examined through the application of Cronbach’s Alpha and an exploratory factor analysis. Finally, correlations between the different variables were determined using Pearson’s bivariate correlation coefficient. More detail for the procedures carried out in this phase can been explored in Chapter Four.

Phase two – integration phase.

During the Integration phase of analysis, direction for the Qualitative phase was determined. Firstly, the quantitative findings were explored in relation to literature. Then the anomalies were reported as is characteristic of the sequential explanatory design. Classification of all parents and Year Eights into three categories for each affective variable was determined using the results of the PEAMS, CEAMS, PMSEFF and CMSEFF (PEAMS and CEAMS – maths
anxious, vulnerable to maths anxiety, and calm. PMSEFF and CMSEFF – low maths self-efficacy, moderate maths self-efficacy, and high self-efficacy). The rationale for this analysis is discussed further in the section Qualitative Phase Rationale.

Parental modelling was specifically defined in this research as the interactions and actions associated with homework. Whilst it is acknowledged that there are many other forms and opportunities for parents to model their mathematical affect, interactions and actions associated with homework were the focus of the qualitative phase of the current study.

The first level of coding of the qualitative stage, was categorising Year Eight responses into those where the participating parent does assist with homework and those that do not. Question six of the Year Eight survey was used to determine this. 60 parents assisted with homework according to survey responses, 23 did not. One Year Eight did not answer question six so that pairing was removed. The total number of pairings considered was 83.

As a secondary quantitative investigation was possible using this first level of coding, a new variable was entered into SPSS. ‘1’ was used to identify those that assisted, and ‘2’ was used for those that did not. Using this new variable on SPSS, it was then possible to calculate whether or not a correlation existed between the parents’ emotional arousal to mathematics and maths self-efficacy, and the Year Eights’ emotional arousal to mathematics and maths self-efficacy, according to reports of assisting, or not, with mathematics homework.

Phase three – qualitative phase.

A general inductive approach for analysing the qualitative data was used (Thomas, 2006). “The inductive approach is a systematic procedure for analysing qualitative data in which the analysis is likely to be guided by specific evaluation objectives” (Thomas, 2006, p. 238). In the case of the current study, the specific evaluation objective was to explore why parents do not assist with mathematics homework, and when they do, the ways they assist, as reported by the Year Eights. Initially the raw data was coded into those that assisted and those that did not, as discussed in the section above. The next level of coding required the identification of parents as either mothers or fathers. Then those that did not assist with mathematics homework, coded ‘no’, were coded further. Initially ten categories came out of the first analysis of the raw data. Each response could only be coded into one category, so the predominant explanation was used. These ten were combined, where appropriate to make four categories: Doesn’t want/need help with mathematics homework; Parent can’t help; No homework given; and, Other Parent assists. However, during the second coding it became
apparent that the last category needed to be split to reflect whether the Year Eight choose the other parent to assist, or whether the participating parent delegated to the other parent. Five final categories were used and a final coding was applied to determine frequencies and distributions according to familial relationship.

The analysis for the parents who did assist with homework, those coded ‘yes’, occurred in a similar way. Again, as with the non-assisting parents, each response could only be coded into one category, so the predominant explanation was used. Initially coding occurred to determine familial relationship. The next level of coding highlighted 12 categories. These were reduced to eight and were used for the final analysis to determine frequency and distribution according to familial relationship.

The categories of assisting were also explored in relation to the emotional arousal classification of the parents. In this case each pairing was identified by their identifier, their category of helping, and their reason, for example 977 yes – explains problems. All pairings were bundled according to category. So all the ‘yes - explains problems’ were bundled as determined by the parent and/or child. Then the pairings in the categories were separated according to classification according to the PEAMS, for example, yes – explains problems – Calm. When reporting the responses from the analysis, Year Eight responses will be reported with the identifier and a “c” (i.e., 543c), and parent responses will be reported with the identifier and a “p” (i.e., 543p).

**Ethical Considerations**

The University of Otago Ethical Practices in Research and Teaching Involving Human Participation clearly establishes the ethical boundaries that the current study will be carried out within. As mentioned in the section that discusses the sequential explanatory design, ethical consent for studies that use the sequential explanatory design can be problematic as the second phase of the study is undetermined initially, as it is constructed from the results of the quantitative phase (Creswell, 2011; Ivankova et al., 2006). However, this was not the case in the current study. Ethical approval was sought and approved from the University of Otago Ethics Committee, and amendments to the initial design were ratified. Consent was sought from the participating schools. Information and consent packages were given to all Year 8 students at the participating schools. This included a separate information/brochure with a brief background to the study, an outline of the study, the required level of involvement, credentials of the researcher/s and an opportunity to discuss any aspect of the study in person or my phone or email contact. It was clearly stated that withdrawal at any time was permitted.
and would not be challenged. Copies of the information sheets and consent forms can be found in the appendices (see appendix 4-7).

As this study involved personal disclosure both in the surveys and the accompanying short answer section, confidentiality was paramount. In the information sheet and consent sheet it was made clear that data will be kept in a locked cabinet and will be destroyed after 5 years. Participants and schools were not identifiable in the findings and reporting. Special considerations need to be made as children are involved in the study. All Year 8 students in the participating schools were invited to be involved in the study. During the administration of the survey the researcher was vigilant to any obvious emotional responses such as anxiety that were demonstrated by students as a reaction to the instruments or questions. The researcher was prepared to intervene if appropriate and had immediate access to the appropriate member of staff who could deal with an incident of this nature.
Chapter Four - Findings and Discussion

In this chapter the findings from the current study are presented. As the design of the study follows the general pattern of a sequential explanatory mixed method design (see Figure 5), the results and findings of three phases of analyses are presented. Results of the quantitative exploration are presented first and take priority (Plano Clark & Creswell, 2008). In the integration phase, discussion of the quantitative findings in relation to literature are presented, along with the presentation and rationale of questions to be explored in the qualitative phase. These questions aim to suggest provisional explanations for the findings and anomalies that arose from the quantitative results. Finally, the qualitative phase will explore the responses of the study population in relation to these questions.

Phase One – Quantitative Results

The quantitative data was collected from 84 pairings of children and their parents across seven schools. The data consisted of demographic identification and numeric responses from the Parent Maths Self-Efficacy Scale (PMSEFF), the Parental Emotional Arousal to Mathematics Scale (PEAMS), the Child Maths Self-Efficacy Scale (CMSEFF), and the Child Emotional Arousal to Mathematics Scale (CEAMS). These responses were gathered using 4-point Likert type scales. The maths self-efficacy scales ranged from 1-not confident at all to 4-very confident. The emotional arousal scale was based on ratings of 1-very anxious to 4-very calm.

This quantitative data was analysed using IBM SPSS Statistics version 22 (IBM Corporation, 2013) software to explore the following hypotheses:

1. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ maths self-efficacy.
2. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ emotional arousal to mathematics.
3. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ emotional arousal to mathematics.
4. There is a significant positive correlation between Years Eight children’s emotional arousal to mathematics and parents’ maths self-efficacy.

The literature has suggested that there is a significant difference in means between males and females in relation to maths anxiety (see the section Effects of Maths Anxiety in Chapter Two)
(Ma & Cartwright, 2003; Tobias, 1993). In response to this literature, the demographic distributions are explored along with comparisons across genders.

**Measures of central tendency and variability for maths self-efficacy and emotional arousal to mathematics.**

Individuals’ responses to questions were totalled for each instrument and the mean and median scores were calculated (see Table 1). The possible ranges of total scores for the instruments were between 8 and 32 for the CMSEFF and PMSEFF, and between 15 and 60 for the CEAMS, and between 16 and 64 for the PEAMS.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>Mdn</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CMSEFF</strong></td>
<td>25.56</td>
<td>26.00</td>
<td>3.94</td>
</tr>
<tr>
<td><strong>PMSEFF</strong></td>
<td>24.55</td>
<td>25.00</td>
<td>5.22</td>
</tr>
<tr>
<td><strong>CEAMS</strong></td>
<td>42.61</td>
<td>41.00</td>
<td>9.21</td>
</tr>
<tr>
<td><strong>PEAMS</strong></td>
<td>48.20</td>
<td>49.00</td>
<td>8.79</td>
</tr>
</tbody>
</table>

To investigate the strength of the relationship between maths self-efficacy and emotional arousal to mathematics, correlations between the maths self-efficacy scales and emotional arousal to mathematics scales were calculated. To determine this correlation the summed scores of the scales were used. There was a strong positive significant correlation of $r (82) = .89, p < .01$ between the parent scales, PMSEFF and PEAMS. The coefficient of determination was $r^2 = .79$, indicating that 79% of variation in parent maths self-efficacy was explained by the variation in parent emotional arousal in mathematics. There was also a moderate yet significant positive correlation of $r (82) = .61, p < .01, r^2 = .37$ between the Year Eights’ maths self-efficacy (CMSEFF) and emotional arousal in mathematics (CEAMS). The coefficient of determination was $r^2 = .37$, indicating that 37% of variation in Year Eight maths self-efficacy was explained by the variation in Year Eight emotional arousal to mathematics.

The means and standard deviations according to ethnicity are presented in Table 2. Again summed scores were used to determine these measures of central tendencies and variability.
Table 2. Means and Standard Deviations for Ethnicity for Year 8 Participants

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>CMSEFF M</th>
<th>CMSEFF SD</th>
<th>CEAMS M</th>
<th>CEAMS SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakeha/NZ European (72)</td>
<td>25.65</td>
<td>3.69</td>
<td>42.89</td>
<td>9.25</td>
</tr>
<tr>
<td>Māori (5)</td>
<td>21.80</td>
<td>4.60</td>
<td>35.20</td>
<td>7.53</td>
</tr>
<tr>
<td>Asian (1)†</td>
<td>28.00</td>
<td>-</td>
<td>49.00</td>
<td>-</td>
</tr>
<tr>
<td>Other (2)</td>
<td>31.50</td>
<td>.71</td>
<td>48.5</td>
<td>10.61</td>
</tr>
<tr>
<td>Pakeha/Māori (2)</td>
<td>24.50</td>
<td>9.19</td>
<td>42.00</td>
<td>14.14</td>
</tr>
<tr>
<td>NZ/Asian (1)</td>
<td>25.00</td>
<td>-</td>
<td>38.00</td>
<td>-</td>
</tr>
<tr>
<td>NZ/Pasifika (1)</td>
<td>26.00</td>
<td>-</td>
<td>47.00</td>
<td>-</td>
</tr>
</tbody>
</table>

To investigate if there were any differences between means when ethnicity was considered, independent samples t-test were performed using the summed scores for both the CMSEFF and CEAM scales. The Year Eights who identified as Pakeha/NZ European had a maths self-efficacy mean of 25.65 (SD = 3.69), while Year Eights who identified as Māori had a mean of 21.8 (SD = 4.60). Maths self-efficacy levels between Pakeha/NZ European Year Eights and Māori Year Eights differ significantly within this study sample, t (75) = 2.22, \( p = .03 \) (\( p < .05 \)). A significant difference was found in maths self-efficacy levels between Pakeha/NZ European Year Eights and Māori Year Eights, t (75) = 2.22, \( p = .03 \) (\( p < .05 \)); the effect size was large (0.92). Cohen’s \( d \) was used to determine effect size, and the size was classified accordingly (Smith, 2009). The large effect size between the reported maths self-efficacy of children who identify as Pakeha/NZ European and Māori points to a significant difference in maths self-efficacy between these two groups, in that Pakeha/NZ European Year Eights had higher levels of maths self-efficacy, according to means, than their Māori Year Eight counterparts. However, Māori Year Eights only accounted for 6% (5 Year Eights) of the sample population, which is small, so it is difficult to generalise from this. No other ethnicities had enough representative Year Eights to carry out an independent sample t-test with any significance. No significant difference was found between means in relation to emotional arousal.

† In cases where only one student identified as a specific ethnicity then the total score is presented.
The means and standard deviations for all participants according to gender are presented in Table 3. The summed scores for all four scales were used to calculate these measures of central tendencies and variability.

Table 3. Means and Standard Deviations for All Participants by Gender

<table>
<thead>
<tr>
<th></th>
<th>CMSEFF</th>
<th>CEAMS</th>
<th>PMSEFF</th>
<th>PEAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Year 8 Girls (63)</td>
<td>24.89</td>
<td>3.93</td>
<td>41.14</td>
<td>9.26</td>
</tr>
<tr>
<td>Year 8 Boys (21)</td>
<td>27.57</td>
<td>3.28</td>
<td>47.02</td>
<td>7.69</td>
</tr>
<tr>
<td>Parent Female (62)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parent Male (22)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

To investigate if there were any differences between means when gender was considered, independent samples t-test were performed using the summed scores for the CMSEFF and CEAM, and PMSEFF and PEAM accordingly. Mean Year Eight boys maths self-efficacy level was 27.57 (SD = 3.28), while that of Year Eight girls was 24.89 (SD = 3.93). Maths self-efficacy levels between girls and boys differ significantly within this study sample, $t(82) = -2.81, p = .006$ ($p < .01$). A significant difference was found in maths self-efficacy levels between boys and girls, $t(82) = -2.81, p = .006$ ($p < .01$); effect size was moderate (0.74). Cohen’s $d$ was calculated to determine the effect size. Year Eight boys are moderately more confident (self-efficacious) than their female counterparts when presented with tasks that require mathematics problem solving.

Mean Year Eight boys mathematics emotional arousal level was 47.02 (SD = 7.69), while that of Year Eight girls was 41.14 (SD = 9.26). Mathematics emotional arousal levels between girls and boys differ significantly within this study sample, $t(82) = -2.63, p = .01$ ($p < .05$). A significant difference was found in mathematics emotional arousal levels between boys and girls, $t(82) = -2.66, p = .01$ ($p < .05$); effect size was moderate (0.69). Year Eight boys are moderately less anxious than their female counterparts in relation to school mathematics. No other significant differences between gender means were found within this study sample.

**Reliability.**

As described in the section *Child Emotional Arousal to Mathematics*, Cronbach’s alpha was used to measure internal consistency (Smith, 2009). This coefficient of reliability was used
initially on all four scales in their complete form. The CMSEFF scale consisted of 8 items and yielded an $\alpha = .81$; the PMSEFF scale consisted of 8 items and yielded an $\alpha = .91$; the CEAMS consisted of 15 items and yielded an $\alpha = .94$; and, the PEAMS consisted of 16 items and yielded an $\alpha = .93$, as all alphas are above 0.7 they are considered to be good for reliability coefficients (Santos, 1999). To further explore the dimensionality of these scales, an exploratory factor analysis was performed on the CEAMS and PEAMS using principal component extraction and direct oblimin rotation. Direct oblimin rotation was used as it was believed that all items were related and using this rotation meant that the results did not need to be forced to be orthogonal. This was appropriate for the CEAMS as it allowed for comparison with the original version of the instrument, CAMS (Jameson, 2013). It was also appropriate for the PEAMS as this was an adapted version of the CAMS devised for the current study. Therefore, the factors could then be compared between the child version and the parent version to identify any commonalities.

Table 4. Factorial Structure of CEAMS

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking about working on maths in class makes me feel</td>
<td>.872</td>
<td>.417</td>
</tr>
<tr>
<td>Compared to other school subjects I feel</td>
<td>.852</td>
<td>.546</td>
</tr>
<tr>
<td>When I think about doing maths I feel</td>
<td>.846</td>
<td>.581</td>
</tr>
<tr>
<td>When I am working on maths problems that are difficult and make me think hard I feel</td>
<td>.828</td>
<td>.382</td>
</tr>
<tr>
<td>When I have a hard maths question I feel</td>
<td>.816</td>
<td>.457</td>
</tr>
<tr>
<td>When I know that my class will be working on maths at school I feel</td>
<td>.813</td>
<td>.607</td>
</tr>
<tr>
<td>When the teacher is showing the class how to solve a maths problem I feel</td>
<td>.766</td>
<td>.446</td>
</tr>
<tr>
<td>When I solve a maths problems I feel</td>
<td>.749</td>
<td>.598</td>
</tr>
<tr>
<td>When I solve maths puzzles I feel</td>
<td>.746</td>
<td>.333</td>
</tr>
<tr>
<td>When the teacher gives the class a maths problem I don’t understand I feel</td>
<td>.665</td>
<td>.662</td>
</tr>
<tr>
<td>Working on maths at home I feel</td>
<td>.653</td>
<td>.328</td>
</tr>
<tr>
<td>When I make a mistake in maths I feel</td>
<td>.554</td>
<td>.537</td>
</tr>
</tbody>
</table>
The items were formed into two subscales, in accordance to factor loading, and the resulting reliabilities were determined using Cronbach’s alpha. Factor 1 consisted of 12 items (α = .94) and Factor 2 consisted of three items (α = .82). Factor 1 relates to internal judgements, such as working on mathematics problems. This is conceptualised in this study as *Perceived Mathematics Cognitive Effort*. Factor 2 relates to external judgements, such as sharing answers in front of the class and is conceptualised as *Perceived Mathematics Performance*. *Figure 10* shows the scree plot for the factor analysis for the *CEAMS*. The line on the scree plot illustrates two clear factors as described above.
The identification of two factors in this study are somewhat different therefore from the research of Jameson (2013), who identified three factor loadings in the exploratory factor analysis of her CAMS data: general math anxiety (α = .81), math performance anxiety (α = .73), and math error anxiety (α = .74). This differed from the current study because of the inclusion of a third factor. However, the items from the CAMS (Jameson, 2013) that loaded on math performance anxiety matched the loadings on perceived maths performance in the current study, with the exception of the question *When I solve maths puzzles I feel*, which loaded on the maths performance anxiety in Jameson’s study and perceived maths cognitive effort in the current study. The difference between the loadings across factors in the two studies could be accounted for by the difference in the age of the participants. The CAMS was administered to children aged between six and eleven years old, and the current study involved children between 12-13 years old. Difference in perception of curriculum delivery, specifically the use of differing pedagogical practises in mathematics, could also account for this difference. Finally, the operational purpose of the CAMS was to measure math anxiety as a conceptual variable, and the operational purpose of the current CEAMS was to measure emotional arousal as a conceptual variable. This difference in operational purpose can also account for the difference in interpretations of the generated factor loadings and their subsequent labelling. The CAMS three factor solution accounted for 50% of variance; this
compares slightly lower to the CEAMS, for which the two factor solution accounted for 63% of variance.

An initial exploratory factor analysis of the PEAMS showed factor loadings on three factors. However, one item, the question *If I was asked to run the sausage sizzle at the school fair and I made a mistake, I would feel* being the single item in one of the factors. This item was removed because of the loading and also because of the ambiguous nature of the question, as it had several clauses that could evoke emotional arousal, contrasting to other items that only had one action to evoke emotional arousal. The remaining items loaded across two factors. See appendix eight for the initial three factor solution.

**Table 5. Factorial structure of PEAMS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I am faced with everyday problems that involve maths, I feel…</td>
<td>0.857</td>
<td>-0.497</td>
<td>0.737</td>
</tr>
<tr>
<td>If I was asked to work out a 65% discount on a jacket before I reached the checkout, I would feel…</td>
<td>0.820</td>
<td>-0.552</td>
<td>0.675</td>
</tr>
<tr>
<td>When I know it is time to check my tax return using maths calculations, I feel…</td>
<td>0.815</td>
<td>-0.613</td>
<td>0.682</td>
</tr>
<tr>
<td>If I was asked to work out the average electricity used in our home over a year for a price comparison website, I would feel…</td>
<td>0.800</td>
<td>-0.571</td>
<td>0.648</td>
</tr>
<tr>
<td>If a bank consultant was explaining interest rates to me, I would feel…</td>
<td>0.773</td>
<td>-0.517</td>
<td>0.600</td>
</tr>
<tr>
<td>When I know I have to use maths, I feel…</td>
<td>0.761</td>
<td>-0.455</td>
<td>0.579</td>
</tr>
<tr>
<td>When someone asks me the answer for a times table like 7 x 9, I feel…</td>
<td>0.743</td>
<td>-0.571</td>
<td>0.570</td>
</tr>
<tr>
<td>If a new job or course required me to take a maths paper or course, I would feel…</td>
<td>0.735</td>
<td>-0.628</td>
<td>0.587</td>
</tr>
<tr>
<td>If I was asked to be the treasurer for a sports club, I would feel…</td>
<td>0.734</td>
<td>-0.685</td>
<td>0.622</td>
</tr>
<tr>
<td>Working out the area and volume of paint I need for a fence makes me feel…</td>
<td>0.660</td>
<td>-0.511</td>
<td>0.452</td>
</tr>
<tr>
<td>Working out quantities when I need to double a recipe makes me feel…</td>
<td>0.631</td>
<td>-0.272</td>
<td>0.423</td>
</tr>
<tr>
<td>When my child asks me to help with maths homework, I feel…</td>
<td>0.586</td>
<td>-0.898</td>
<td>0.807</td>
</tr>
<tr>
<td>Item</td>
<td>Factor 1</td>
<td>Factor 2</td>
<td>Communality</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>When I am helping my child with maths, I feel…</td>
<td>.563</td>
<td>-.895</td>
<td>.802</td>
</tr>
<tr>
<td>When my child’s teacher is discussing maths strategies with me, I feel…</td>
<td>.505</td>
<td>-.791</td>
<td>.626</td>
</tr>
<tr>
<td>If I had to use some of the maths I learnt at school like algebra, I would feel…</td>
<td>578</td>
<td>-.789</td>
<td>.634</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Eigenvalue</th>
<th>% of variance</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.26</td>
<td>55.09</td>
<td>Maths A/PS</td>
</tr>
<tr>
<td></td>
<td>1.18</td>
<td>7.86</td>
<td>Engage</td>
</tr>
</tbody>
</table>


The items were formed into two subscales, in accordance to factor loading, and the resulting reliabilities were determined using Cronbach’s alpha. Factor 1 consisted of 11 items ($\alpha = .93$) and Factor 2 consisted of four items ($\alpha = .86$). Factor 1 can described as Mathematics Application and Problem solving. Factor 2 can be described as Engagement in School Mathematics. The PEAMS two factor solution accounted for 63% of variance. Figure 11 shows the Scree Plot for the factor analysis for the PEAMS. The action of the line illustrates two clear factors as described above.
Whilst hypothesis testing methods have been applied to compare means within demographical data for exploratory purposes, the research hypotheses for this study will be presented in the current section. Pearson’s Product-Moment correlation coefficients were used to determine the correlation between the variables as described by the hypotheses.

The first hypothesis stated that there is a significant positive correlation between Year Eight children’ maths self–efficacy and parents’ maths self-efficacy. This was examined by correlating the summed scores of the CMSEFF and the summed score of the PMSEFF. The results indicated that the correlation between Year Eight children’ maths self-efficacy and parent maths self-efficacy was not significant, $r (82) = .14, ns$. Therefore, the hypothesis that there is a significant correlation between Year Eight maths self-efficacy and parent maths self-efficacy was rejected.

The second hypothesis stated that there is a significant positive correlation between Year Eight children’ emotional arousal to mathematics and parents’ emotional arousal to mathematics. This was examined by correlating the summed scores of the PEAMS and the CEAMS. The results indicated that the correlation between Year Eight emotional arousal to mathematics and parent emotional arousal to mathematics was not significant, $r (82)= .14, ns$. 

![Scree Plot](image)

*Figure 11. PEAMS Factor Analysis scree plot.*
Therefore, we reject the hypothesis that there is a significant correlation between Year Eight emotional arousal to mathematics and parent emotional to mathematics.

The third hypothesis stated that there is a significant positive correlational between Years Eight children’s emotional arousal to mathematics and parents’ maths self-efficacy. This was examined by correlating the summed scores of the CEAMS and the PMSEFF. The results indicated that the correlation between Year Eight emotional arousal to mathematics and parent maths self-efficacy was not significant, $r (82) = .16$, ns. Therefore, we reject the hypothesis that there is a significant correlation between Year Eight emotional arousal to mathematics and parent maths self-efficacy.

The fourth, and final, hypothesis stated that there is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ emotional arousal to mathematics. This was examined by correlating the summed scores of the CMSEFF and the PEAMS. The results indicated that the correlation between Year Eight maths self-efficacy and parent emotional arousal to mathematics was not significant, $r (82) = .17$, ns. Therefore, we reject the hypothesis that there is a significant correlation between Year Eight maths self-efficacy and parent emotional to mathematics.

In light of the significant findings relating to gender, and the factors generated from the exploratory factor analysis, further exploration of the data was conducted which uncovered two noteworthy correlations. Firstly, and most notably, there was a moderate positive correlation between male emotional arousal to mathematics (when females and males were separated in each measure) and child maths self-efficacy, $r (20) = .45$, $p < .05$. However, the $r^2 = .22$ showed the variance that it accounted for was small (22%). This anomaly will be explored further in the integration phases and subsequently the third qualitative phase.

Secondly, a small yet statistically significant positive correlation was initially found between factor 2 of the PEAMS, Engagement in School Mathematics and Year Eight maths self-efficacy, $r (83) = .227$, $p < .05$, $r^2 = .05$. However, during the qualitative phase of analysis, the authenticity of one participant’s response was questioned, resulting in the removal of the pairing from the study. This removal affected the correlation’s significance; there was no longer statistical significance, $r (82) = .21$ $p = .05$. 
External validity.

The *Attitude to Maths Scale* from the National Monitoring Study of Student Achievement (NMSSA) 2013 was used as part of the battery of instruments used in the current study. This 8-item Likert type scale was used so that the current sample could be compared against the national population for purposes of generalisability. The scoring of the *Attitude to Maths Scale* matched the other scales in the study, in that it was scored from 1-4 with 1 being the more negative response and 4 being the more positive response. *Figure 12* illustrates a comparison for each item between the national mean and standard deviation, and the study sample mean and standard deviation.

*Figure 12. Comparison of NMSSA national sample and study sample for Attitude to Maths.*

The two dots that represent the means for each item are very similar, suggesting that the responses from the study sample are similar to trends of the NMSSA national population. This suggests that the study sample shares similar characteristics with the Year Eights who participated in the NMSSA assessment across New Zealand in 2013. Despite not being able to
compare means because of NMSSA’s data protocols, it could be tentatively suggested that the responses to the current study’s instruments may be generalizable to the national population.

**Phase Two - Integration Phase**

In this section the quantitative findings are discussed in relation to literature and the anomalies are presented and discussed. The integration phase in a sequential explanatory mixed methods design facilitates the development of further lines of exploration. In this study, the integration phase includes further quantitative analysis with initial qualitative coding and abductive formulation of questions for qualitative exploration. The aim of this is to provide possible explanations for the results and anomalies.

**Discussion of quantitative findings.**

All four hypotheses relating to a correlation between parents’ and Year Eight children’s maths self-efficacy and emotional arousal in mathematics were rejected. This indicates that no relationship was found between how parents respond to mathematics and how their Year Eight children respond. This result is contrary to literature in the field of maths anxiety and self-efficacy (Bandura, 1997; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Vukovic, Roberts, & Green Wright, 2013). There are a number of possible explanations as to why these findings differ from those in the literature.

Firstly, the scales for parents used in the current study excluded reference to the participants’ perceptions of their experience of mathematics at school and this may have influenced the absence of a correlation between parents’ and Year Eight students’ maths self-efficacy and emotional arousal to mathematics. This was a purposeful exclusion based on literature around the reliability of memory (Gardner, 2001; Loftus, 2003). The malleable nature of the memory means that recollections of mathematics experiences can be influenced and changed through time by differing accounts and suggestive questioning (Gardner, 2001). For this reason, the current context for mathematics application and learning was used. The parents’ scale, **PEAMS**, generally focused on everyday applications of mathematics with one indirect reference to the mathematics encountered at school, and three references to their child’s school environment. This contrasted with the children’s scale, **CEAMS**, which generally focused on mathematics education in the classroom, with one direct reference to completed mathematics work at home. For parents, the items in the scale reflected everyday applications of mathematics problem solving, and in the case of the children, the items reflected mathematics interactions and problem solving at school. It could be argued that this variation in context had a significant impact on the correlational outcomes, as the scales were
measuring two different contexts. It is also possible that school mathematics was viewed by
the participants as a subject different from a life skill that is applicable in everyday activities.
The contrast of these two contexts with the scales could have exacerbated this dichotomy,
thus having an effect on the how the participants responded and perhaps, the resulting lack of
correlation.

Secondly, Bandura (1997) pointed out that the strength of influence of any factor is strongly
predisposed to circumstantial and situational factors. Bandura (1997) proposed that school
becomes the most significant context for the development of academic self-efficacy because
of the opportunity to compare one’s capability to that of one’s peers. As children develop and
transition through school, the influence of peer modelling becomes stronger (Bandura, 1997).
Teaching practices also influence academic self-efficacy, as discussed in the section
Development of Self-Efficacy (Bandura, 1997; Schunk & Pajares, 2009). The strength of peer
modelling and teaching practices in mathematics could be more influential than parent
modelling at Year Eight, compared to earlier years. This may explain the absence of any
significant correlation between parents’ maths self-efficacy and emotional arousal to
mathematics, and their children’s maths self-efficacy and emotional arousal to mathematics.
Further exploration of the possible influencing factors, especially peer modelling and teaching
practices warrants exploration, but this will not be explored further in this study.

Finally, in relation to an absence of a correlation between parents’ and Year Eight maths self-
efficacy and emotional arousal to mathematics, participant recruitment did not specify that the
parent participating had to be the parent who predominantly assists with mathematics
homework. Parents who feel inadequate and anxious about assisting their children with
mathematics may avoid helping and divert responsibility to their spouse or more able family
members. Furthermore, when low maths self-efficacy and anxiety towards mathematics is a
family-wide trend, parents may resort to engaging the assistance of a tutor (Díez-Palomar,
Ortín, & Roldán, 2012).

The role of vicarious experience in the development of maths self-efficacy, in the current
context parental modelling of positive and negative behaviours and beliefs associated with
mathematics, can only be assimilated when the associated behaviour is demonstrated. If the
participating parent avoids assisting the child with mathematics homework, opportunities for
transference are limited. Furthermore, the act of avoidance may not go unnoticed and
therefore may have an impact on the child as the child reflects on the avoidant behaviour and
the interactions that occur alongside it. For example the child may hear “Go and ask your
father, I am terrible at maths”. In the current study, 28% of participating parents reported that they did not help their child with homework. An explanation for the parents’ lack of participation in mathematics homework is a consideration in the current study that can be explored through the analysis of the qualitative responses in relation to the following questions.

**Why do some parents not assist with mathematics homework?**

**Quantitative anomalies.**

The one notable anomaly that emerged from more in-depth statistical data was a significant correlation between fathers’ emotional arousal to mathematics and Year Eight maths self-efficacy $r (20) = .45, p < .05, r^2 = .22$, despite no overall significance arising between parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy.

One possible explanation is that a father’s level of emotional arousal when assisting with mathematics homework may have some influence on their children’s maths self-efficacy. Maloney, Ramirez, Gunderson, Levine, and Beilock (2015) suggested that parents’ maths anxiety only has an influence on their children’s level of maths anxiety and therefore, their achievement, when the anxious parent assists with homework on a frequent basis. As vicarious experience/modelling plays a role in the development of self-efficacy, it can be argued that parents who show levels of anxiety towards mathematics during interactions around homework also may have an impact on their child’s maths self-efficacy. More specifically, other research that has explored the emotionality associated with homework has suggested that mothers’ emotions around mathematics homework is highly correlated with their children’s emotions, and consequently is linked to their child’s mathematical performance (Else-Quest, Hyde, & Hejmadi, 2008). However, Else-Quest et al. (2008), only explored the homework interactions with mothers. In the current study, during the iterative back and forth nature of the analysis in the integration phase, with the initial qualitative coding of the open questions from the participants, it began to emerge that fathers in the current study frequently played a significant role in homework sessions. This, accompanied with the statistically significant positive correlation between fathers’ emotional response to mathematics and their children’s maths self-efficacy, led to the generation of the question.

**How are the fathers’ emotional response to mathematics modelled by their assistance with mathematics homework and other mathematics related activities?**
Secondary quantitative analysis.

To explore the two questions proposed in previous sections, the survey responses from question six of the Year Eight survey and question four from the parent survey, were coded into those that assisted with mathematics homework and those that did not. All responses from the 84 pairings were analysed. One participant pairing was withdrawn as the question was not answered by either the parent or the child, leaving 83 pairings.

23 responses indicated that the participating parent did not assist with mathematics homework. The participating parent was the primary caregiver who filled in the survey. Year Eights were made aware of this distinction so as not to respond using another parent/caregiver when answering the survey items. In nearly all of the cases it was apparent that neither the participating parent nor another parent/caregiver assisted with mathematics homework, or that the Year Eight choose to ask for assistance from the other parent. However, this could not be assumed in all cases.

A further set of correlations were examined to explore the relationship between parents’ and children’s maths self-efficacy and emotional arousal to mathematics but this time, the data was sorted by those who assist with homework and those that did not. As with the correlations discussed in the quantitative findings, the summed scores of the CMSEFF, PMSEFF, CEAMS, and PEAMS were used. Notably, there was a small yet statistically significant positive correlation between the parents’ emotional arousal to mathematics, and the Year Eights’ maths self-efficacy when parents who assisted with homework were examined separately. The results indicated that there was a positive correlation between Year Eight children’s maths self-efficacy and parent emotional arousal to mathematics, $r (59) = .27, <.05, r^2 = .07$. However, the $r^2 = .07$ showed the variance that it accounted for was very small (7%). There were no correlations between the parent and child measures when correlations were explored for the parents who did not assist with homework.

These findings tentatively support the argument in the current study that, through the interactions and actions of mathematics homework, parental modelling of maths self-efficacy and emotional arousal to mathematics does have a relationship with the maths self-efficacy and emotional arousal of their children. This warrants further exploration in the qualitative phase.
Qualitative phase rationale.

Sequential explanatory mixed method design allows for further exploration into findings that arise out of the quantitative phase, as discussed in the section on Sequential Explanatory design in the methodology chapter (Creswell, 2011; Ivankova, Creswell, & Stick, 2006). The aim of this secondary exploration is to suggest possible explanations for the results and any anomalies that have resulted.

In the section that discussed the quantitative findings, the discussion around possible explanations for the absence of a correlation between the parents and Year Eights’ maths self-efficacy and emotional arousal to mathematics were presented. One of the possible explanations for an absence of correlations was that parents who feel anxious about mathematics avoid assisting with mathematics, and delegate assisting to another member of the family, or external tutor. This means the parent who does assist with homework, through doing this activity, models their own emotional response to mathematics, and has more opportunities to model their emotional response to mathematics, in contrast to the non-assisting parent. For example, when the homework is delegated to the father, who may be more confident in mathematics, then his confident response will be more frequently observed by the Year Eight, in contrast to the non-assisting parent who delegated assistance. However, as mentioned in the discussion of quantitative findings, the delegating parent’s response to mathematics may still be assimilated by the child. The following question was presented to explore this explanation,

*Why do some parents not assist with mathematics homework?*

The most significant anomaly that came out of the quantitative findings was the positive correlation between fathers’ emotional arousal to mathematics and Year Eights’ maths self-efficacy, as described in the section that describes the quantitative anomaly. To explore this anomaly the following question was formulated,

*How are the fathers’ emotional response to mathematics modelled by their assistance with mathematics homework and other mathematics related activities?*

However, the findings in the section that presented the results from the secondary quantitative analysis suggested that parental modelling, through the interactions and actions of mathematics homework, of emotional arousal to mathematics does relate to the maths self-efficacy. Put simply, homework may be a vehicle for the transference of emotional responses
and attitudes towards mathematics. Therefore, it is warranted to explore the responses of all the parents who reported to assist with mathematics homework.

To be pragmatic, it seemed appropriate to carry out an in-depth analysis of all the participants’ responses in relation to homework assistance and emotional responses to mathematics. The following two questions were therefore considered,

**Why do some parents not assist with mathematics homework?**

**How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?**

In answering these questions the emotional responses, particularly the associated level of emotional arousal, will be examined and discussed in view of the correlation between parents’ emotional arousal to mathematics and Year Eights maths self-efficacy. In exploring the connection between parents’ assistance with mathematics homework, or lack of, and their reported level of emotional arousal to mathematics, it was necessary to classify and then group the parents according to their reported level of emotional arousal to mathematics.

**Classification of emotional arousal to mathematics and maths self-efficacy.**

The classification of the emotional arousal to mathematics and maths self-efficacy, using the summed scores of the CEAMS, PEAMS, CMSEFF and PMSEFF, was deemed appropriate as it allowed all the participants to be classified in relation to emotional arousal to mathematics and maths self-efficacy. This classification allowed differences in gender to be explored. Whilst it is only the parents’ emotional arousal to mathematics that is being focused on in the qualitative phase, in some cases making comparisons with the Year Eight’s level of maths self-efficacy and also level of emotional arousal to mathematics was necessary to give a fuller picture of the influence of the interactions. The focus on the parents’ emotional arousal to mathematics is because of the positive correlation found between parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy.

Classification of the emotional arousal to mathematics for all parents and Year 8 students was determined using boundaries across the summed scores which were identified based on response options. If an individual responded to any of the items with a 2 (anxious) or a 1 (very anxious) then some level of arousal was perceived and reported by the individual. The following category boundaries were used; Year Eight Maths Anxious ≤ 30, 30 < Year Eight Vulnerable to Maths Anxiety ≤ 41.25, Year Eight Calm Response to Maths > 41.25, Parent
Maths Anxious ≤ 32, 32 < Parent Vulnerable to Maths Anxiety ≤ 44, Parent Calm Response to Maths > 44.

Table 6 illustrates the distribution across the three emotional arousal categories for Year Eight children and their parents. Notably, 51% of Year Eights were maths anxious, or experienced some level of anxiety associated with mathematics. It can also be noted that the proportion of parents in the ‘Calm response to maths’ category, was substantially larger than the Year Eights positioned in the same category. This suggests that parents were calmer about approaching mathematics than their Year Eight children.

Table 6. Emotional arousal to mathematics scales Classification Distributions

<table>
<thead>
<tr>
<th></th>
<th>Maths Anxious</th>
<th>Vulnerable to Maths Anxiety</th>
<th>Calm response to Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Year 8 (84)</td>
<td>9</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>Parent (84)</td>
<td>5</td>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 7 illustrates the distribution across the three categories for Year Eight children according to level of emotional arousal to mathematics and gender. This distribution pattern for boys that is weighted to the right, corroborates with the significant difference in the mean between Year Eight boys and girls scores in relation to emotional arousal to mathematics, as discussed in the section Measures of Central Tendencies and Variabilities for Maths Self-efficacy and Emotional Arousal to Mathematics.

Table 7. Child Emotional arousal to Mathematics Scales Classification Distributions – Gender

<table>
<thead>
<tr>
<th></th>
<th>Maths Anxious</th>
<th>Vulnerable to Maths Anxiety</th>
<th>Calm response to Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Girls (63)</td>
<td>8</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>Boys (21)</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 3 illustrates the distribution across the three categories for parents according to gender. Males (fathers) are weighted to the right of the table suggesting that overall males, specifically fathers, are calmer when faced with mathematics.

Table 8. Parent Emotional Arousal to Mathematics Scales Classification Distributions – Gender

<table>
<thead>
<tr>
<th></th>
<th>Maths Anxious</th>
<th>Vulnerable to Maths Anxiety</th>
<th>Calm response to Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Females (62)</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Males (22)</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Classification of the maths self-efficacy for both parents and Year 8s was determined in a similar manner to the maths anxiety classifications; using boundaries across the summed scores with reference to response options. If an individual responded to any of the items with a 2 (not confident) or a 1 (not confident at all) then some lack of maths self-efficacy was perceived and reported by the individual. The following category boundaries were used; Year Eight Low Maths Self-efficacy ≤ 20, 20 < Year Eight Moderate Maths Self-efficacy ≤ 24, Year Eight High Maths Self-efficacy > 24, Parent Low Maths Self-efficacy ≤ 16, 16 < Parent Moderate Maths Self-efficacy ≤ 24, Parent High Maths Self-efficacy > 24. The boundary for Year Eight low maths self-efficacy was higher than the parent boundary because of the nature of the tasks used in the scale. The tasks were taken from NEMP 2009 tasks and several of the tasks where used for both Year Four and Year Eight students. Therefore some of the tasks would be expected to be well below the ability of Year Eights. This was accounted for by increasing the Year Eight low maths self-efficacy boundary.

Table 9 illustrates the distribution across the three maths self-efficacy categories for Year Eight children and their parents. Notably, 87% of Year Eights had moderate to high maths self-efficacy when faced with the presented mathematic self-efficacy tasks.
Table 9. *Maths Self-Efficacy Scales Classification Distributions*

<table>
<thead>
<tr>
<th></th>
<th>Low SEFF</th>
<th></th>
<th>Moderate SEFF</th>
<th></th>
<th>High SEFF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>n</em></td>
<td><em>%</em></td>
</tr>
<tr>
<td>Year 8 SEFF (84)</td>
<td>11</td>
<td>13</td>
<td>18</td>
<td>21</td>
<td>55</td>
<td>66</td>
</tr>
<tr>
<td>Parents SEFF (84)</td>
<td>7</td>
<td>8</td>
<td>33</td>
<td>39</td>
<td>44</td>
<td>52</td>
</tr>
</tbody>
</table>

Table 10 illustrates the distribution across the three maths self-efficacy categories for Year Eight children according to gender. The Year Eight boys are spread more to the right of the table when compared to Year Eight girls. The difference in spread suggests the boys are more self-efficacious in mathematics when faced with problem solving than their female counterparts. This corroborates with the difference in mean discussed in the section *Measures of Central Tendencies and Variabilities for Maths Self-efficacy and Emotional Arousal to Mathematics*.

Table 10. *Child Self-Efficacy Scale Classification Distributions – Gender*

<table>
<thead>
<tr>
<th></th>
<th>Low SEFF</th>
<th></th>
<th>Moderate SEFF</th>
<th></th>
<th>High SEFF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>n</em></td>
<td><em>%</em></td>
</tr>
<tr>
<td>Girls (63)</td>
<td>10</td>
<td>16</td>
<td>14</td>
<td>22</td>
<td>39</td>
<td>62</td>
</tr>
<tr>
<td>Boys (21)</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>19</td>
<td>16</td>
<td>76</td>
</tr>
</tbody>
</table>

Table 11 illustrates the distribution across the three maths self-efficacy categories for parents according to gender. The distribution across the three categories for males (fathers) follows a pattern similar to that described for boys, in that it is heavier to the right of the median. Unlike with the Year Eight boys’ distribution, this did not corroborate with a significant difference between the parent gender means in an independent-samples t test.

Table 11. *Parent Self-Efficacy Scale Classification Distributions – Gender*

<table>
<thead>
<tr>
<th></th>
<th>Low SEFF</th>
<th></th>
<th>Moderate SEFF</th>
<th></th>
<th>High SEFF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>n</em></td>
<td><em>%</em></td>
<td><em>N</em></td>
<td><em>%</em></td>
</tr>
<tr>
<td>Females (62)</td>
<td>6</td>
<td>10</td>
<td>26</td>
<td>42</td>
<td>30</td>
<td>48</td>
</tr>
<tr>
<td>Males (22)</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>32</td>
<td>14</td>
<td>64</td>
</tr>
</tbody>
</table>
Phase Three – Qualitative Findings

As outlined in the methodology chapter, the initial sorting for the Qualitative phase occurred during the integration phase, when those parents who assisted with homework were separated from those that did not. To determine this, item six of the Year Eight survey (i.e., Does the parent who has agreed to participate in this study help you with maths homework? If they do help, how do they help you? If they don’t help, why do you think they don’t help you?), was analysed and item four of the parent survey was also considered in some cases (i.e., Do you help your child with maths homework? If yes, describe how you help your child with their maths homework? If no (or only sometimes), what prevents you from helping your child with maths?). Where appropriate, reference is also made to item one in the parent survey (i.e., Describe your emotional response to maths. List all the words or phrases you can think of that you could use), and item two of the Year Eight survey (i.e., How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?). In this discussion the first question presented in the section Qualitative Phase Rationale will be outlined and findings presented. Following this the second question will be discussed and the findings presented. Interactions and actions around mathematics homework are defined in this study as the behaviour that facilitates parental modelling of maths self-efficacy and emotional arousal to mathematics. Although it is recognised that there are many other opportunities to model mathematics affect, the extent and influence of this modelling can be explored through examining how accurately Year Eights’ perceive their parents emotional response to mathematics when their parent assists with mathematics homework. This discussion is presented within the second question. Finally, in this chapter a comparison between the ways fathers’ and mothers’ assist with mathematics homework will be explored to provide some possible explanations for the anomaly found that suggested a positive correlation between fathers’ emotional arousal to mathematics and Year Eights’ maths self-efficacy,

Why do some parents not assist with mathematics homework?

When the responses to item six from the Year Eight survey and item four from the parent survey, were categorised into either assisting or not assisting with mathematics homework, the results suggested that 23 out of the 83 pairings reported the participating parent did not assist with mathematics homework.

Two themes and five categories arose out of the analysis of non-assisting parents. Table 12 illustrates the two themes and five categories associated with why the participating parents did not assist with mathematics homework. The coding features, referred to in the table, are the
phrases and words that were scanned for during analysis. The first theme was that the *Year Eight does not ask for assistance from the participating parent*. Four categories contributed to this theme. The first category was that the Year Eight did not need or want help from the parent, the second category was that assistance was given by the spouse of the participating parent as chosen by the Year Eight. The third category was that assistance was not given as the Year Eight identified that the parent could not help because of their lack of understanding of mathematics, and the fourth and final category was that no homework was brought home. The only category that related to the second theme, that the *participating parent made the decision to not assist with mathematics homework*, was that assistance was given by the spouse of the participating parent as recommended by the participating parent. Table 12 presents these themes and categories. Table 13 illustrates each theme and the distribution of parents according to their PEAMS classification. Each theme will be described and then discussed in relation to the frequencies of reported levels of emotional arousal.

**Table 12. Subcategories for Non-assisting Parents with Frequencies**

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Coding/Features</th>
<th>Representative Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistance not required</td>
<td>10</td>
<td>Don’t need help</td>
<td>[My mother has] really never helped me mainly because there’s no need as I usually can easily do my homework. (103c)</td>
</tr>
<tr>
<td>Assistance given by other parent (Year Eights’ choice)</td>
<td>7</td>
<td>Usually ask Mum/Dad (other parent) Mum/Dad is better at maths</td>
<td>[My father] doesn’t help I think because I usually ask Mum to help me. (517c)</td>
</tr>
<tr>
<td>Assistance not given because the Year Eight identifies that it is too hard for the parent</td>
<td>1</td>
<td>Dad/Mum can’t help Too hard They are not good at maths</td>
<td>Dad doesn’t help because it’s too hard. He can’t do the algebra or $3 + 3 \times 3 + 3 - 3$ where I find that easy. (605c)</td>
</tr>
<tr>
<td>Assistance not given as no homework is brought home</td>
<td>2</td>
<td>Don’t get any No homework given Get it done at school</td>
<td>[My daughter] seems to do it all at school and doesn’t really bring any home. (702p)</td>
</tr>
<tr>
<td>Parent decides not to assist (parent’s choice)</td>
<td>3</td>
<td>He/she (father/mother) tells me to ask Mum/Dad His/her father/mother is better at maths</td>
<td>I am able to help with some maths but usually get Dad to do most of the maths homework. (202p)</td>
</tr>
</tbody>
</table>
Table 13 *Distribution of Non-Assisting Theme Across PEAMS Classifications*

<table>
<thead>
<tr>
<th>Non-Assisting Theme</th>
<th>MA</th>
<th>VMA</th>
<th>Calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year Eight does not ask for assistance from the participating parent</td>
<td>2</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>The participating parent made the decision to not assist with mathematics homework</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

Interpretation of table 13 suggests that 11 out of the participating parents that did not assist with mathematics homework were classified as being either maths anxious or vulnerable to maths anxiety. The other 12 were classified as calm. Notably, all the parents in the second theme were either maths anxious or vulnerable to maths anxiety. Each theme will now be discussed in relation to emotional response, particularly the level of emotional arousal to mathematics. Some responses from other items in the survey are also included in this part of the discussion.

**Year Eight does not ask for assistance from the participating parent**

Twenty of the 23 parents who were reported to not assist with mathematics homework fitted into the theme *Year Eight does not ask for assistance from the participating parent*. Four subcategories contributed to this theme. The desire for independence and the capability and confidence to work independently appeared to be a premise in this decision. The following examples are representative of this desire for independence.

I don’t think I need homework help because I need to learn myself. (708c)

Show I can figure it out [the mathematics homework task] by myself. (403c)

Because I need to figure out the problems by myself, and to be honest, my Mum wouldn’t know some of the answers of my hard questions. (521c)

The second response also suggests that the Year Eight perceives that his or her mother would not be able to help. The parent in this pairing reported being vulnerable to maths anxiety, so the Year Eight may have perceived this vulnerability in terms of their ability to help or it may
be because the mother, in the past, had not been able to help in similar tasks. Year Eights perceptions of the participating parent’s ability to help was reflected in other responses within this theme. Eight participating parents in this theme reported being anxious about mathematics or vulnerable to maths anxiety. In many of these cases their Year Eight child had high maths self-efficacy. In three of these cases, the Year Eight, or the parent themselves, identified that they could not assist but they have tried to do so in the past. The following two examples describe this ‘trying’, but also allude to the Year Eight showing methods or, having the major role in doing homework. This reversal of roles may suggest that the Year Eight perceives their parents hesitance to participate in mathematics homework:

I don’t mind maths when I have to use it for myself but if I am put in a position where I was tested on it, I get anxious about it. I don’t know the strategies my son is using and get confused when he shows me and asks me to help. I do try but cannot very often help him. (509p)

Sometimes she asks me to help with complicated questions but I am happy to help. Most of the maths problems she does, I kind of help (521c).

In the first example, it could be interpreted that the parent compares trying to assist her son to being tested, or put on the spot. Both situations evoke anxiety. The mother also makes reference to not understanding the methods her son is using. This is a common thread in the second question, How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics? which is discussed later in this chapter. In the second example, the Year Eight appears to take the ‘teacher role’ with their parent. This example was a response to item two of the Year Eight survey (i.e., How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?).

Year Eight perception or judgement of which parent is most capable of assisting with mathematics, is another factor that contributed to this theme. Seven cases were identified in this category (Assistance given by other parent (Year Eights’ choice). In three of the cases the participating parent was classified as calm in terms of their level of emotional arousal to mathematics (according to their result on the PEAM), and had high to moderate maths self-efficacy (their result on the PMSEFF). For these cases, it can be argued that the lack of assistance with mathematics homework does not reflect the emotional response of the parent. It is instead a reflection of the Year Eights’ preference and judgement of who is better at mathematics.
My daughters’ like asking their Dad and ask me for spelling (assistance). (111p)

He [the father] doesn’t help I think because I usually ask Mum to help me. (517c)

These responses could be interpreted as reflecting family norms, or routines. The norm in the first example could be that the children have decided that spelling is the mother’s thing and mathematics is the father’s thing. This may reflect common gender stereotypes. In the second example, it may be that the mother is the primary provider of homework assistance, and mathematics homework assistance is just part of the assistance given.

However, in the remaining three of the seven cases, the Year Eight chooses the other parent as they perceive that the participating parent is not good at mathematics.

[My mother] doesn’t help me my Dad helps me because he is good and she is not. (316c)

She sometimes does but Dad is better at maths so he usually does. (322c)

Because Mum doesn’t understand the problem so I just ask Dad. (206c)

The participating parents were classified according to PEAM scores as either maths anxious or vulnerable to maths anxiety, and in each of these cases the Year Eight recognises the struggle to some extent when responding to item two (i.e., How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?)

Feels like she doesn’t understand and it is hard for her. (316c)

She will do it if it’s not too hard. Rather be doing something else. (322c)

My Mum is not a big maths person if she had a choice to do maths she wouldn’t. (206c)

Notably in the final two responses the Year Eight alludes to the fact that their mothers would avoid mathematics if they could.

The Year Eights in these cases may perceive their parent’s level of emotional arousal to mathematics as an indication of their ability to help. The parent’s anxiety to mathematics, or their vulnerability to maths anxiety may have been communicated on some level at home and the Year Eight may have picked this up. Notably, in these three pairs, both the Year Eight and parent either report being vulnerable to maths anxiety, or report being maths anxious.
Pairing 603 is a notable example of the Year Eight reporting their perception of their parent’s strong emotional response to mathematics. The Year Eight reported that their mother hated mathematics and this was why he choose not to ask her for assistance.

Dad helps with maths homework. She doesn’t because she hates maths.(603c)

The Year Eight’s perception of his mother’s emotional response to mathematics accounts for him not asking her for help. The mother’s level of emotional arousal according to the PEAMS classification was calm, suggesting that she does not experience any anxiety whilst doing mathematics. Her son’s perception is based on the observation that she doesn’t enjoy mathematics, and not that she is anxious about it.

The final subcategory in the theme Year Eight does not ask for assistance from the participating parent, relates to the Year Eight reporting that they are not given homework, or that it is not brought home. In two of these cases the Year Eight’s report that they do not get mathematics homework and the parents in these cases believe the child is doing the mathematics homework at school.

I don’t get homework but on the off chance I do she helps me. (702c)
She seems to do it all at school and doesn’t really bring any home. (702p)

I don’t get any. (401c)
She doesn’t ask for help. She gets it all done at school. (401p)

In both these examples the parents assume the Year Eights are getting homework but are choosing to do it at school. Obviously, in these cases, the parent’s level of emotional arousal to mathematics is not connected with them not assisting with mathematics in any notable way.

The first theme, Year Eight does not ask for assistance from the participating parent, accounted for 17 of the 23 cases where the participating parent did not assist with homework. Year Eights determined the absence of assistance because of, a desire for independence, their perceptions of their parents’ ability to assist, their perception of which parent was more capable of assisting, and the fact that homework was not brought home. In several of these factors, the parent’s emotional response to mathematics was a factor in the perception and choice of the Year Eight. The parent, in these cases, did not play an active role in determining whether they were going to assist with mathematics homework. This is in contrast to the second theme.
The participating parent made the decision to not assist with mathematics homework.

Three of the 23 parents who were reported to not assist with mathematics homework fitted into the theme ‘the participating parent made the decision to not assist with mathematics homework’. In two of the cases the parent describes directing the Year Eight to ask their spouse for assistance with mathematics. In the third case the parent describes keeping out of the way from assisting with mathematics homework as the father is a confident mathematician

I am able to help with some maths homework but usually get [her] Dad to do most of the maths homework. (202p)

When I am asked to help my child, I have a bit of a panic as I know what I know and nothing else, therefore I either tell my girl, “Dad doesn’t know” which makes me feel stink or tell her to go see her mother. (601p)

Luckily my husband is a maths/physics graduate and teacher. He talks about maths concepts and ideas a lot— it’s all maths and science with him, so they have a very positive and frequent exposure to maths ideas. I keep right out of it— I don’t want to get in the way of the positive thinking. (705p)

The mother in the last example assumes that her involvement would only have negative consequences and appears aware of the importance of being positive during homework interactions. All of the parents in this theme were classified according to PEAM scores as either maths anxious or vulnerable to maths anxiety. The descriptions of their emotional response were also generally negative. Indeed, the following three descriptions could be interpreted as the strongest negative reactions across the whole survey population.

Worried, frustrated, unsure, incapable, ‘blocked’, disability. (705p)

I feel dyslexic when it comes to maths. (202p)

Some maths makes me feel stupid. (601p)

In all these cases the Year Eight reports that they do not think the participating parent is good at mathematics and in two cases the justification for the response was because the parent had talked about their lack of ability, or because they do not assist with mathematics homework.

I don’t know he helps me with the other subjects but leaves that one to Mum. (601c)
Mum often says she’s bad at maths. She can do calculations as that’s part of her job but she struggles with on the spot questions. (202c)

In these cases, the parents’ reluctance to assist with mathematics may be directly connected to their level of emotional arousal to mathematics and emotional response and the child is very aware of their parent’s response. It can be argued that whilst some of the negativity and anxiety is deflected by the presence of a mathematically confident parent, it can also be argued that some negativity and anxiety is assimilated by the child. Of these three Year Eights, two are vulnerable to maths anxiety according to their CEAM classification. In this second theme, the parent actively avoids assisting with homework because of their emotional response to mathematics, and in at least one case their fear that their involvement may have negative consequences on their child’s learning.

To summarise, when the responses from pairings where the participating parent did not assist with mathematics homework were analysed, five categories were apparent. Four of the subcategories related to *Year Eight does not ask for assistance from the participating parent*, and one of the subcategories related to the participating parent delegating the homework assistance to their spouse, the theme being *the participating parent made the decision to not assist with mathematics homework*. In the previous sections that discussed the quantitative findings and presented the rationale for the question *why do parents not assist with mathematics homework?* it was argued that the act of avoiding providing assistance might be assimilated by the Year Eight. This argument was supported by the presence of the final category. These findings substantiate the findings in other research that has linked parents’ beliefs and emotional responses to mathematics with resistance to assisting with mathematics homework (Anthony & Walshaw, 2007; Díez-Palomar et al., 2012; Lange & Meaney, 2011; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). “Parental hesitancy to participate is sometimes influenced by their unhappy mathematical experiences and lack of confidence in their ability to help their child” (Anthony & Walshaw, 2007, p. 161). Specifically, this finding was consistent with Díez-Palomar et al. (2012) that argued that a pattern of diversion to others in the family or external assistance such as tutors, in relation to mathematics homework assistance, existed. However, the Year Eights decision to not request assistance was a stronger finding and in some cases, this was linked to their perception of their parent’s emotional response to mathematics and ultimately, their judgement of their parent’s ability or willingness to assist. The desire for independence was also a finding from the analysis.
The findings from this study, specifically relating to the theme ‘the Year Eights does not seek assistance from participating parent, connects the Year Eights need for assistance, or lack of, to the desire for independence and their perception of their parent’s inability to help are interesting and point to potential new directions in research.

**How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?**

Assisting with homework is the context within which parents model their relationship with mathematics. As part of this, they are also modelling their emotional response to mathematics. By exploring the different ways parents assist with homework, evidence will be sought to illustrate how parents’ model their emotional response, particularly their level of emotional arousal.

When the responses to question six from the Year Eight survey and question four from the parent survey, were categorised into either assisting or not assisting with mathematics homework, the results suggested that 60 out of the 83 pairings reported that the participating parent did assist with mathematics homework. Eight subcategories arose out of the analysis, which were grouped into three themes. Table 14 illustrates the three themes and eight categories associated with the ways the participating parents assist with mathematics homework. The first theme was that assistance was given that involved some level of positive engagement such as explaining the homework, showing alternative ways to approach the task, and working alongside the Year Eight without giving the answer. The second theme was generally assisting with mathematics homework as the student stated they needed the help, or content specific assistance was given. The third theme was that assistance was given but the Year Eight questioned the benefit of the assistance. Table 15 illustrates each theme and the distribution of parents according to their PEAMS classification.
Table 14. *Subcategories for Assisting Parents with Frequencies*

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Coding/Features</th>
<th>Representative Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Engagement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assists by explaining the problem</td>
<td>31</td>
<td>Explains Helps me understand questions Helps me with hard questions Step by step</td>
<td>Sometimes I get confused and find it hard to work things out so Dad helps to explain it, he is calm and works really well with what I struggle with (109c).</td>
</tr>
<tr>
<td>Assists by showing alternative ways</td>
<td>7</td>
<td>Shows me easier ways Shows me different ways Different strategies/methods</td>
<td>He teaches me new strategies with maths and helps me learn how to figure out how to get the answer (514c).</td>
</tr>
<tr>
<td>General or content specific</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assists without telling the answer</td>
<td>7</td>
<td>Shows me but doesn’t tell me the answer Doesn’t give me the answer</td>
<td>Helps me solve the answer without telling me the answer (504c).</td>
</tr>
<tr>
<td>Assists by giving similar practice questions</td>
<td>1</td>
<td>Gives me examples to practice</td>
<td>She gives me examples to figure out and work on until I get the concept of it (405c).</td>
</tr>
<tr>
<td>Benefit of assistance questioned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assists by giving general help when needed</td>
<td>6</td>
<td>I need help Sometimes Only when I need help</td>
<td>She helps because usually I need a lot of help and she is really helpful (314c).</td>
</tr>
<tr>
<td>Assists with specific mathematics homework</td>
<td>3</td>
<td>Mental Maths Telling the time</td>
<td>They help with questions to do with telling the time (518c).</td>
</tr>
<tr>
<td>Positive Engagement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistance is given but it is not satisfactory</td>
<td>3</td>
<td>Try to help but can’t They don’t understand</td>
<td>She tries to [help] but doesn’t understand it or she tries to make it more complicated than it already is. (T04)</td>
</tr>
<tr>
<td>Assists using “old ways”/algorithms</td>
<td>2</td>
<td>Helps by using algorithms Using their old ways</td>
<td>They use their old way they used when they were younger (506c).</td>
</tr>
<tr>
<td>Total Assisting Parents</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 15. Distribution of Theme Across PEAMS Classifications

<table>
<thead>
<tr>
<th>Assisting Theme</th>
<th>MA</th>
<th>VMA</th>
<th>Calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive engagement</td>
<td>-</td>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>General or content specific assistance</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>The benefit of assistance is questioned</td>
<td>2</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

**Positive engagement.**

The first theme, Positive Engagement, included four subcategories. Assists by explaining the problem, assists by showing alternative ways, assists without telling the answer, and assists by giving similar practice questions. In some cases the Year Eights reported a secondary form of assistance occurred as well. Pairing 323 is an example of this.

They often talk me through the problem that’s bothering me/I’m stuck on, until I understand it and then she makes up similar questions for me to complete so it’s in my head. (323c)

The theme Positive Engagement accounted for 46 of all assisting parents (60%). Notably, 36 were Calm according to their classification from PEAMS. This suggests that parents who have a calm response to mathematics appear to be more likely to use techniques that are associated with positive engagement.

**General or specific content specific assistance.**

The second theme that arose out of the analysis of the responses given by pairings, was that the participating parent assisting with mathematics homework was generally helping as the Year Eight needed help, or assisting with content specific help. These two subcategories were grouped together as they did not explicitly describe how the parent assisted. The first of the two subcategories, generally helping as the Year Eight needed help, accounted for six of the total 60 responses. The second subcategory, assisting with content specific help, accounted for three of the total 60 responses.

All parents who assisted by generally helping and by assisting with content specific homework, were classified as being Calm according to their PEAMS score. Another example
of assistance with content specific homework is the response given by the Year Eight in pairing 602.

    Helps me with times tables – gives me the times tables. Helps me with division – which is same as time tables. (602c)

The inclusion of times tables, and in other responses that are content specific, may reflect what the student was studying at the time of the survey administration. These responses do not describe how the parent assists but describes the content they assist with.

**Benefit of assistance questioned by Year Eight**

The third theme, benefit of assistance questioned by the Year Eight, related to two subcategories, *assistance given but is not satisfactory* and *assists using old ways/algorithms*.

Parents of Year Eights who reported gave assistance but said it was not helpful, were classified as being Calm according to their PEAMS results. Notably, in several of the cases assisting using different methods was another factor, which may explain why the assistance was ineffective.

    My mum helps me by teaching me the equations but I personally think that they takeover my homework and my mum teaches me maths in a different way to my teacher (712c).

This conflict between methods was frequently reported by parents. The following response is a representative statement of responses that illustrates this conflict.

    I try to…but methods have changed and they don’t listen to how I was taught. We usually end up having words and not talking for a bit, but laugh about it later. (604p)

In the two cases that reported that their participating parent predominantly assisted by using old ways, both were classified as being maths anxious. There appears to be a connection between new methods and feelings of anxiety. The following response is an example of this anxiety.

    When I look at the kids’ maths (from Year seven upwards) I feel overwhelmed. They learn it differently and I feel helpless as I can’t explain how I know the answer. (703p)
It can be suggested that parents may be anxious about their understanding of new methods, and in turn may vocalise this concern and resort to what is perceived as old methods. Reference to new methods was mentioned in 18 pairings. Parents’ perceptions of how mathematics is taught today differs from their memory of how they were taught. The perceived lack of emphasis on teaching of algorithms is a re-occurring point of conflict in this sample. In several cases Year Eights revoice this conflict. The following response to item five of the Year Eight survey (i.e., Has the parent who has agreed to participate in this study ever talked about their experience of maths when they were at school?), is an example of this.

That more people would understand it [mathematics] back in their day and hates how we do it now. (501c)

This final theme illustrates how the Year Eight perceives the assistance given by the participating parent. As with all the responses it is only the perception of the Year Eight and it is impossible to validate this perception within this study. However, it is possible to explore the Year Eights’ perception of their parents’ emotional response to mathematics in this study as the parents emotional response was also solicited, and therefore can valid the accuracy of the Year Eights perception.

**Year Eights perceptions of their parents’ emotional response to mathematics**

The nature and extent of the influence of parental modelling of emotional responses to mathematics, through the actions and interactions associated with mathematics homework, is determined by how the Year Eight perceives the behaviours (i.e. assisting categories). It is important to determine how Year Eights perceived their parents’ emotional response and if this matched the emotional response reported by the participating parent. Emotional response to mathematics, a wider concept than emotional arousal which has predominantly been used up until now, will be used. To determine this, the responses from question one of the parent survey (i.e., Describe your emotional response to maths. List all the words or phrases you can think of that you could use) and question two of the Year Eight survey (i.e., How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?) were matched and compared. Two pairings had not answered the questions so were removed from this specific analysis. Of the 60 Year Eights who reported that the participating parent assisted with homework, 36 accurately identified their parent’s emotional response to mathematics. The following representative examples illustrate the accurate perception some Year Eights hold.
I feel maths is very useful, powerful, and helpful. Using maths makes me feel confident, smart, accomplished. Some components of maths like algebra, and calculus can make me feel frustrated and annoyed when I find them difficult. (310p)

I think that my mum is quite confident with statistical maths, but not so much at calculus. She is happy to help, but sometimes doesn’t know how, when it is very difficult, or if it is something that she had forgotten. (310c)

It’s maths! Emotions don’t really come into it. Occasional frustration or elation if I got to the end of a complex calculation and it’s right/wrong. Mostly feel positive maths, because it has a logical/dependable set of rules. (710p)

I don’t think she has any strong feelings on math. She neither likes, nor dislikes it. (710c)

In the first pairing, it would appear that the discussions around mathematics, specifically high school mathematics content, have occurred as the Year Eight is differentiating between statistics and calculus. This may have occurred as a result of discussions involving older siblings. Nevertheless, it suggests that the Year Eight has a predetermined idea about these high school subjects and is aware of the frustration her mother experienced when she was studying these areas of mathematics. In the second pairing, it appears that the parent has been calm when interacting with mathematics in front of the Year Eight. This is supported by their calm classification according to their PEAMS score.

In contrast, some Year Eights had an inaccurate perception of their parent’s emotional response to mathematics. Pairing 106 had a significant mismatch that warranted further exploration. The Year Eight in pairing 106 described the father’s emotional response to mathematics as being very positive in nature.

My Dad loves maths. He thinks (I think he thinks) that it’s really important and that there is no way anyone should get below, because we do it every day. I just don’t think he understands that I don’t pick up on things very easily (106c).

The final comment about the daughter’s perception that the father did not understand that the daughter struggled, conveyed the extent of the disconnect between how she feels and how she perceives he feels about mathematics. However, the father’s description of his emotional response suggests that daughter’s perception is mistaken.
Worried, anxious especially with problem solving questions and complexity and question. It takes time to try and make sense of the question and can become too big to handle emotionally, can become frustrated. (106p)

Furthermore, the father goes on to describe in detail the experiences that he associated with his vulnerability to maths anxiety. Figure 13 shows the father’s drawings that appeared underneath the question and then again on the consent form. This suggests that it was a very strong memory of a painful experience, which may have influenced his response to mathematics.

I was given corporal punishment (strapped) for getting questions wrong. I learnt everything by rote. Especially my times tables and while I know my times tables and while I know up to 12x, I cannot do anything “other” than that. If I see a written question concerning problem solving I have trouble breaking the question down to its simplest form. I put this down to my early childhood education with poor maths teachers. I have a vivid memory of my brother (older) trying to help me work out the volume of a swimming pool and finally giving up and shouting at me until I started crying. I can still remember the pool. (106p).

Figure 13. Drawings of pool included in Father 106’s booklet and repeated on consent form.

When we look at the description of the daughter’s emotional response to mathematics the daughter’s response seems to mirror that of the father.

Sometimes it takes me quite a while to understand things in maths so often I just sit there wondering what to do. I find that only the teacher can explain what to do, not pupils, so usually it takes a while for the teacher to get some time to help me. (106c)
The daughter does not describe worrying or feeling anxious, but she does report that she struggles and is often left wondering what to do. However, her score on the CEAM suggests that she may be vulnerable to maths anxiety. Her father expresses this in a similar way, but goes on to include reporting feeling frustrated.

It takes time to try and make sense of the question and can become too big to handle emotionally, can become frustrated. (106p)

In this pairing it appears that the father, who does assist with homework, adjusts his approach to mathematics and conceals his natural emotional response. This adjustment, or compensation for their own experiences and feelings towards mathematics, was apparent in two other cases. In pairing 404 the mother reports feeling anxious about mathematics and her PEAMS score, vulnerable to maths anxiety, supports this.

I do feel anxious when asked to work out maths problems. Confusion. Feeling of incompetency. (404p)

However, she assists her daughter in mathematics so that she in turn does not have the same response.

I do try to help my daughter so she doesn’t have the same issues. I often get her to do maths squares where she has to work out the multiplications (404p)

Her daughter is aware of her mother’s lack of confidence in mathematics and reports this perception when answering item three (i.e., Do you think the parent who has agreed to participate in this study is good at maths?)

Yes, because my mum tells me she’s not that good but she is better than me. (404c)

Pointedly, her daughter’s CEAMS score suggested that her daughter’s level of emotional arousal to mathematics was Calm. The mother’s assistance and conscious shift in attitude to approaching mathematics has shadowed the transference of maths anxiety. Not wanting to repeat her own experiences of mathematics was also apparent in the response of the mother in pairing 706.

While I loved maths and was good at it, I also had a father who wanted to push me. He would leave me algebraic equations to solve if I was babysitting my sisters and I would be in tears knowing I couldn’t do it, or would get it wrong – and he’d be angry when he got home… 😟 very bad… but at school – all good! (706p)
My own anxiety about my childhood experiences – not wanting her to have the same feelings … She doesn’t get much maths homework – and games online are so individual … I’m reluctant to ‘test’ her times tables because I don’t want her to feel like a failure if she gets it wrong… (706p)

The Year Eight in this pairing is ambivalent to mathematics and responds that she “doesn’t need maths” (706c).

However, in many cases the Year Eights accurately perceived their parents anxiety, and their level of emotional arousal matched that of the participating parent. Pairing 511 is an example of this.

Frustration! (511p)

Mum once told me that at about 15, she was failing maths big time. This was because the teacher never explained the problems to her clearly, and every time she would ask for help, she would feel dumb (511c).

She [the parent] is very calm towards most mathematical problems, but when it comes to my maths homework, she gets very nervous. Mum likes to think she is bad at maths, but I disagree. (511c)

When I do basic maths I feel calm. But more complex questions make me feel very nervous, worried, and a little bit apprehensive to answer. (511c)

Both the parent and the Year Eight in this pairing are classified as vulnerable to maths anxiety according to their PEAMS and CEAMs scores.

To summarise, when the ways in which parents assisted with mathematics homework as perceived by Year Eights was analysed, three themes became apparent. Firstly, they assisted by using techniques that are associated with positive engagement such as explaining the homework, showing alternative ways to approach the task, and working alongside the Year without giving the answer. Secondly, they assisted in a general way or assisted with content specific help. Thirdly, assistance was given but the Year Eight questioned the benefit of the assistance. Positive Engagement was the biggest category and accounted for 46 out the 60 pairings where the Year Eight reported the participating parents assisted with homework. Notably, 36 of the pairings that fitted into this category were classified according to the PEAMS as Calm. By way of contrast, findings show that parents who use old ways, as
perceived by the Year Eights, tend to be more maths anxious and their children question the
benefit of this assistance. The findings also illustrated that many of the Year Eights accurately
perceived their parent’s emotional response to mathematics. In the cases where they did not,
some evidence suggested that the parent consciously compensated for their anxiety by
actively participating in mathematics homework, or encouraging mathematical related activities
in the home.

When the findings from this question, namely the presence of three themes to describe how
parents’ assist with mathematics homework and how this relates to their level of emotional
arousal are considered in light of other research and literature, it can be argued that the
findings are consistent. Firstly, Bandura (1997) argues that self-efficacy is developed through
vicarious experience/modelling. The findings of the current study, firstly the correlation found
between parent levels of emotional arousal to mathematics and Year Eights level of maths
self-efficacy when only homework assisting parents were examined, and secondly
qualitatively, when the responses suggested that fathers were calmer and modelled positive
attitudes and risk taking, supports Bandura’s theory. Furthermore, the incidence of matching
levels of emotional arousal to mathematics between Year Eights and their parents are also
consistent with findings from Maloney et al. (2015), in that negative attitudes and maths
anxiety are transferred when anxious parents assist with mathematics. However, by contrast,
the findings of the current study, considering the first question as well, also suggest that the
Year Eights accurately perceive their parents maths anxiety and negative emotional response
to mathematics regardless of assistance. Avoidance and delegation are observed by the Year
Eights and are assimilated into their beliefs and attitudes about mathematics.

The current study’s findings in relation to the presence of the theme benefit of assistance
questioned, and the subcategories assists using old ways, and assistance given but not
satisfactory, along with secondary accounts that question or conflict with new methods, is
also consistent with other research findings. Other research findings have attributed parents’
reluctance to assist with homework and conflict during homework sessions, to not
understanding new strategies or methods in mathematics education (Lange & Meaney, 2011;
Muir, 2012b). Furthermore, this echoes literature that suggests that parents’ can be
uninformed about pedagogical practises in mathematics (Anthony & Walshaw, 2007; Muir,
2012a; Pritchard, 2004). The implications for these findings will be discussed in the final
chapter.
Gender differences in the provision of assistance

The presence of an anomaly that suggested a statistically significant positive correlation between fathers’ emotional arousal to mathematics and Year Eights’ maths self-efficacy, as discussed in the integration phase, warranted further exploration. 70% (43) of all participating mothers and 77% (17) of all participating fathers did assist with homework. Table 16 shows the distribution across the themes for assisting parents, according to PEAMS classification and gender. Percentages in this table were used to account for the discrepancy between the numbers of mothers and fathers in the study which misleads the initial interpretation of the data. The percentages present the percent of the total numbers either assisting or not, by gender.

Table 16. Distribution Across the Themes for Assisting Parents, According to Peams Classification and Gender.

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Assisting Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mother</td>
</tr>
<tr>
<td>Positive Engagement</td>
<td>MA (%)</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
<tr>
<td>General or content specific assistance</td>
<td>-</td>
</tr>
<tr>
<td>Benefit of assistance Questioned</td>
<td>5</td>
</tr>
</tbody>
</table>

Interpretation of this table suggests that fathers are slightly more likely to use techniques associated with positive engagement, 74% for mothers compared to 82% of fathers. This begins to suggest a possible explanation for the positive correlation between the fathers’ level emotional arousal to mathematics and their children’s level of maths self-efficacy as discussed in the section Quantitative Anomalies. Fathers’ in this sample, may be calmer and positive about mathematics and this is assimilated by the Year Eights. Notably, when the responses to item six in the Year Eight survey was analysed and when positive words and phrases were highlighted, such as he/she really likes to help, he/she really enjoys helping, or
the description appears to convey a sense of calm and patience, two mothers were identified as fitting this coding compared to six fathers. Two representative examples are as follows.

Because he loves to help people if they are stuck in maths and likes showing different ways to solve a problem. (201c)

Because if he sees that I’m struggling he likes to help and see what I’m learning. He teaches me new strategies with maths and helps me learn how to figure out how to get the answer. (514c)

In some of the cases the Year Eight identifies that the father is not strong in mathematics but still tries to assist.

They just talk to me and try work it out together or that their not quite sure, but he does the best he can to help me. (701c)

In these cases it can be argued that the fathers’ are modelling self–efficacious behaviour, either through positive attitudes about assisting with mathematics, or through demonstrating risk taking as seen in the latter example. This in turn could be assimilated by the Year Eight. Other factors such as time and availability due to commitments may contribute to the absence of reporting this modelling in the female parent population in this study but, it also may contribute to the explanation for the anomaly with fathers. As discussed in section Actions and Interactions Associated with homework in the literature review chapter, research suggests that females are more likely to report maths anxiety (Ashcraft, 2002; Beilock, Gunderson, Ramirez, & Levine, 2010; Hembree, 1990; Ma & Cartwright, 2003). The findings from this study, as presented in the section Classification of Emotional Arousal to Mathematics and Maths Self-efficacy, support this premise, in that five mothers reported being maths anxious (according to their PEAM score) compared to no fathers. Similarly, eight more mothers were classified as vulnerable to maths anxiety than fathers. Therefore, because of the connection between maths anxiety and avoidance (Ashcraft & Moore, 2009; Hembree, 1990; Ramirez, Gunderson, Levine, & Beilock, 2013; Sheffield & Hunt, 2006; Suinn & Winston, 2003) it may be argued that more mothers avoid assisting with mathematics because of maths anxiety. Evidence of this in the current study, is the fact that two of the three parents who were reported to avoid assisting with mathematics were mothers. However, these numbers are too small to generalise but further research around this aspect is recommended. Furthermore, literature has focused on mothers’ emotionality and emotional response to mathematics in relation to mathematics homework (Else-Quest et al., 2008). However, the current study
suggests that fathers’ equally participate in the provision of mathematics homework and through modelling, contribute to the maths self-efficacy of their children.

**Conclusion for Chapter**

In Chapter Four, the findings for all three phases were presented and discussed. The key findings from the quantitative phase were:

- No significant correlations were found between parents’ maths self-efficacy and emotional arousal to mathematics, and Year Eights’ maths self-efficacy and emotional arousal to mathematics
- Year Eight girls appear to have a more anxious response to mathematics than Year Eight boys. Similarly, Year Eight girls report to have lower maths self-efficacy than Year Eight boys.
- A small positive correlation was found between the fathers’ emotional arousal to mathematics and Year Eights’ maths self-efficacy.

In the Integration phase, secondary quantitative analysis using coded qualitative data suggested:

- A small positive correlation was found between the parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy when the participating parents assisted with mathematics homework.

During the integration phase, two questions were formulated for qualitative exploration and rationale was presented to justify these questions. The resulting analysis suggested that:

- When exploring why some parents do not assist with mathematics homework, the most notable factor was because Year Eights did not ask for assistance.
- When exploring how parents assist with mathematics homework, the most notable factor was assisting by incorporating techniques that demonstrate positive engagement.
- Fathers are slightly calmer than mothers and are more likely to use techniques associated with positive engagement.
Chapter Five – Conclusion

The current study aimed to explore how parental modelling of maths self-efficacy and emotional arousal to mathematics relates to the perceived maths self-efficacy and emotional arousal of their children. Mathematics homework was identified as an authentic context to explore parental modelling of the affective variables along with more wider emotional responses to mathematics in the qualitative phase of the study. This study aimed to fill a gap in the literature, with researchers in the field of mathematics affect recommending more research into the role parents play in the development of children’s affective factors, namely maths anxiety (Jameson, 2014; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Vukovic, Roberts, & Green Wright, 2013). In this chapter a summary of the findings are presented in relation to the research questions, and the limitations of the research are discussed. Finally, future research directions are discussed in relation to the findings of the current study.

Summary of Findings

The design of the current study was a sequential explanatory mixed methods design with three distinct phases. The first and most dominant phase the quantitative phase, set out to test the following hypotheses;

1. There is a significant positive correlation between children’s maths self-efficacy and parents’ maths self-efficacy.
2. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ emotional arousal in mathematics.
3. There is a significant positive correlation between Year Eight children’s maths self-efficacy and parents’ emotional arousal to mathematics.
4. There is a significant positive correlation between Year Eight children’s emotional arousal to mathematics and parents’ maths self-efficacy.

Summary of quantitative findings.

The quantitative findings, although prominently focusing on hypothesis testing, also set out to examine the measures for central tendencies relating to the demographic descriptions of the participants and uncovered and presented notable anomalies in the analysis.

When the correlations were calculated and considered in regard to the four hypotheses, no significant correlations were found to suggest a relationship between parents’ maths self-
efficacy and emotional arousal to mathematics, and children’s maths self-efficacy and emotional arousal to mathematics. This conflicts with self-efficacy literature which suggests that parents contribute to the self-efficacy of their children through modelling and verbal persuasion (Bandura, 1997; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996).

The findings from the study also suggest that Year Eight girls have a more anxious response to mathematics than their male counterparts. Evidence of this was the difference in mean when scores for the CEAMS were compared and the effect size was moderate. However, these results were not replicated in the adult population; no significant difference was found between males and females in the parent population. The findings in relation to maths self-efficacy are similar to those of emotional arousal. Year Eight girls have lower maths self-efficacy than Year Eight boys. Again, evidence of this was the difference in mean when scores for the CMSEFF were compared and the effect size was moderate. Again, no significant in difference in mean was found in the adult population. The findings from demographic information, specifically gender, were consistent with findings in other research and literature in the field of maths anxiety (Ashcraft, 2002; Hembree, 1990; Pajares & Kranzler, 1995a).

Notably, a small yet significant positive correlation between fathers’ emotional arousal to mathematics and Year Eight maths self-efficacy was found \( r (20) = .45, p < .05, r^2 = .22 \), despite no overall significance arising between parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy. This notable anomaly was initially presented as a focus for the qualitative phase of the study.

**Findings from the integration phase.**

The integration phase in the design allowed for possible explanations for the quantitative results framed through the process of abductive reasoning, to be discussed. Possible explanations were presented as the focus for analysis in the qualitative phase. One of the interesting possible explanations, that corroborated with literature, related to parental avoidance of assisting with mathematics activities in the home (Díez-Palomar, Ortín, & Roldán, 2012). This premise was selected as one of the focuses for further exploration in the qualitative phase and the following question was formulated to explore this: *Why do some parents not assist with mathematics homework?*

During the integration phase, secondary quantitative analysis was carried out which amalgamated some of the qualitative data with some of the quantitative data. Specifically this
was exploring correlations between parental affective variables and Year Eight affective variables, but this time separating those that assisted with mathematics homework from those that did not. Interactions and actions associated with mathematics homework was chosen as a behaviour that provides an opportunity for parents and children to interact and engage in mathematics and therefore incorporates parental modelling of mathematic affect. The findings from this secondary analysis suggested that there was a small yet significant positive correlation between Year Eight children’s maths self-efficacy and parent emotional arousal to mathematics, $r (59) = .27, < .05, r^2 = .07$. As result of this finding the following question was formulated for further exploration: *How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?*

To explore these two questions qualitatively, it was deemed necessary to determine the classification and distribution of participants according to maths self-efficacy and emotional arousal to mathematics. By classifying each participant’s level of emotional arousal to mathematics and level of maths self-efficacy, it was then possible to compare this with each parent participant’s response to either their reason for not assisting with mathematics homework, or the ways they did assist. Some connection was made with the Year Eights level of maths self-efficacy as well.

Classification findings suggested that maths anxiety, as determined by boundaries associated with the CEAM and PEAM scale, were more prevalent in the female population in the current study. At Year Eight 13% of girls reported being maths anxious compared to 5% in Year Eight boys. In the parent population 8% of the females were anxious compared to 0% in the males. Again, these findings support literature and research that suggests that there is a gender difference in the prevalence of maths anxiety (Ashcraft, 2002; Hembree, 1990; Pajares & Kranzler, 1995a).

**Summary of the qualitative findings.**

The qualitative findings aimed to answer the following two questions:

1. Why do some parents not assist with mathematics homework?
2. How might the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?

The findings from each question are discussed in chronological order.
**Why do some parents not assist with mathematics homework?**

Two reasons, described as themes in chapter four, for not assisting with mathematics homework were uncovered during the analysis of the qualitative data. The most frequent reason/theme was that Year Eights did not ask the participating parent to assist with mathematics homework. Specifically this related to reports of four factors. 1) Year Eights did not want or need help with the mathematics homework, in some cases this linked to their desire for independence, 2) Year Eights chose the other parent to assist with mathematics homework, 3) Year Eights identified that the mathematics homework was too hard for the participating parent, and 4) Year Eights reported that they did not bring mathematics homework home. In some of the cases, evidence supported the suggestion that the Year Eight perceived their parent’s level of emotional arousal to mathematics and/or emotional response to mathematics and when the parent’s response was negative or anxious, chose not to ask for assistance. To summarise, the parent did not have an active role in the choice of whether to assist or not with mathematics homework.

In contrast, the second reason/theme that the parent chose not to assist with mathematics homework, suggested that the parent did have an active role in the choice of whether or not assist with mathematics homework. The participating parent in these cases frequently diverted assistance to their spouse. Notably these parents were either maths anxious or vulnerable to maths anxiety and were predominantly mothers. In these cases evidence suggested that the Year Eights perceived their parents level of emotional arousal to mathematics and/or emotional response to mathematics. Notably, the Year Eights in these cases mirrored their parent’s level of emotional arousal. These findings suggest that parents who were maths anxious or vulnerable to maths anxiety tend to avoid assisting with their children’s mathematics homework by diverting to their spouses. This is consistent with the findings in Díez-Palomar et al. (2012).

However, the significant finding relating to the question Why do some parents not assist with mathematics homework?, suggests that when their children are in Year Eight the parent predominantly does not make the choice to not assist, the Year Eight does, or report to. In relation to providing an explanation for the absence of a correlation between parental affective variables and Year Eight affective variables, which is different to literature in the field of mathematics affect to some extent (Bandura, 1997; Bandura et al., 1996; Vukovic et al., 2013), perhaps these Year Eights were no longer influenced by their parents’
mathematical affect to the same extent that they may have been in the past. This may be because they are no longer frequently exposed to parental modelling as they develop as independent learners. Other factors such as classroom practices and peer interactions may have more of an influence at this stage in development.

**How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?**

Three ways of assisting, or themes, which arose out of the data analysis relating to this question suggested a connection with the level of emotional arousal reported by some of the parents. The most frequent theme related to positive engagement and included the parents explaining the problem, showing alternative ways to solve the problem, supporting the Year Eight without revealing the answer, assisting with content specific tasks, and providing practice questions. Predominantly, the parents who were reported to assist in this way also reported being calm according to their emotional arousal classification.

The second theme General or content specific assistance, was not specific in the way the parent assisted, but it can be argued that the parents were confident enough with their content knowledge to be able to assist. Evidence to support this is the finding that all parents in this theme were classified as Calm according to the PEAMS score on the PEAMS.

The third, and final theme was that the Year Eight questioned the benefit of the assistance given. Evidence of this was responses that stated that the participating parent used old ways, or deemed the assistances unsatisfactory. Parents in this theme were either maths anxious, or calm. Notably, 18 references were made about new methods in mathematics education, and frequently this was associated with conflict and resistance. This supports other findings in literature which recognises parents’ perception and lack of understanding of new methods in mathematics education (Lange & Meaney, 2011; Muir, 2012a, 2012b; Peressini, 1998; Pritchard, 2004).

The question, How do the ways parents assist with mathematics homework reflect their level of emotional arousal to mathematics?, was formulated to explore the positive correlation between parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy, when participating parents were reported to assist with mathematics homework. The qualitative findings suggest that when the parents are calm, they are more likely to assist using ways that can be described as positively engaging. It is suggested that this calm positive engagement modelled through assistance with mathematics homework may be observed and
assimilated by the Year Eights. This is consistent with Bandura’s theory of self-efficacy development (Bandura, 1997), and ultimately substantiates the rationale and theory behind the current study, as described in the introduction of this chapter.

Finally, the quantitative findings suggested that there was a positive correlation between father’s emotional arousal to mathematics and Year Eight’s maths self-efficacy. Further exploration into the qualitative data suggested that fathers were as likely to assist with mathematics homework as mothers, contrary to other literature in the field of mathematics affect in homework (Pritchard, 2004), which focuses on mothers as the predominant provider of assistance with mathematics homework. Furthermore, the fathers in this study were slightly calmer, and more likely to assist with ways that encouraged positive engagement, and demonstrated affection for mathematics and risk taking behaviours when problem solving.

**Key findings of the current study.**

No significant correlations were found between parents’ maths self-efficacy and emotional arousal to mathematics, and Year Eights’ maths self-efficacy and emotional arousal to mathematics

- Year Eight girls appear to have a more anxious response to mathematics than Year Eight boys. Similarly, Year Eight girls are reported to have lower maths self-efficacy than Year Eight boys.
  A small positive correlation was found between the fathers’ emotional arousal to mathematics and Year Eights’ maths self-efficacy.
- A small positive correlation was found between the parents’ emotional arousal to mathematics and Year Eights’ maths self-efficacy when the participating parents assisted with mathematics homework.
- When exploring why some parents do not assist with mathematics homework, the most notable reason was because Year Eights did not ask for assistance.
- When exploring how parents assist with mathematics homework, the most notable way parents’ assisted was by incorporating techniques that demonstrate positive engagement.
- Fathers are slightly calmer than mothers’ and were more likely to use techniques associated with positive engagement.

A gap in the literature in relation to the role parents’ play in the development of affective factors, particularly maths anxiety and maths self-efficacy was identified. The current study
provided evidence that suggests that parents no longer play an important role in the
development of maths self-efficacy and maths anxiety when their children reach early
adolescence. However, when parents assist with mathematics homework, particularly when
the assistance is characterised by positive engagement, this contributes in a small way to an
increase in their children’s maths self-efficacy.

**Limitations of the Research**

There are a number of limitations that need to be acknowledged. These limitations relate to
the limited diversity of the study population, the timing of data collection and the subsequent
impact on responses, the administration of the survey to Year Eight students with unidentified
learning needs, and the manipulation of the open questions to answer questions arising out of
the quantitative findings.

The current study is limited to the parents and children who were willing to participate. The
socio-economic decile of participating schools seemed to have an impact on this participation.
The schools ranged from decile three through to decile ten. In the lower decile schools fewer
parents and children participated in comparison to the higher decile schools. For example, at
one end of the continuum a decile ten school had 52% of all Year Eights and their parents
participating in the research. In contrast, at the other end, a decile three school had only 19%
of Year Eights and their parents participating. Toomey (1996) argues that literature and
research in the field of parental involvement in school does not represent ‘hard to reach’
parents. It can be argued that the study has missed the hard to reach parents. Maths self-
efficacy and maths anxiety do not appear to be influenced significantly by socio-economic
level. However, the possible disproportionate representation from willing and able parents
suggests that the views and experiences of those who have shied away from participation have
not been heard. It can be argued that those parents or students that are particularly anxious
about mathematics may have heard the mention of mathematics and decided on the spot not to
participate.

Similarly, there was heavy representation from participants who identified as being
Pakeha/NZ European (86%). However, this may be indicative of the population diversity of
the Otago/Southland region of New Zealand.

The timing of the administration of the research was carefully considered. Term two of the
New Zealand academic year was chosen as the data collection period because it avoided the
period in schools when formal assessment was predominantly administered, and allowed for
class routines and mathematics programmes to have been established. Four to six weeks were allowed between the initial distribution of parents’ surveys and the administration of the Year Eight surveys, to mitigate the influence of possible discussions between parents and Year Eight students and the possibility of increased focus on homework interactions, as described in the methodology.

The survey may have triggered a greater focus on mathematics in the home. This may have resulted in a temporary increase in the homework assistance given or seeking assistance from external providers between the distribution of the parent surveys and the administration of the Year Eight surveys. This sudden shift away from the norm, and the time between the parents and children doing the surveys, may have resulted in some responses from Year Eights contradicting the responses given by parents. Some students wrote that the parent did help with homework but the parent had earlier written that they did not. It is possible that the parent began assisting after the research had drawn attention to interactions between parents and children in mathematics.

Another limitation of the study was that reader/writer assistance was not offered to students with specific learning needs. In one of the first classroom-based Year Eight sessions it became apparent directly after administration, through discussions with the teacher, that a student may have struggled to read the survey. In all schools after this point reader/writer assistance was offered to those that needed assistance, as identified by the teacher or elected to have assistance themselves.

The final limitation of the study related to the manipulation of the open questions during qualitative analysis. As discussed in the methodology, conducting interviews or distributing a second questionnaire was not pragmatic. Qualitative responses were collected at the same time as the quantitative scales. As the questions used to elicit qualitative analysis were predetermined, the strength of the responses in relation to the questions that arose out of the integration phase may have been affected.

**Future Research Directions**

The findings of the current study suggest directions for future research. Further research is warranted to explore the relationship between parental avoidance of mathematics homework assistance and other mathematics activities in the home, and how this is perceived by children who observe this behaviour.
The findings from the current study suggest that at Year Eight, other factors may have more influence on an individual’s mathematics affect and it may be more appropriate to explore this relationship in children of a range of ages. Furthermore, other significant factors that contribute to Year Eight students’ mathematic affect also warrant further study as noted below.

The findings from the current study suggest that fathers have an active role in mathematics homework and encouraging mathematics activities in the home. Literature has focused on mothers as the primary source of homework assistance regardless of subject area (Else-Quest, Hyde, & Hejmadi, 2008). Fathers’ emotional response to mathematics was found to be correlated with their children’s maths self-efficacy. More research is required to determine whether this is the case in the wider population. If this is the case this may also contribute to the perpetuation of gender stereotypes in mathematics, and more research in this area is warranted to determine the extent of this gender bias in the family environment.

Future research is also warranted to explore intervention programs that can improve the maths self-efficacy and limit the anxious responses of parents when faced with interactions around mathematics and their children’s mathematics learning.

**Implications for Schools and Educators**

In the methodology section, the essential underpinnings of this study were discussed and the motivation for the study presented. The motivation was pragmatic. The goal of the study being to further understanding in the field of mathematics affect in relation to exploring how parental modelling of maths self-efficacy and emotional arousal to mathematics relates to the perceived maths self-efficacy and emotional arousal of their children. The hope is that a greater understanding of this relationship may contribute to future considerations and changes in schools that reflect the implications of this study.

One of the implications for schools and education policy makers from the current study’s findings relate to providing more opportunities for parents to engage with mathematics strategies in a positive way. Findings suggested that parents still experience conflict and confusion around what they perceive as new methods in mathematics education. Parents, particularly mothers, need to be shown and encouraged to incorporate mathematics application in everyday activities in the home environment so children can observe the application of mathematics as well as observe parent modelling of risk taking in mathematics problem solving in a positive and constructive manner. Finally, schools need to provide
opportunities for maths anxious parents, and those who are vulnerable to maths anxiety, to gently and sensitively address their struggles through appropriate intervention programs. These considerations may contribute to more positive interactions between children and parents in relation to mathematics and in turn, increase positive engagement in mathematics at school and ultimately, provide the essential connection between the two environments that are so important to the child as a mathematics learner. A learner whose confidence in mathematics opens new and creative pathways in future communities and technological worlds.
References


Dudding, A. (2013, 8th December). Time to panic over maths?, *Sunday Star Times*


Appendix 1. Year Eight Survey

A study exploring the relationship between parent and child emotional responses to mathematics

Please complete

Gender  Male/Female
Age  
Ethnicity  Pakeha/NZ European  Maori  Pasifika
  Asian  Other  (Circle One)

Thank you for participating in this study

This task has four parts to it
Read each question carefully and then answer the question by circling either very confident, confident, not very confident, or not very confident at all.

How confident would you feel answering this question?

1) This recipe makes 10 muffins

<table>
<thead>
<tr>
<th>For 10 Muffins:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 eggs</td>
</tr>
<tr>
<td>1 ½ cups of self-raising flour</td>
</tr>
<tr>
<td>½ cup of milk</td>
</tr>
</tbody>
</table>

For each ingredient write down how much you would need to make 30 muffins

___ eggs  ___ cups of milk

___ cup of sugar  ___ grams of butter

___ cups of self-raising flour  ___ diced apple

How confident would you feel answering this question?

2) Look at the three booklets of raffle tickets.

Each booklet has a different number of tickets, and each booklet has a different ticket price.
If each booklet of raffle tickets was sold, which booklet would make the most money? Ticket the best answer.

Booklet A  
Booklet B  
Booklet C  

How confident would you feel answering this question?

3) Look carefully at this graph

How many children walk to school? ______
How many more children come by bus than by car? ___
This graph is for the 23rd of May.
Would the graph look the same every day? ___
Why do you think that?

What does the row with ‘Train’ tell you about how these children go to school?

Tom was not at school on that day. How do you think he normally gets to school?

Why do you think that?

| very confident | confident | not very confident | not very confident at all |

How confident would you feel answering this question?

4) Matt did the Weet-Bix Triathlon.  
   Look at how far he had to swim, run and ride.

   Triathlon Distances
   Swim 200 metres  
   Run 1.5 kilometres  
   Ride 8 kilometres

   The pool used for the triathlon was 25 metres long. How many lengths did Matt have to swim? ___

   The track used for the triathlon was 500 metres long. How many laps of the track did Matt need to run? ___
Look at the times on the stopwatches. They show how long it took Matt to finish each part of the triathlon.

How long did it take to do the whole triathlon? ___________

| very confident | confident | not very confident | not very confident at all |

How confident would you feel answering this question?

5) Imagine you have a time machine. You can travel in it from the year (2005) back to the past and forward to the future. The trip meter can be set to show you what year you will travel to.

Write what the trip meter will show if the time machine travels **two years into the future** from:

| 2005 |
| : 26 |

Write what the trip meter will show if the time machine travels **twenty years into the future** from:

| 2005 |
| : 64 |

Write what the trip meter will show if the time machine travels **two hundred years into the future** from:

| 2005 |
| : : |

Write what the trip meter will show if the time machine travels **two thousand years into the future** from:

| 2005 |
| : : |

Write what the trip meter will show if the time machine travels **two years back to the past** from:

| 2005 |
| : : |

Write what the trip meter will show if the time machine travels **twenty years back to the past** from:
Write what the trip meter will show if the time machine travels two hundred years back to the past from:

![Image](2005.png)

Write what the trip meter will show if the time machine travels two thousand years back to the past from:

![Image](2005.png)

| very confident | confident | not very confident | not very confident at all |

How confident would you feel answering this question?

6) Look carefully at the picture. One litre of paint is needed to paint this wall.

![Wall Image](wall.png)

If the wall was 10m by 6m, how much paint would you need? ______________

| very confident | confident | not very confident | not very confident at all |

How confident would you feel answering this question?

7) The card tells you that 54 times 6 is 324
Use this fact to work out 56 times 6.
What is 56 × 6 =

Show how you worked this out

<table>
<thead>
<tr>
<th>very confident</th>
<th>confident</th>
<th>not very confident</th>
<th>not very confident at all</th>
</tr>
</thead>
</table>

**How confident would you feel answering this question?**

8) A boy used a calculator to work out some number problems.
   There is something wrong with his calculator. It doesn’t show the decimal point.
   For each problem, put the decimal point where you think it should go. Make sure your decimal point is easy to read.

26 ÷ 5 =

1.5 × 7 =

735 ÷ 19 =
211.4 x 196 = 414344

<table>
<thead>
<tr>
<th>very confident</th>
<th>confident</th>
<th>not very confident</th>
<th>not very confident at all</th>
</tr>
</thead>
</table>

Read the questions carefully and tick the box in that row that is most like how you feel.

<table>
<thead>
<tr>
<th>When I solve maths problems, I feel:</th>
<th>Very anxious/nervous</th>
<th>Anxious/nervous</th>
<th>Calm</th>
<th>Very calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I think about doing maths, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I am working on maths problems that are difficult and make me think hard I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compared to other school subjects, maths makes me feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I solve maths puzzles, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I have a hard maths question, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When the teacher calls on me to answer a maths question, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When the teacher is showing the class how to solve a maths problem, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I had to add up numbers on the whiteboard in front of the class, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I make a mistake in maths, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thinking about working on maths in class makes me feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very anxious/nervous</td>
<td>Nervous/anxious</td>
<td>Calm</td>
<td>Very calm</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>----------------------</td>
<td>----------------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>Working on maths at home makes me feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When the teacher gives the class a maths problem I don’t understand, feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When my teacher says that he or she is going to give me a maths question on the whiteboard, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I know that my class will be working on maths at school, I feel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Read the questions carefully and tick the box in that row that is most like how you feel

Please answer the following questions as fully as you can.

1) Describe your emotional response to maths. List all the words or phrases you can think of that you could use.

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

2) How would your parent (the adult who has agreed to participate in this study) describe their emotional response to maths?
3) Do you think the parent who has agreed to participate in this study is good at maths? Yes / No (Circle one)

Why do you think this? (If you can think of examples to support your reason please include e.g. Mum loves working out the savings when we go shopping or Dad often says ‘he is rubbish at maths’)

4) Is maths important in your family? Yes/No (Circle one)
How do you know this?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5) Has the parent who has agreed to participate in this study ever talked about their experiences of maths when they were at school?

Yes/No (circle one)

What have they told you?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
6) Does the parent who has agreed to participate in this study help you with maths homework? Yes/No (circle one)

   If they do help, how do they help you?

   If they don’t help, why do think they don’t help you?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Thanks for helping with this study. It is really appreciated
Appendix 2. Parent Survey

A study exploring the relationship between parent and child emotional responses to mathematics

Please complete

Gender  Male/Female

Age  ______________

Ethnicity  Pakeha/NZ European  Māori  Pasifika

Thank you for participating in this study

This task has three parts to it
Read the questions carefully and tick the box in the row that is most like how you feel.

<table>
<thead>
<tr>
<th>When I am faced with everyday problems that involve maths, I feel…</th>
<th>Very anxious</th>
<th>Anxious</th>
<th>Calm</th>
<th>Very calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I know I have to use maths, I feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If a bank consultant was explaining interest rates to me, I would feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I was asked to work out a 65% discount on a jacket before I reached the checkout, I would feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working out quantities when I need to double a recipe makes me feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I know it is time to check my tax return using maths calculations, I feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working out the area and volume of paint I need for a fence makes me feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When my child asks me to help with maths homework, I feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I was asked to run the sausage sizzle at the school fair and I made a mistake giving change, I would feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I had to use some of the maths I learnt at school like algebra, I would feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I am helping my child with maths, I feel…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When my child’s teacher is discussing maths strategies with me, I feel…

When someone asks me the answer for a times table like $7 \times 9$, I feel...

If I was asked to be the treasurer for a sports club, I would feel…

If a new job or course required me to take a maths paper or course, I would feel…

If I was asked to work out the average electricity used in our home over a year for a price comparison website, I would feel…
How confident would you feel answering the following mathematics tasks?

Please answer these questions as fully as you can.

1) Describe your emotional response to maths. List all the words or phrases you can think of that you could use.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2) How did you feel about maths when you were at school?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
3) If you have a significant memory of maths at school that shaped how you feel about maths today, please describe that memory.
4) Do you help your child with maths homework? Yes/No (circle one)
If yes, describe how you help your child with their maths homework?
Describe a recent experience if possible.
If no (or only sometimes), what prevents you from helping your child with maths?

______________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

Thank you for participating in the study. Your time and consideration is greatly appreciated.
Appendix 3. Letter for Schools

Reference Number 15/004
02/03/2015

Sarah Bartley
Master of Arts student
University of Otago College of Education
145 Union Street East
P.O. Box 56
Dunedin 9054

13th March, 2015

Dear ,

I am writing to enquire if your school would be prepared to participate in my research for my Masters of Arts degree.

The aim of the current study is to explore the relationship between the experiences of parents/guardians and their emotional responses to maths and their child’s emotional responses to maths. To recompense for the school’s participation in the project, I am offering one day’s relieving. I am a registered and experienced teacher who, up until the start of this research in December 2014, was an active member of the Dunedin relieving teaching pool.

Participants

For this study we are recruiting Year 8 students and their parents/guardians. Parents/guardians in this study means anyone who is the permanent primary carer of the child and could include grandparents and other members of the extended family/whanau. We are looking to recruit between 100 and 120 parent/child pairings. All children from contributing schools are invited to participate in the study. Only children whose parents/guardians have agreed to participate will be included in the study.

What the Participants will be asked to do

Both the parents and children will be asked to complete a survey with some open questions about how they feel about maths and their experiences of learning and using maths in school, and in everyday activities. The children will complete their survey and questionnaire in class at
the beginning of a maths lesson. The parent survey is included in an information package and they are able to complete it at their convenience. The survey should take no more than 45 minutes in both cases.

After initial analysis of the collected data I may invite some parents to attend an interview. It is envisaged that any interviews would take no more than 45 minutes and will take place at the university.

**Expected Level of Commitment from School**

If you agree to participate in this study, you will be asked to distribute the participation packages to all year 8 students. This package will include the relevant information and consent forms for both the children and the parents, along with the parent survey and an envelope for returns. A ‘post box’ will be provided to the school so forms can be returned. A list of participating students will be collated and coded to provide anonymity.

I will then work with the teacher/teachers of year 8 students to co-ordinate a convenient time to administer the survey. This should take approximately 45 minutes.

**Data Collection**

The two main forms of data that will be collected are the written answers to the questionnaires and survey responses, and the audio recording and transcript of the any eventuating interviews. The data from the study will be coded and categorised into themes around beliefs and attitudes to mathematics and explored across all participants.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. Data obtained as a result of the research will be retained for at least 5 years in secure storage. Any personal information held on the participants such as contact details, audio recordings, surveys and questionnaires may be destroyed at the completion of the research even though the data derived from the research will, in most cases, be kept for much longer or possibly indefinitely.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity. The hope is that findings from this study will help develop school initiated support programs for parents to develop their confidence in mathematics, so they become confident models for their children.

Please be aware that if any of the participants decide not to take part in the project, or decide to withdraw for any reason during the study, they may do so without any disadvantage to themselves, their child, or the school of any kind. If you wish for me to come and speak to your Board of Trustees or staff about this research I am happy to do so.

If you are happy for your school to participate in this research please sign the attached consent form and post in the stamped pre-addresses envelope enclosed. If you have any
questions please do not hesitate to contact me or my supervisor. Thank you very much for your consideration with this request.

Yours sincerely,

Sarah Bartley, Masters Candidate
Email: sarah.bartley@otago.ac.nz
University of Otago College of Education
Tel 03 479 4260

Supervisor:
Dr Naomi Ingram
Email: naomi.ingram@otago.ac.nz
University of Otago College of Education
Tel 03 479 4284

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +64 34798256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix 4. Information Sheet for Parents

A study exploring the relationship between parent and child emotional responses to mathematics

INFORMATION SHEET FOR PARENTS OR GUARDIANS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the aim of the project?

When faced with calculations and maths problems an all too common response is to panic. This anxious response is the experience of many children and adults and may limit engagement and confidence in mathematics. The aim of the current study is to explore the relationship between the experiences of parents/guardians and their emotional responses to maths, and their child’s emotional responses to maths. This study is being undertaken as part of the requirements for Sarah Bartley’s Master of Arts thesis.

What type of participants are being sought?

For this study we are recruiting Year 8 students and their parents/guardians. Parents/guardians in this study means anyone who is the permanent primary carer of the child and could include grandparents and other members of the extended family/whanau. We are looking to recruit between 100 and 120 parents and children pairings. All children from contributing schools are invited to participate in the study. Only children whose parents/guardians have agreed to participate will be included in the study.

What will participants be asked to do?

Should you agree to participate and allow your child to take part in this project, you will both be asked to complete a survey about how you feel about maths and your experiences of learning and using maths in school and in everyday activities. Your child will complete their survey in class at the beginning of a maths lesson. Your survey is attached to this information sheet and can be completed at your convenience. The survey should take no longer than 20 minutes.
After initial analysis of the collected data we may invite some parents to attend an interview. If you are happy to attend an interview please tick the appropriate box on the Parental Consent Form and include details about your preferred method of contact. It is envisaged that any interviews would take no more than 45 minutes. You may choose to do the survey but not the interview, which is fine.

**What data or information will be collected and what use will be made of it?**

The two main forms of data that will be collected are the written answers to the survey questions, and the audio recording and transcript of the any eventuating interviews. The data from the study will be coded and categorised into themes around beliefs and attitudes to mathematics and explored across all participants.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. Data obtained as a result of the research will be retained for at least 5 years in secure storage. Any personal information held on the participants such as contact details, audio recordings, and survey responses may be destroyed at the completion of the research even though the data derived from the research will, in most cases, be kept for much longer or possibly indefinitely.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity. The hope is that findings from this study will help develop school initiated support programs for parents to develop their confidence in mathematics, so they can become confident models for their children.

**Can participants change their mind and withdraw from the project?**

If you, or your child, decide not to take part in the project, or decide to withdraw for any reason during the study, you may do so without any disadvantage to yourself or your child.

**How do I agree to participate or allow my child to participate?**

If you agree to participate and your child is happy to participate in the study please fill the consent form titled *Parental or Guardian Participant Consent Form.* Your child also needs to agree to participate and needs to read the child information brochure and sign the *Child Consent form.* Please return these two consent forms together with your completed survey to school by the 3rd of June. An envelope is included to maintain your anonymity.

**What if participants have any questions?**

If you have any questions about our project, either now or in the future, please feel free to contact either:-

*Sarah Bartley (Student Researcher)*  or  *Dr Naomi Ingram*

College of Education  
Tel  03 479 4260  
sarah.bartley@otago.ac.nz

College of Education  
Tel  03 479 4284  
naomi.ingram@otago.ac.nz
This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
About me
My name is Sarah Bartley and I am a university student interested in how children and parents feel about maths. I am working towards a Masters of Arts.

Contact Me
Phone: 03 479 4260
Email: sarah.bartley@otago.ac.nz

My supervisor
My supervisor is Dr Naomi Ingram. You can contact Dr Ingram if you have any other questions too.

Contact Dr Naomi Ingram
Phone: 03 479 4284
Email: naomi.ingram@otago.ac.nz

What do I do next?
If you are happy to participate in this study please read and sign the Consent Form for Child participants and give this to your parent/guardian so they can put it in the envelope provided and return it to school by the 3rd of June.

If you change your mind about taking part at any time that is okay.

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Who would I like to help me?

For this study I am interested in Year 8 students only. I am looking for between 100-120 children and their parents to help. Everyone in your class and their parents (this could be your mum/dad/grandma/granddad or special adult) are invited to take part.

To acknowledge your participation, you will go into a draw at your school to receive a pair of movie tickets.

What will I be asked to do?

If you are happy to take part in this study, and your parents have agreed to participate in the study you will be asked to fill in a survey about how you feel about maths. This is likely to happen in your classroom, or somewhere quiet around the school and should only take about 30 minutes.

What information will be collected and what will it be used for?

Data (the information and answers collected from the activities) will be recorded using pen and pencil. The data will be stored at the university in a locked cabinet and only I will be allowed to use it. After the study is complete the data is kept very safe for at least five years. Any personal information like your name, will be destroyed at the end of the study. The results and findings from the study may be published and will be available in the University of Otago Library but every effort will be made to make sure that no one can tell that you took part.

What am I trying to find out?

Some students are very excited about doing maths tasks, while other students get nervous about it and hope the teacher won’t ask them to share their answers. Some adults feel like this too!

I want to learn more about how Year 8 students and their parents/guardians feel about maths.

I want to explore how Year 8s and their parents talk about maths, and how they describe their experiences of learning and using maths either in the classroom or in everyday activities like cooking and shopping.
Appendix 6. Parent Consent Form

Reference Number 15/004

A study exploring the relationship between parent and child emotional responses to mathematics

PARENT OR GUARDIAN CONSENT FORM

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the project is entirely voluntary, and I can decline to answer any question or may stop at any point;

2. My child’s participation in the project is entirely voluntary;

3. My child and I are free to withdraw from the project at any time without any disadvantage;

3. Personal identifying information (audio recordings, interview transcripts, and surveys) may be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project and I confirm that I am over 18 years of age

................................................................. .................................................................
(Signature of participant) (Date)

........................................................................................................................................
........................................................................................................................................
(Printed Name) (Child’s Name)

□ Please tick if you are happy to attend an interview

Preferred method of Contact (Please add details as appropriate)

Email ............................................................

Phone ............................................................
This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix 7. Year Eight Consent Form

Reference Number 15/004

A study exploring the relationship between parent and child emotional responses to mathematics

CONSENT FORM FOR CHILD PARTICIPANTS

I have read the Information Brochure for Year 8 Students and have had any questions that I have had answered.

I know that:

1. Participation in this study is voluntary, which means that I do not have to take part if I don’t want to. I can also stop taking part at any time and don’t have to give a reason.

2. If I don’t want to answer some of the questions, that’s fine.

3. If I have any worries or if I have any other questions, then I can talk about these with Sarah.

4. The paper and computer file with my answers will only be seen by Sarah. She will keep whatever I write private.

5. Sarah will write up the results from this study for her University work. The results may also be written up in journals and talked about at conferences. My name will not be on anything Sarah writes up about this study.

I agree to take part in the study.

............................................................................................................... ..................................................
Signed  Date
Appendix 8. Initial Factorial Structure of PEAMS

*Initial Factorial Structure of PEAMS with three factors*

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I am faced with everyday problems that involve maths, I feel…</td>
<td>.858</td>
<td>-.077</td>
<td>-.492</td>
<td>.754</td>
</tr>
<tr>
<td>If I was asked to work out a 65% discount on a jacket before I reached the checkout, I would feel…</td>
<td>.820</td>
<td>.202</td>
<td>-.538</td>
<td>.698</td>
</tr>
<tr>
<td>When I know it is time to check my tax return using maths calculations, I feel</td>
<td>.812</td>
<td>.226</td>
<td>-.596</td>
<td>.710</td>
</tr>
<tr>
<td>If I was asked to work out the average electricity used in our home over a year for a price comparison website, I would feel…</td>
<td>.798</td>
<td>.158</td>
<td>-.561</td>
<td>.659</td>
</tr>
<tr>
<td>If a bank consultant was explaining interest rates to me, I would feel…</td>
<td>.770</td>
<td>-.212</td>
<td>-.519</td>
<td>.668</td>
</tr>
<tr>
<td>When I know I have to use maths, I feel…</td>
<td>.759</td>
<td>-.234</td>
<td>-.458</td>
<td>.659</td>
</tr>
<tr>
<td>When someone asks me the answer for a times table like 7 x 9, I feel…</td>
<td>.741</td>
<td>.233</td>
<td>-.553</td>
<td>.603</td>
</tr>
<tr>
<td>If I was asked to be the treasurer for a sports club, I would feel…</td>
<td>.727</td>
<td>.205</td>
<td>-.668</td>
<td>.641</td>
</tr>
<tr>
<td>If a new job or course required me to take a maths paper or course, I would feel…</td>
<td>.727</td>
<td>-.007</td>
<td>-.631</td>
<td>.592</td>
</tr>
<tr>
<td>Working out the area and volume of paint I need for a fence makes me feel…</td>
<td>.653</td>
<td>-.220</td>
<td>-.528</td>
<td>.525</td>
</tr>
<tr>
<td>Working out quantities when I need to double a recipe makes me feel…</td>
<td>.639</td>
<td>.336</td>
<td>-.244</td>
<td>.520</td>
</tr>
<tr>
<td>If I was asked to run the sausage sizzle at the school fair and I made a mistake, I would feel…</td>
<td>.181</td>
<td>.853</td>
<td>-.173</td>
<td>.752</td>
</tr>
</tbody>
</table>
When my child asks me to help with maths homework, I feel…

<table>
<thead>
<tr>
<th></th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.569</td>
<td>-.002</td>
<td>-.896</td>
<td>.806</td>
</tr>
</tbody>
</table>

When I am helping my child with maths, I feel…

<table>
<thead>
<tr>
<th></th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.546</td>
<td>.082</td>
<td>-.890</td>
<td>.797</td>
</tr>
</tbody>
</table>

If I had to use some of the maths I learnt at school like algebra, I would feel…

<table>
<thead>
<tr>
<th></th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.560</td>
<td>-.227</td>
<td>-.804</td>
<td>.722</td>
</tr>
</tbody>
</table>

When my child’s teacher is discussing maths strategies with me, I feel…

<table>
<thead>
<tr>
<th></th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.491</td>
<td>.303</td>
<td>-.777</td>
<td>.683</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.31</td>
<td>1.31</td>
<td>1.17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of variance</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51.93</td>
<td>8.18</td>
<td>7.33</td>
</tr>
</tbody>
</table>