Unpacking Mathematics Anxiety in Year 9 Students

A thesis presented in partial fulfilment of
the requirements for the degree of:

Master of Education
in
Mathematics Education

Massey University
New Zealand

Lee Coveny Mann

2017

Abstract

This thesis explored the extent of mathematics anxiety in Year 9 students in a rural/provincial region of New Zealand. The study's aim was to examine how students' individual and school variables (such as gender, ethnicity, school decile, school gender type and school type) related to their levels of mathematics anxiety. This mixed methods sequential explanatory design utilised two phases: First, a survey was completed by 434 Year 9 students to identify their levels of mathematics anxiety (in terms of mathematics learning anxiety and mathematics test anxiety). Second, focus group interviews were conducted with the most highly-mathematically-anxious students to examine their experiences with mathematics anxiety. The results showed that 21.4% of students, particularly girls, reported high levels of mathematics anxiety. Social categories for which mathematics anxiety was most prevalent was, in general, consistent with the "priority learners" identified by the New Zealand Education Review Office—Māori and Pāsifika students and those from low socioeconomic backgrounds. The four main themes that emerged from the interviews were: the importance of teacher quality; the detrimental effect of high-frequency, high-stakes assessment; the impact of social comparison; and the big jump when starting secondary school. Reasons accounting for these results, and implications for teaching and learning, are discussed.

Acknowledgements

Firstly, my thanks go to the Board of Trustees, Principal, and colleagues from the school at which I teach, for supporting me to complete this research, especially the time afforded to me.

I am grateful to have received practical and financial support from TeachNZ and Massey University's Institute of Education which has made life a lot easier.

I appreciate for the "green light" from all of the participating schools and their Boards of Trustees, Principals, and teachers. It is humbling and encouraging that our wider school community has seen this research as important for the advancement of our collective understanding of our young people's experiences with mathematics. A big thank you to all of the students who participated in this study; I really appreciate your openness, honesty and willingness to participate. It is great that your voice will be heard. Thanks also to your obliging parents who allowed you to participate.

My sincere thanks go to my supervisor, Professor Margaret Walshaw, and my co-supervisor, Raewyn Eden. Your patience, support, advice, guidance, and encouragement during this rollercoaster ride has been truly amazing.

Finally, thank you to my husband Shane. Words cannot do justice to describe the myriad of ways in which you have supported me throughout this challenging process. I sincerely appreciate the many small sacrifices that our family (including our children Cameron and Lauren) have made to enable me to do this thing. x

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Introduction

During more than a decade of secondary mathematics teaching, I have often been faced with a wide range of different attitudes that students have towards mathematics: from keen, interested and clever students, apathetic, disinterested and disengaged students, to a large group of fearful, stressed and anxious students who are eager to succeed but seem to find mathematics to be an insurmountable wall. This experience is heart-breaking to witness and frustrating to battle against. I have often wondered what factors and influences contribute to this mathematics anxiety, and what strategies could be utilised to reduce its effect. My own teaching practice can only improve with a deeper understanding of the factors and influences as well as the ways to minimise their impact.

Many researchers have undertaken work in the field of mathematics anxiety. It is obviously an important area to research and has implications for everyone in their daily lives and futures. However, most research studies have been completed overseas, and typically with university students or pre-service teachers. Therefore, there is currently a gap for a study of mathematics anxiety in New Zealand adolescents.

This work will be an important indicator of the extent of mathematics anxiety in Year 9 students and may prompt more research into the area, and/or begin a conversation in schools, classrooms, homes and communities. My hope is that this research will illuminate the difficulties and anxieties that some students face in mathematics, and offer a starting point in discussing strategies for teachers to help to reduce its impact.

1.2 Statement of the Problem

Mathematics anxiety is a global phenomenon which is pervasive in all societies: "Mathematics is unique in its ability to polarise students and adults alike" (Fraser Webb, 2013, p. 1). The prevalence of mathematics anxiety has been estimated at 20%, based on Ashcraft and Kirk's (2001) research with university undergraduates. Nationally, mathematics anxiety is a critical educational, social, and economic issue. On an individual level, mathematics anxiety can be debilitating and have lifelong effects.

Mathematics anxiety at school is an issue because, typically, it does not disappear when students complete their formal education; it can become a lifelong problem for adults. It limits opportunities to develop the skills to engage productively with mathematics such as through attention to personal finances and career choices. Mathematically anxious people may avoid numerical encounters in everyday life, which, in turn, reduces their life opportunities. Such adults may also create a dependency on technology (such as calculators, computers or cell phones) because their estimation and basic numeracy skills are compromised. Society's goal is focused toward numerate citizens, not citizens who are constrained educationally, socially, or economically because of a fear of mathematics.

Disengagement from mathematics and anxiety over mathematics were both explored in the 2012 Programme for International Student Assessment (PISA) study. Many participants reported feelings of mathematics anxiety: 61% of students reported that they worry about getting poor grades in mathematics; 59% that they often worry that it will be difficult for them in mathematics classes; 31% that they get very nervous doing mathematics problems; and 30% that they feel helpless when doing mathematics problems. New Zealand recorded the largest increase of any country in mathematics anxiety over the previous decade (OECD, 2013a).

1.3 Background and Rationale for the Study

The New Zealand Education Review Office's (2015) *Wellbeing for Young People's Success at Secondary School* report states that the wellbeing of young people is essential for their success as "confident, connected, actively involved, lifelong learners" (Ministry of Education, 2007, p. 7). "Most young people in New Zealand are creative and resilient and thrive during their adolescent years – but 20 per cent exhibit behaviours or emotions or have experiences that put their wellbeing at risk" (ERO, 2015, p. 1). We want our students to experience "positive feelings and attitudes, positive relationships at school, resilience, self-optimism and a high level of satisfaction with learning experiences" (Noble, McGrath, Roffey, & Rowling, 2008, p. 30). To promote and enhance students' wellbeing, ERO has recommended that schools review their assessment practices to decrease the volume of assessment, and engage parents and whānau in decisions that impact on the wellbeing of young people. "Students would also benefit from schools being more deliberate in promoting wellbeing in the curriculum…. [However,] what they experienced was very assessment driven and caused anxiety for many students" (ERO, 2015, p. 2).

The Organisation for Economic Co-operation and Development (OECD) has claimed that mathematical capability is vital for life in modern society:

> A growing proportion of problems and situations encountered in daily life, including in professional contexts, require some level of understanding of mathematics, mathematical reasoning and mathematical tools, before they can be fully understood and addressed. Mathematics is a critical tool for young

> people as they confront issues and challenges in personal, occupational, societal, and scientific aspects of their lives. (OECD, 2013b, p. 24)

Alarmingly, 43% of New Zealand adults aged 16 to 65 do not have sufficient mathematical skills to fully engage in the economy and society. Māori and Pāsifika adults are over-represented among this group. "This impacts everyone, because it can perpetuate intergenerational disadvantage and limit economic growth and social development" (Tertiary Education Commission, 2015, p. 5).

1.4 Purpose of the Study

The overarching research question guiding this thesis is:

How do New Zealand Year 9 students' individual and school variables relate to their levels of mathematics anxiety?

Unpacking this further, the research objectives addressed in this study are:

1. To find out the extent of mathematics anxiety amongst Year 9 students in the region.
2. To explore the relationship between students' levels of mathematics anxiety and their gender, ethnicity, school decile, school gender type, and school type.
3. To determine what aspects of students' experiences contribute to their mathematics anxiety.

1.5 Thesis Overview

The thesis is divided into three sections. Section I provides the rationale for the study, through this introductory chapter and the Literature Review in Chapter 2. The literature review explores a number of factors and social categories related to mathematics anxiety. New Zealand studies in the area and gaps in the literature are also explored.

Section II (Chapters 3 and 4) describes organisation and findings of the study in response to the research objectives. Chapter 3 details the research method and design. The chapter describes the methodological approach taken, the study's process, and relevant validity and reliability measures for the study. The quantitative findings from the survey results and the qualitative findings that emerged from the interviews are described in Chapter 4.

Section III (Chapters 5 and 6) discusses the conclusions drawn from the research. Chapter 5 provides the discussion of the research findings in regard to the main research objectives. Chapter 6 summarises the findings from the study and is divided into three areas of discussion: limitations, implications for teaching and learning, and recommendations for future research.

Chapter 2: Literature Review

2.1 Introduction

The overarching research question guiding this thesis is:

How do New Zealand Year 9 students' individual and school variables relate to their levels of mathematics anxiety?

The literature review will be organised around a number of factors and social categories known to be related to mathematics anxiety.

2.2 Theoretical Framework

This thesis is grounded in the ideas expressed within Cultural Historical Activity Theory (CHAT). This theory, based on the writings of Vygotsky and Leont'ev, and developed by Cole (1996) and Engeström (1999), asserts that cognition (thoughts) and emotion (feelings) are mutually constitutive (Roth & Radford, 2011). CHAT explores the relationship between "the historical movement of society, on the one hand, and the biographical development of its members, on the other hand" (Roth & Radford, 2011, p. 153). Each person is a measure of their society: "It is in, through, and as a result of experience that people develop" (Roth & Walshaw, 2015, p. 223).

> The school itself is only a microcosm of society, which it both reflects like a raindrop reflects the surrounding world, and constitutes. Without *this* school, the society is different, but *this* society exists only in and through the totality of its concrete constituents, including *this* school… without *this* raindrop, the world would be other. (Roth & Radford, 2011, p. 146, emphasis in original)

Figure 2.1 illustrates the representation of the nested relations that show how society is produced in classroom interactions.

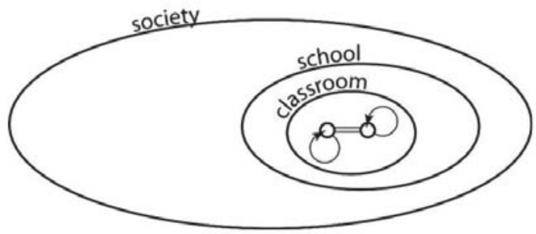

Figure 2.1. Schematic representation of the constitutive whole-part and therefore nested relations that exhibit how society is produced in seemingly innocuous classroom events such as student-teacher interactions. From *A cultural-historical perspective on mathematics teaching and learning* (p. 145), by W.-M. Roth, & L. Radford, 2011, Rotterdam, The Netherlands: Sense Publishers. Copyright (2011) by Sense Publishers. Reprinted with permission.

Based on Vygotsky's views, Roth and Walshaw's (2015) cultural-historical approach to mathematics anxiety includes the following assumptions:

> (a) affect is an integral part of a layering of complex systems of relationships; (b) characteristics relating to the personal (e.g., age, gender, ethnicity, social class), environmental (e.g., parental support), dispositional (e.g., attitudes and self-esteem), situational (e.g., instructional approach, classroom factors, the curriculum), and historical (e.g., earlier mathematics experiences) planes do not simply mediate students' reactions; and (c) anxiety, as for other forms of affect, is part of the societal relations in concrete settings that constitute its origins. (p. 224)

This thesis attempts to explore some of those relationships.

2.3 Mathematics Anxiety

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). It can induce negative feelings such as worry, nervousness, panic, frustration, tension, and fear (Eden, Heine, & Jacobs, 2013; Liebert & Morris, 1967; Roth & Walshaw, 2015). It negatively effects mathematics achievement/performance (Ma & Kishor, 1997) by triggering avoidance and negative self-beliefs (Ashcraft, Krause, & Hopko, 2007). Mathematics anxiety can influence students' choices to continue with mathematics courses and pursue careers involving mathematics (Dowker, Sarkar, & Looi, 2016; Hembree, 1990; Ma, 1999; Meece, Wigfield, & Eccles, 1990). Such avoidance behaviour can result from low self-efficacy and poor attitudes (Ashcraft & Kirk, 2001; Dodd, 1992). Ultimately, a vicious spiral develops between mathematical difficulties, feelings, attitudes and anxiety (Dowker et al., 2016).

Precursors of mathematics anxiety involve environmental (e.g., negative mathematics experiences), dispositional (e.g., negative attitudes), and situational (e.g., classroom factors) factors (Cemen, 1987). This point is echoed in the 2015 PISA results of 15-year-old students from around the world which concluded that students' well-being is the result of interactions between four main dimensions: psychological, social, cognitive and physical, within proximal (school environment, teachers, peers, family, household resources, and community/neighbourhood) and contextual (education policies, economic and social policies, inequality, global issues and trends, macroeconomic and political conditions, technology and innovation, and cultural determinants) sources (OECD, 2017). Students' well-being is "supported by self-esteem, motivation, resilience, self-efficacy, hope and optimism; it is hindered by anxiety, stress, depression and distorted views of the self and others" (OECD, 2017, p. 62).

Mathematics anxiety may emerge as early as the first year of school (Ramirez, Gunderson, Levine, & Beilock, 2013), although most research suggests that it begins in middle school, as children develop greater self-awareness, self-assessment, and cognitive sophistication as they get older (Ashcraft et al., 2007; Dowker et al., 2016).

Research evidence that quantifies the prevalence of mathematics anxiety is scarce. Part of the difficulty is that different instruments are typically used to measure mathematics anxiety (Stodolsky, 1985), and most scales have been amended and updated over time. Different instruments are also used with different age groups; for example, scales used commonly with university students and adults (such as the 98-item MARS scale) are generally seen as not appropriate for use with school students. However, research has shown that the prevalence of mathematics anxiety is about 20% (Ashcraft & Kirk, 2001).

The extent of mathematics anxiety in first- and second-grade American children was investigated by Ramirez et al. (2013). Using an 8-item scale based on the MARS instrument, the children responded to each question using a sliding pictorial scale, which was converted into a numerical scale between 1 and 16. Response scores were then averaged over the 8 items, giving a mean score of 8.07. Beilock and Willingham (2014) hence made the claim that this implied that "nearly 50 percent of the students reported medium to high levels of math anxiety, being 'moderately nervous' to 'very, very nervous' about math" (p. 29).

However, Betz (1978) found that it is not possible to determine the presence of mathematics anxiety by interpreting scores on an instrument's scale, although examining item response percentages could suggest its presence. She estimated that approximately one quarter to one half of the American undergraduate students surveyed indicated that mathematics made them feel "uncomfortable, nervous, uneasy, and confused" (p. 446). Resnick, Viehe, and Segal (1982) also aimed to quantify the prevalence and intensity of mathematics anxiety in American first-year university students but concluded that "the prevalence of math anxiety differs dramatically from one institution to another, limiting any generalizations based on only one college sample" (p. 44).

2.4 Test Anxiety

Both mathematics anxiety and test anxiety affect performance and respond to treatment in a similar way (Hembree, 1990). Test anxiety is defined as the tendency to judge tests as threatening (Putwain, Daly, Chamberlain, & Sadreddini, 2015). Test anxiety in adolescents has three main factors:

> (a) Social Derogation (worries of being socially belittled and deprecated by significant others following failure on tests), (b) Cognitive Obstruction (poor concentration, failure to recall, difficulties in effective problem solving, before or during a test), and (c) Tenseness (bodily and emotional discomfort). (Friedman & Bendas-Jacob, 1997, p. 1035)

Test anxiety contributes to poor performance by disturbing the recall of prior learning, especially in average-ability students, females, and tests perceived as difficult (Hembree, 1988). Evidence supports the "interference" model of test anxiety (as proposed by Liebert and Morris, 1967; Wine, 1971) rather than a "deficits" model (such as that of Tobias, 1985) which reverses the direction of the causal claim.

New Zealand students have recorded some of the highest levels of test anxiety when compared with other OECD countries. For example, 72% of New Zealand students reported that "even if I am well prepared for a test I feel very anxious", compared with 56% for the OECD average. The study found that students' levels of test anxiety were determined by the level of threat posed by tests (i.e., high- or low-stakes), rather than by the frequency of tests (OECD, 2017).

Timed tests can cause stress in students which they do not experience when working on the same mathematics questions in untimed situations (Engle, 2002). As Engle has argued, education's pervading preference for timed tests (and other speed-related activities such as flash cards), in the interests of automaticity, has created the damaging myth amongst students that "fast maths is good maths". Creating high-level mathematical thinking and understanding requires working in depth, not at speed (Boaler, 2014). Timed tests can contribute to slow mathematical students becoming discouraged in class and developing mathematics anxiety (Schwartz, 2000).

2.5 School Effects

2.5.1 Teacher effects.

Teacher quality has a large impact on student outcomes. Indicators with effect sizes greater than $d = 1.00$ generally relate to teachers' understanding of effective pedagogy, such as providing varied, demanding and engaging work ($d = 1.37$; Hattie, 2008).

The 2015 PISA study found that students reported less anxiety when the teacher provided individual help when they were struggling. This in turn facilitated higher motivation and better academic performance in students (OECD, 2017). Teacher support can be a critical variable when predicting mathematics anxiety, particularly emotional support (empathy, friendliness, encouragement, esteem and caring) and instrumental support (tangible, practical support; for example, helping to solve a problem or accomplish a difficult task) (Federici & Skaalvik, 2014).

In their work with Māori students, Bishop, Berryman, and Richardson (2002) discussed how important teacher-student relationships are for implying agency, efficacy and respect for what students brings to class from their home and culture. Effective variables include non-directivity, empathy and warmth (Hattie, 2008).

Performance in mathematics may be more susceptible to the effects of emotional distress than other comprehension-based subjects such as English or science (Gregor, 2005) because different academic subjects have different working memory requirements (Bull, Espy, & Wiebe, 2008; Latzman, Elkovitch, Young, & Clark, 2010).

Mathematically anxious students may prefer explanatory teaching because they lack the confidence to explore and discover. Some such participants in Jennison and Beswick's (2010) study wanted to give answers quickly, rather than fully understand the mathematical concepts.

Hattie's (2008) meta-analysis revealed that reducing class size from 25 to 15 had a surprisingly small effect size of d = 0.10-0.20. He claimed this was because teachers do not change their teaching methods (e.g., using optimal strategies such as more student feedback, interaction, and diagnosis) when class size is reduced.

2.5.2 Ability grouping.

Belfi, Goos, De Fraine, and Van Damme's (2012) literature review revealed some interesting interactions between ability grouping and students' wellbeing and academic self-concept. Ability grouping benefits able students' wellbeing but is detrimental for the wellbeing of weak students. Being placed in a low-stream class invites negative attitudes and feelings of failure, status loss, interest loss, insecurity, and alienation (Belfi et al., 2012). The reverse is found in the high-track students, known as the "basking-in-reflected-glory-effect" (Liu, Wang, & Parkins, 2005). Conversely, academic self-concept shows the reverse trend: being placed in a high track can lower academic self-concept, known as the “big-fish-little-pond-effect”. In short, homogeneous classes reduce low-ability students’ school wellbeing but improve their academic self-concept, and improve high-ability students’ wellbeing but lower their academic self-concept.

2.5.3 School transitions.

Highly mobile and transient students are negatively affected by their lack of stability in education (Siber, 2003). This seems to especially impact ethnic minority students and those from low socioeconomic backgrounds. Neighbour’s (2000) study of New Zealand primary school children found that mobile students fall behind academically due to the discontinuity in their learning, are placed in “low” groups, and have low self-esteem. However, stability during school changes can be supported through extracurricular activities, school cultures and parental involvement (Strobino & Salvaterra, 2000).

The effect of student transience or mobility has been shown by many studies to have a negative impact on students’ achievement and friendship patterns, as seen by Hattie’s (2008) meta-analysis effect size of $d = -0.34$. Farrell (2006) argues that one of the common causes of mathematics anxiety is a “dropped stitch”— “a gap in a student's prior math education that holds him or her back from learning more-complicated concepts” (p. 42). These dropped stitches can occur during any type of school transition. School transitions during early adolescence are detrimental because they a) disrupt social networks at a time when peer relationships are important; b) emphasise competition and social comparison at a heightened time of self-focus; c) decrease decision making and choice when the desire for control in life is increasing; and d) reduce the opportunity to form close relationships with nonfamilial adult role models while seeking independence from parents. This mismatch can increase the risk of negative motivational outcomes, especially for adolescents "at risk" due to negative past experiences with peers, school, and/or family (Eccles, Lord, & Midgley, 1991).

The evidence shows that school transitions are particularly difficult for young adolescents, regardless of school type and age at transition because "students are faced with the challenges of managing new friendships and peer groups, navigating a new school and a different class schedule, and receiving more difficult schoolwork" (Grills-Taquechel, Norton, & Ollendick, 2010, p. 505) at the same time as their self-worth is decreasing.

Wigfield, Eccles, MacIver, Reuman, and Midgley (1991) examined changes in children's self-perceptions and self-esteem in mathematics across the transition from elementary to junior high school. They found that adolescents' self-esteem decreased immediately following the transition, but then rebounded once the students adjusted to their new environment. However, they found that students' mathematics self-concept and liking of mathematics continued to decline and that differences in classroom environments played a major role. They suggested that secondary teachers are less efficacious, student-teacher relationships are less positive, and assessment practices are stricter. They also reported that the transition effect was greater for girls and low-ability students.

2.5.4 School gender type.

Advocates of single-sex education argue that such classes reduce distractions, pressure and stereotypes and improve non-achievement outcomes such as wellbeing, especially for girls (Belfi et al., 2012; Hart, 2015). However, analysis of the longitudinal study of a birth cohort of 1265 individuals born in 1977 in New Zealand revealed that females achieve better in co-educational schools and males achieve better in single-sex schools (Gibb, Fergusson, & Horwood, 2008). Alternatively, it has been shown that students have more positive attitudes towards mathematics when they have a teacher of the same gender (Dee, 2007). Critics argue that the success of single-sex education may instead be attributed to the composition of students (such as higher socioeconomic status) and that single-sex classes actually serve to perpetuate sexist attitudes (Bigler & Eliot, 2011; Patterson & Pahlke, 2011).

2.5.5 School type.

There is a dearth of research pertaining to differences between school type, particularly between state and integrated schools. Integrated schools are former private schools that have become part of the state system whilst retaining their special character (often Christian). Of the studies available, most focus on the academic achievement or inspection reports of Catholic schools (e.g., Bryk, Lee, & Holland, 1984). Comparisons between public and Catholic high school students in America revealed no statistically significant differences for affective variables such as self-esteem and academic self-concept (Marsh, 1991). However, some have claimed that "students in religious schools outperform their public school peers, mainly because of the increased attention to the teacher-student relationship a greater fostering of parent-school interactions, shared values between families and school, and the underlying philosophies of caring and commitment, and a higher work ethic" (e.g., Coleman, 1992; Russo & Rogus, 1998; as cited in Hattie, 2008, p. 76).

2.6 Social Categories and Factors

2.6.1 Age.

Young children generally have a positive view of mathematics when they start school (Stevenson et al., 1990). Unfortunately, attitudes towards mathematics decline sharply during adolescence; a time of heightened emotion, stress, and social comparison (Dowker et al., 2016). This could be due to increasingly challenging mathematical concepts (especially in algebra), and increasing pressure in high-stakes assessments (Ashcraft & Rudig, 2012). This is unfortunate timing, as middle school years are also crucial period in the development of students' mathematical understanding (Jennison & Beswick, 2010).

Hembree's (1990) meta-analysis showed that mathematics anxiety increases during adolescence and reaches its peak in Grades 9 and 10, then levels off in upper secondary and tertiary years, with females consistently reporting levels of mathematics anxiety about 10% higher than their male peers for all age groups. Despite these findings, the majority of research into mathematics anxiety has been undertaken with post-secondary students and adults (Hembree, 1990). My study will focus on the "peak mathematics anxiety" Year 9 level, when New Zealand students begin their first year of secondary education, following their transition from primary school.

2.6.2 Gender.

Although there are few gender differences in mathematics achievement, female students report higher levels of mathematics anxiety than males (e.g., Bieg, Goetz, Wolter, & Hall, 2015; Goetz, Beig, Lüdtke, Pekrun, & Hall, 2013; Stoet, Bailey, Moore, & Geary, 2016). It has been suggested that girls' issues may stem from the cumulative pressures of social conformity (Grills-Taquechel et al., 2010; Harter, 2006; Ryan, Sungok, & Makira, 2013). Alternatively, it could be due to "stereotype threat" (females being reminded of the stereotype that mathematics is a male domain; Bieg et al., 2015) or the influence of mathematically-anxious female teachers (Beilock et al., 2010). Social expectations are also often different: boys are typically encouraged to be independent and tough, whereas it is more acceptable for girls to admit their anxiety (Grills-Taquechel et al., 2010; Hembree, 1990).

2.6.3 Socioeconomic status (SES).

The socioeconomic disparities in mathematics achievement is a global phenomenon, as seen in the 2012 PISA results. "Socioeconomic differences are often compounded by racial and ethnic differences in achievement, as many poor children and adolescents are also from minority groups whose native languages are different from the language in which these students are taught at school" (OECD, 2013a, p. 171). The PISA study found that most socioeconomic disparities in mathematics dispositions (such as engagement, drive, motivation and self-beliefs) could be attributed to the differences in mathematics performance. Socioeconomically advantaged students may have "greater possibilities to engage in mathematics-related activities after school and to have parents who are able to provide a continued stream of challenging material for their children" (OECD, 2013a, p. 177).

A number of research studies (e.g., Adimora, Nwokenna, Omeje, & Eze, 2015; Kalaycioglu, 2015) have found an inverse relationship between SES and mathematics anxiety. The impact of SES is arguably more important at the school level than at the individual level. White's (1982) meta-analysis of the relationship between SES and academic achievement found that the effect size was greater at the school level (d = 0.73) than at the individual student level (d = 0.55). "It is difficult for [low SES] children in these two worlds [home and school] to build a reputation as a learner, learn how to seek help in learning, and have a high level of openness to experiences of learning" (Hattie, 2008, p. 63).

The large quantitative *Kids' Ideas about Maths* study of Year 5-8 New Zealand primary school students revealed that students from lower SES backgrounds reported higher levels of mathematics anxiety than students in middle and high SES schools (Grootenboer & Marshman, 2016). The authors argue that:

> there is overwhelming evidence that students from lower SES backgrounds are disadvantaged in terms of their educational outcomes, and in a sense these findings only serve to further confirm that well-known situation. What now would be more useful is to have some research and development studies that seek to explore positive ways to address this perennial issue (something our studies did not do) and to find ways to bring about meaningful change. (pp. 84-85)

2.6.4 Ethnicity.

The *Kids' Ideas about Maths* study revealed that Māori and Pāsifika students had higher levels of mathematics anxiety than Pākehā[1] students (Grootenboer & Marshman, 2016).

Lee's (2009) synthesis of PISA 2003 findings found that Asian countries tended to demonstrate low mathematics self-efficacy and high mathematics anxiety, whereas Western European countries showed the opposite. This finding was tentatively explained by noting that academic achievement is highly valued and very competitive in

---

[1] Pākehā is a Māori language term for non-Māori or for New Zealanders who are of European descent.

Asian countries, whereas students from Western countries are more relaxed about their academic performance because social benefits and value systems are not necessarily derived from school achievement.

2.6.5 Parental support.

The 2015 PISA study found that students whose parents "spent time just talking" reported higher levels of life satisfaction and academic performance. They suggested that parents can help their children manage anxiety by encouraging self-efficacy and self-confidence. "All in all, a clear way to promote students' well-being is for schools to encourage all parents to be more involved with their child's school life. If parents and teachers establish relationships based on trust, schools can rely on parents as valuable partners in the cognitive and socio-emotional education of their students" (OECD, 2017, p. 6). However, because the relationship is stronger among girls than among boys, this may suggest that "parents have more difficulty communicating with and addressing the insecurities of their sons" (OECD, 2017, p. 43).

2.6.6 Social comparison.

Individuals have an inherent desire to compare themselves to others (Jensen, Pond, & Padilla-Walker, 2015). Comparisons may be "upward" (with superior peers, which negatively affects one's self-concept) or "downward" (with inferior peers, which positively affects one's self-concept). Individuals have a different "social comparison orientation"—the propensity to socially compare (Buunk & Dijkstra, 2014). Girls have been shown to engage in higher levels of social comparison (Gibbons & Buunk, 1999). Social comparisons are a particularly relevant source of information for self-evaluation in the first year of secondary education (Kuyper, Dijkstra, Buunk, & van der Werf, 2011) because secondary schools are more performance-focussed rather than masteryfocussed (Kumar, 2006). These social comparisons can impact students' self-concept, motivation and performance (Ryan & Pintrich, 1998). Self-worth and perceived social acceptance are protective factors which provide resilience during adolescent stress (Grills-Taquechel et al., 2010).

Siblings provide "a constant and meaningful frame of reference for social comparison" (Jensen et al., 2015, p. 2067) due to shared genetics and environments. This influence includes sibling modelling, sibling differentiation and parental differential treatment. Siblings close in age, girls, and younger siblings are more likely to compare.

2.7 New Zealand Studies

Sepie and Keeling's (1978) study into the performance of three ability-groups of intermediate-aged children found that mathematics anxiety differentiated the under-achieving group from the other two groups more strongly than the measures of general and test anxiety.

Townsend, Moore, Tuck, and Wilton (1998) conducted a study of university students enrolled in an educational psychology course, which included a laboratory component in social science statistics. In a deliberate attempt to provide a positive learning environment, teaching practices emphasised cooperative learning activities and full-class discussion. The results of the study indicated that while self-concept and confidence with the mathematical content improved significantly over time, mathematics anxiety did not show a significant reduction.

Whyte and Anthony (2012) published a literature review which found that the potential origins of mathematics anxiety could be from in the home, society, or in the classroom. They concluded that teachers can reduce or prevent mathematics anxiety in a variety of ways, such as helping students to build positive attitudes towards mathematics by reflecting on their feelings about mathematics, promoting a positive classroom culture, and using effective teaching practices.

Winheller, Hattie, and Brown (2013) studied factors influencing early adolescents' mathematics achievement. The results found that students' mathematics self-efficacy was more related to outcomes than to perceptions of teacher quality or peer involvement. They also found that the perceived quality of learning is connected with "confidence in" and "liking mathematics", which in turn predicts students' mathematics achievement.

Roth and Walshaw (2015) examined the mathematics anxiety of the student from a societal-historical perspective. In this approach, the origins of affective responses such as mathematics anxiety involve environmental, dispositional, and situational characteristics, and are "produced by mutually reinforcing societal activity and practices" (p. 228). Mathematics anxiety, they argue, "is as much influenced by society and the kinds of demands it makes and the situation it creates for the children, as it is of the children themselves" (p. 229).

Chin, Williams, Taylor, and Harvey (2017) conducted research to investigate the influence of emotions in predicting academic performance in senior secondary school students (in Years 12 and 13) in New Zealand. Girls had higher levels of test anxiety and negative affect, even though they achieved higher exam grades than boys. Negative affect was found to be a bidirectional influence on academic performance: it directly influenced the worry component of test anxiety, which impaired exam performance, but also directly influenced the tension component of test anxiety, which facilitated better exam performance. Higher levels of tension in tests (such as feeling distressed, uneasy, and panicky) can be associated with better exam grades because mild levels of apprehension activate greater cognitive functioning (Lowe et al., 2008). However, anxiety only improves exam grades when it is below a certain threshold of severity (Fletcher, Lovatt, & Baldry, 1997).

2.8 Gaps in Research

Much research has been undertaken in the field of mathematics anxiety. It is an important area to research and has implications for daily lives and futures. However, my literature review has shown that most mathematics anxiety research has been completed overseas, the majority of which has been conducted with post-secondary students or pre-service teachers and utilised self-reported quantitative surveys. Therefore, there is currently a gap for a study of mathematics anxiety in New Zealand adolescents. This work aims to fill that gap and become an important indicator of the levels of mathematics anxiety in Year 9 students and may prompt more research into the area, and/or begin a conversation in schools, classrooms, homes and communities.

2.9 Summary

This literature review has explored a number of factors and social categories that may trigger a student's mathematics anxiety. However, research has not yet been undertaken that specifically explores all those elements within a New Zealand context. Therefore, this proposed research study is timely, valuable, and justified.

The following chapter (Chapter 3) presents the methodological design for the study.

Chapter 3: Methodology

3.1 Introduction

Evidence from the Literature Review relating to mathematics anxiety and individual and school variables, within a socio-cultural theoretical framework, has provided the direction for this study's methodology.

Most of the studies in the mathematics anxiety literature have been quantitative investigations that compared the prevalence of mathematics anxiety and/or its relationship with mathematics achievement. However, they do not incorporate the voices of participants to describe the reasons for these results. One issue that arises, then, is that the quantitative results fall short of fully describing and explaining students' experiences with mathematics anxiety. A need exists in the literature to not only obtain quantitative results but to explain such results in more detail, especially in terms of detailed voices and participant perspectives.

This chapter outlines the design and methods used in this study.

3.2 Methodological Design

Mixed methods research looks at "*what* happened?" (quantitative) and "*how* and *why* did it happen?" (qualitative; Buckley, 2015). Mixed methods research is defined as that in which "the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry. A key concept in this definition is integration" (Tashakkori & Creswell, 2007, p. 4). Johnson and Onwuegbuzie (2004) argue that mixed methods research frequently results in superior research compared to single-method research. They argue that:

> The goal of mixed methods research is not to replace either of these approaches [quantitative and qualitative] but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies. If you visualize a continuum with qualitative research anchored at one pole and quantitative research anchored at the other, mixed methods research covers the large set of points in the middle area. (p. 14)

This research employed a mixed methods sequential explanatory research design with two distinct phases: a quantitative survey followed by group interviews. The rationale for this approach is that while the first (quantitative) phase provides a general understanding of the research problem, the second (qualitative) phase refines, explains and explores the discovered issues in more depth. The overall purpose of the explanatory design is to use a qualitative method to explain initial quantitative results; further qualitative questions based on quantitative trends can be developed to assess and explain the reasons and mechanisms behind the emerging trends (Creswell & Plano Clark, 2011).

All Year 9 students in one rural/provincial region in New Zealand were eligible to participate in the initial survey. Then, the most highly mathematically-anxious participants were identified and invited to participate in the focus group interviews. Therefore, Phase I (survey) utilised "availability sampling"—a technique in which "elements are selected because of their accessibility to the researcher" (Dattalo, 2008, p. 5) and Phase II (focus group interviews) utilised "purposeful (or purposive) sampling"—intentionally selecting and recruiting participants who have "experienced the central phenomenon or the key concept being explored in the study" (Creswell & Plano Clark, 2011, p. 173).

A mixed methods research design is relatively straightforward and clear. However, there are also several challenges: The qualitative phase requires more time to implement than the quantitative phase; ethics approval can be difficult because participant selection cannot be specified for the qualitative phase until the initial findings are obtained; and the direction of the qualitative phase, and indeed the entire study, cannot be pre-planned or pre-determined (Creswell & Plano Clark, 2011).

Greene, Caracelli, and Graham (1989) provide a conceptual framework for mixed methods evaluation designs to explain the reasons for mixing quantitative and qualitative methods (p. 259):

- *Triangulation* seeks convergence, corroboration, and correspondence of results from the different methods.
- *Complementarity* seeks elaboration, enhancement, illustration, and clarification of the results from one method with the results from the other method.
- *Development* seeks to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions.
- *Initiation* seeks the discovery of paradox and contradiction, new perspectives of frameworks, the recasting of questions or results from one method with questions or results from the other method.
- *Expansion* seeks to extend the breadth and range of inquiry by using different methods for different inquiry components.

Creswell and Tashakkori (2007) explain the concept of “integration”:

> Mixed methods research is simply more than reporting two distinct “strands” of quantitative and qualitative research; these studies must also integrate, link, or connect these strands in some way.... The expectation is that by the end of the manuscript, conclusions gleaned from the two strands are integrated to provide a fuller understanding of the phenomenon under study. Integration might be in the

> form of comparing, contrasting, building on, or embedding one type of conclusion with the other. (p. 108)

3.3 Role of the Researcher

As the researcher, I was involved in a continuous and intensive experience with participants and stakeholders (schools, teachers, students and parents). Therefore, I need to explicitly state my background which will shape my interpretations of the study (e.g., work experiences, demographics) to help the reader understand the connection between myself and the study.

I have been a secondary mathematics teacher in New Zealand for over a decade. I have taught in a range of schools: single sex (boys-only and girls-only), co-educational, state, integrated, private, and a range of decile ratings from medium to high (but not low). I am a female of European descent who attended high-decile schools (state and private; co-educational and single-sex).

I currently teach mathematics at one of the seven schools involved in this study. The school (School D) is a high-decile, boys-only, integrated school in the rural/provincial region of New Zealand in which the study is situated. However, I did not teach nor had ever taught any of the participants from School D during the year of data collection. This “backyard research”—the connection between myself and the participants at my own school that may unduly influence my interpretations—presents a potential conflict of interest that must be minimised. The information obtained from the students at my school was easy and convenient to collect, However, I have a duty to show how the data were not compromised. To that end, I asked the students’ class teachers to facilitate the survey, and asked for a guidance counsellor to be present during the interviews.

All participants and schools are known only by a code, so are not identifiable.

It was important to gain access to participants by seeking the approval of principals, HODs and teachers at the school sites, in addition to parents, who were asked for consent for the research to be conducted. A series of information sheets were sent: first, to principals, and second, to parents and students (see Appendix B).

3.4 Setting

The principals of all schools with Year 9 students in the study region were initially sent an invitation for their school to participate in the study. The research plan was also presented to Mathematics HODs at a regional mathematics cluster meeting. Seven out of nine eligible schools agreed to participate.

Table 3.1

Descriptors of Participating Schools

School	Year 9 roll	Decile	Decile Type	School Gender Type	School Type
School A	106	6	Medium	Co-educational	State
School B	62	3	Low	Co-educational	State
School C	8	8	High	Co-educational	Integrated
School D	58	9	High	Single-sex (males)	Integrated
School E	22	7	Medium	Single-sex (females)	Integrated
School F	52	9	High	Single-sex (females)	Integrated
School G	225	6	Medium	Co-educational	State
Total	533				

Student rolls (including name and gender) were obtained from each participating school. Each student name was then assigned a code[2] so that individuals could not be identified.

3.5 Phases and Participants

This study consisted of two phases. Phase I utilised a survey, and Phase II consisted of focus group interviews.

The survey (Phase I) was completed at school by the participants in the third term of their Year 9 year. The majority of students completed the survey online, but some (without access to computers) completed it on paper.

The focus group interviews (Phase II) were conducted in each of three schools (as detailed below) in the final (fourth) term of their Year 9 year. The interviews were approximately an hour long and took place in the school's meeting room, with a chaperone (either the school's guidance counsellor or chaplain) present.

3.5.1 Phase I (survey).

Phase I utilised a survey. According to the 1 July roll return from the Ministry of Education, 586 Year 9 students were studying in the study region in 2016. Therefore, the survey was open to 91% (N = 533) of the eligible student population. Ultimately, 74% (N = 434) of the eligible student population participated in the survey.

[2] For example, a code of XXX001 represented the first student (001) on the school list (school code XXX).

Table 3.2

Survey Response Rates

School	Year 9 roll	Number of Participants	Response Rate
School A	106	53	50%
School B	62	53	85%
School C	8	6	75%
School D	58	58	100%
School E	22	19	86%
School F	52	39	75%
School G	225	206	92%
Total	533	434	81%

The results the survey will be compared in relation to the categories of gender, ethnicity,[3] school decile, school gender type, and school type (see Table 3.3).

Table 3.3

Categories Used in the Study

Category	Variables
Gender	Male; Female
Ethnicity	European; Māori; Pacific Peoples; Asian; Middle Eastern/Latin American/African (MELAA); Other Unspecified[a]
School Decile	Low (1, 2, 3); Medium (4, 5, 6, 7); High (8, 9, 10)
School Gender Type	Single-sex; Co-educational
School Type	State; Integrated

[a] The “Other Unspecified” category includes North American Indian, Mauritian, South African Coloured, and New Zealander.

[3] The wording of the survey question about ethnicity was taken from the New Zealand 2013 Census. Ethnicity categories were classified according to the ‘2013 Census ethnic group profiles’. See http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/ethnic-profiles.aspx?request_value=24650#24650

This study of Year 9 students is generalisable in many ways to the New Zealand population of Year 9 students since the study had similar proportions of male and female participants to those found in the New Zealand Year 9 student population. However, the study had different proportions of students from the school decile categories compared to New Zealand Year 9 students, mainly because of the higher numbers from medium-decile schools. The study had similar proportions of students from co-educational versus single-sex schools compared with Year 9 students in New Zealand. However, more study participants attended integrated schools compared with New Zealand Year 9 students.

Table 3.4

Survey Participants by Category

Category	Study participants	NZ Year 9 students
Gender		
Male	50.2%	51.5%
Female	49.8%	48.5%
Decile		
Low	12.2%	19.1%
Medium	64.1%	44.9%
High	23.7%	36.0%
School Gender Type		
Co-educational	73.3%	69.7%
Single-sex	26.7%	30.3%
School Type[a]		
State	71.9%	81.2%
Integrated	28.1%	13.5%

[a] Other school types in New Zealand include Private and Partnership (charter) schools. These types of schools include the remainder (5.3%) of New Zealand Year 9 students. There are no schools of this type in the study region.

Participants were asked to state which ethnic group(s) they belonged to, and were given the option to state multiple ethnic groups. The wording of this survey question about ethnicity was taken from the New Zealand 2013 Census. Ethnicity categories were then classified according to the "2013 Census ethnic group profiles".

Table 3.5

Ethnicity of Participants

Ethnicity	*n*	Proportion of participants
European	376	87%
Māori	98	23%
Pacific Peoples	26	6%
Asian	11	3%
MELAA	3	0.7%
Other Unspecified	4	0.9%
Total	518	119%

Note. Responses sum to more than 100% as participants could identify with more than one ethnic group.

It is not meaningful to compare these relative frequencies of ethnicity groups to those of the New Zealand Year 9 student population or the New Zealand population because of the different ways that ethnicity is categorised: When enrolling at a school in New Zealand, students can identify with a maximum of three ethnic groups. Furthermore, the Ministry of Education uses prioritised ethnicity rankings[4] to report one ethnicity per student in the 1 July roll return statistics. International Fee Paying (IFP) students are included in a separate category.

[4] 1. Māori; 2. Pacific Peoples; 3. Asian; 4. MELAA; 5. Other Unspecified; 6. European.

3.5.2 Phase II (interviews).

Phase II utilised a purposive sample. The participants were selected individuals who met certain criteria (that of being highly mathematically-anxious).

When the survey data collection was completed, participants' *Total Mathematics Anxiety* scores were ranked to create a list of most- to least-mathematically-anxious participants. The top 35 most highly anxious participants were identified, 94% of whom attended one of three particular schools (School A, School D, and School F). These three schools were then contacted and invited to host the focus group interviews, to which they agreed. From the ranked list of participants, the top eight most highly anxious students from each of the three schools were identified (see Table 3.6).

Table 3.6

The Most Highly-Mathematically-Anxious Survey Participants

Rank	School A	School D	School F
1	Student A (41)	**Student I (34)**	**Student Q (42)**
2	**Student B (37)**	**Student J (32)**	**Student R (40)**
3	**Student C (32)**	Student K (30)	**Student S (40)**
4	**Student D (32)**	Student L (30)	Student T (33)
5	Student E (31)	**Student M (29)**	Student U (30)
6	**Student F (30)**	**Student N (29)**	**Student V (30)**
7	**Student G (28)**	**Student O (28)**	**Student W (30)**
8	**Student H (27)**	Student P (27)	**Student X (28)**

Note. Numbers in the brackets indicate their *Total Mathematics Anxiety* score (out of 45). Names in bold are the those who agreed to participate in the focus group interviews.

These eight students from each school were invited to participate in the focus group interviews by their school contact (e.g., dean, guidance counsellor, or chaplain), with the hope that six from each school would participate. Six students from Schools A and F, and five students from School D, agreed to participate in the focus group interviews.

Table 3.7

Interview Participants by Category

Category	School A	School D	School F	Total
n	6	5	6	17
Gender	6 females	5 males	6 females	12 females 5 males
Ethnicity[a]	100% European 33% Māori 17% Pāsifika 17% Asian	100% European 20% Māori	83% European 17% Māori	94% European 24% Māori 6% Pāsifika 6% Asian
Decile	Medium (6)	High (9)	High (9)	
School Gender Type	Co-educational	Single-sex males	Single-sex females	
School Type	State	Integrated	Integrated	
Total Mathematics Anxiety mean score (AMAS)[b]	28.2	27.6	33.2	29.8

[a] Totals sum to more than 100% as participants could identify with more than one ethnic group.

[b] These scores are "with Item 1 removed", so are lower (out of 40) than the "top 8" scores in Table 3.7.

Interestingly, even though School A was co-educational, the focus group participants from that school were all female because the top eight most highly mathematically-anxious students were female. Therefore, the overall focus group participation rate included 71% females and 29% males.

3.6 Data Collection

3.6.1 Phase I (survey).

The survey is a popular quantitative research tool used in the social sciences because it is "easy to create, distribute, collect, and analyse.… Further, if you are using a premade survey that has already been validated and used in other studies, it may be extremely easy to make minor modifications and appropriate it for your own research study" (Butin, 2010, p. 91). However, care must be taken to ensure that the research questions drive the tools, not the opposite.

Mathematics anxiety was measured using the Abbreviated Math Anxiety Scale (AMAS; see Appendix C). This 9-item scale was developed by Hopko, Mahadevan, Bare, and Hunt (2003). The scale comprises two factor loadings: Learning Math Anxiety and Math Evaluation (i.e., test) Anxiety, henceforth referred to as *Mathematics Learning Anxiety* and *Mathematics Test Anxiety* respectively. Items for each factor were coded on a 5-point scale (*1 = No bad feelings; 2 = Some bad feelings; 3 = Bad feelings; 4 = Very bad feelings; 5 = Worst feelings*),[5] and summed to give a measure of *Total Mathematics Anxiety*. Sample items included:

- Having to use the tables in the back of a maths book.
- Thinking about an upcoming maths test one day before.
- Watching a teacher work out a maths problem on the board.

Item 1 ("Having to use tables in the back of a maths book") in the *Mathematics Learning Anxiety* section was included in the survey, but removed for analysis. Too

[5] The survey explained that "'bad feelings' could mean your level of fear / tension / worry / anxiety / nervousness / negativity."

many participants left this question blank or made a comment such as “*What are tables*?” This decision was supported by the Confirmatory Factor Analysis completed by Cipora, Szczygiel, Willmes, and Nuerk (2015) who found that this item’s loadings were not at an acceptable level (.40).

The sum of the four even questions represented the score for the *Mathematics Test Anxiety* factor and the sum of the four odd questions represented the score for the *Mathematics Learning Anxiety* factor. The total sum of the eight items represented the score for *Total Mathematics Anxiety*. Some participants (n = 19, or 4.4%) did not fully complete the survey. However, these omissions were so few in number that it was decided to include their responses in the analysis. For this reason, some scores on the instrument were reduced.

Schools were given the option for their students to complete the survey online or on paper. Students participating online were directed to a website where they were asked to enter in their six-digit code and ethnicity data. Participants were given time in their mathematics class to complete the survey, which took approximately 10 minutes.

3.6.2 Phase II (interviews).

Focus group interviewing is a commonly used qualitative research tool in which the researcher facilitates, moderates, monitors and records group interactions (Punch & Oancea, 2014). “The hallmark of focus groups is the explicit use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group” (Morgan, 1988, p. 12). Focus group interviews are flexible, thought-provoking, inexpensive, and data-rich. However, “there can be problems associated with group culture and dynamics, and in achieving balance in the group interaction” (Punch & Oancea, 2014, p. 186).

A carefully structured interview protocol is vital to try to minimise the effect of "response effect bias"—where participants may tell the researcher what they think they want to hear. Focused or semi-structured interviews "are guided by a set of questions and prompts for discussion, but have in-built flexibility to adapt to particular respondents and situations" (Punch & Oancea, 2014, p. 184). Effective interviews include open-ended questions to elicit deep reflections from participants. Ultimately, the interview conversation allows the researcher and participants to "grasp for meaning together" (Forsey, 2012, p. 372).

Gibson (2012) has offered "recommendations for developmentally sensitive methods of building trust, facilitating understanding of expectations, obtaining informed assent, encouraging thoughtful and detailed responses, and promoting enjoyment and creative expression" (p. 149), and the practical suggestions offered by Horowitz et al. (2003) also informed the conduct of the interviews.

The researcher used a focus group interview plan (see Appendix E) which facilitated the semi-structured interviews. The interview protocol included:

- Introduction (researcher, study explanation, ethics, ground rules);
- Student introductions;
- Icebreaker;
- Questions and probes;
    - What is mathematics anxiety?
    - What causes mathematics anxiety?
    - What factors influence mathematics anxiety?

- How does the transition from primary to secondary school affect mathematics anxiety?
- How does mathematics anxiety affect achievement?
- What strategies can help to reduce mathematics anxiety?

A suitable time and place (e.g., meeting room) was negotiated in each participating school for the focus group interview to take place. A guidance counsellor was also present as a nonparticipant observer. Each interview was digitally recorded and took approximately one hour.

3.7 Validity and Reliability

The validity and reliability of the AMAS instrument has previously been established: The authors of the AMAS "presented a thorough psychometric evaluation of the AMAS, examining internal consistency, test-retest reliability and several validity measures" (Cipora, Szczygiel, Willmes, & Nuerk, 2015, p. 4). The AMAS has been successfully adapted into different cultures such as Iran (Vahedi & Farrokhi, 2011), Australia (Gyuris & Everingham, 2011), Italy (Primi, Busdraghi, Tomasetto, Morsanyi, & Chiesi, 2014), and Poland (Cipora et al., 2015).

The study data were triangulated to enhance and assess the accuracy of findings by using multiple sources of data (survey and group interviews) and participant perspectives (Creswell, 2014).

3.8 Data Analysis

3.8.1 Phase I (survey).

The results of the AMAS instrument were analysed using descriptive statistics and inferential statistics. Statistical analysis using Statistical Package for the Social Sciences (SPSS) software was conducted. Descriptive statistics were calculated for the overall distribution of the AMAS results. Independent samples *t*-tests were conducted to compare the mean scores between subgroups' mean scores. Quotations from the optional comments sections in the survey were selected on the basis of the way they illuminated some of the findings from the survey.

3.8.2 Phase II (interviews).

The recorded interviews were transcribed (using a professional service) and categorised in terms of research questions and emergent themes. Open and axial coding were used to organise the interview data into main issues and themes. Quotations were also selected from the interviews that illuminated the emergent themes.

3.9 Ethical Considerations

This research study has been designed and conducted according to the *Massey University Code of Ethical Conduct for Research, Teaching and Evaluations Involving Human Participants.* The major ethical principles of this code included:

- Respect for persons;
- Minimisation of harm to participants, researchers, institutions and groups;
- Informed and voluntary consent;
- Respect for privacy and confidentiality;

- The avoidance of unnecessary deception;
- Avoidance of conflict of interest;
- Social and cultural sensitivity to the age, gender, culture, religion, social class of the participants;
- Justice (Massey University, 2015, p. 4).

Ethics approval was obtained prior to data collection from the Massey University Human Ethics Committee (Southern B); approval number SOB 16/16 (see Appendix A). Ethical considerations included:

- A cultural consultation took place with an iwi representative to discuss any potential arising issues, including ethnicity classification (e.g., multiple ethnicities) and difficulties in translating language with the Kura Kaupapa Māori school (as there were many likely issues surrounding the translation, and with only one potential participant, the school mutually agreed not to participate);
- Consent for students to participate was given in writing by each school's Principal;
- After Principals had given consent, the researcher visited each school to speak to all Year 9 students to make the "initial approach", which involved explaining details about the study and distributing Parent and Student Information Sheets;
- Given that the students were under 15 years of age, parental consent was required. All schools chose to use "passive consent": a) parents implied consent for their child to participate unless they contacted the researcher, and b) students implied their consent in Phase I by completing the survey. However, "active consent" was required by participants in the focus group interviews, both by

signing a consent form and by verbal acknowledgement at the start and finish of the interview;

- All participants were assigned a code so they, their teacher, and their school could not be identified;
- All participants were reminded of their rights:

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

  - *not answer any particular question;*
  - *withdraw from the study;*
  - *ask any questions about the study at any time during participation;*
  - *be given access to a summary of the project findings when it is concluded.*

- To access the survey online, participants were given a personalised slip of paper which included the website link and ID code;
- Ethnicity data were gathered from participants, who could select all group(s) to which they identified;
- Focus group participants were identified by their AMAS scores. Eight students in selected schools were approached by their school contact (e.g., dean, guidance counsellor, chaplain) and given the choice of participating;
- A guidance counsellor or chaplain was present during each focus group interview;
- All focus group interview participants (including guidance counsellor/chaplain and transcriber) were required to sign confidentiality agreements;

- Findings were shared with the school communities by way of brief summary sheets.

3.10 Summary

This Methodology chapter has discussed how the research process for this study was undertaken. The rationale for the selection of the study's methodology developed from the theoretical framework that grounded the study and the research objectives derived from that framework. The research study has been designed and conducted according to the *Massey University Code of Ethical Conduct for Research, Teaching and Evaluations Involving Human Participants.*

The following chapter (Chapter 4) presents the findings that emerged from the quantitative and qualitative data.

Chapter 4: Findings

4.1 Introduction

This chapter will report the quantitative and qualitative findings from the research study. The quantitative findings from the survey will be presented first, followed by the qualitative findings from the focus group interviews.

4.2 Quantitative Findings (Survey)

The survey was designed to measure the extent of participants' mathematics anxiety, using the Abbreviated Math Anxiety Scale (AMAS). A number of participants (n = 19, or 4.4%) did not fully complete the survey. However, these omissions were so few in number that it was decided to include their responses in the analysis. For this reason, some scores on the instrument were reduced.

The results of the AMAS instrument will be compared in relation to the categories of gender, ethnicity, school decile, school gender type, and school type (see Table 3.3).

The 9-item AMAS scale was developed by Hopko, Mahadevan, Bare, and Hunt (2003) and comprises two factor loadings: *Learning Math Anxiety* and *Math Evaluation* (i.e., test) *Anxiety*. These factors will henceforth be referred to as *Mathematics Learning Anxiety* and *Mathematics Test Anxiety*. Four items for each factor were coded on a 5-point scale (*1 = No bad feelings; 2 = Some bad feelings; 3 = Bad feelings; 4 = Very bad feelings; 5 = Worst feelings*), and summed to give a measure of *Total Mathematics Anxiety*.

4.2.1 Mathematics Test Anxiety.

The *Mathematics Test Anxiety* scores ranged from 0 to 20 (M = 10.35, SD = 4.22). Forty-two participants (9.7%) scored the most common total of 8. Six participants (1.4%) reported the highest possible score of 20. Overall, 92.1% of participants reported some bad feelings to do with some aspect of mathematics tests.

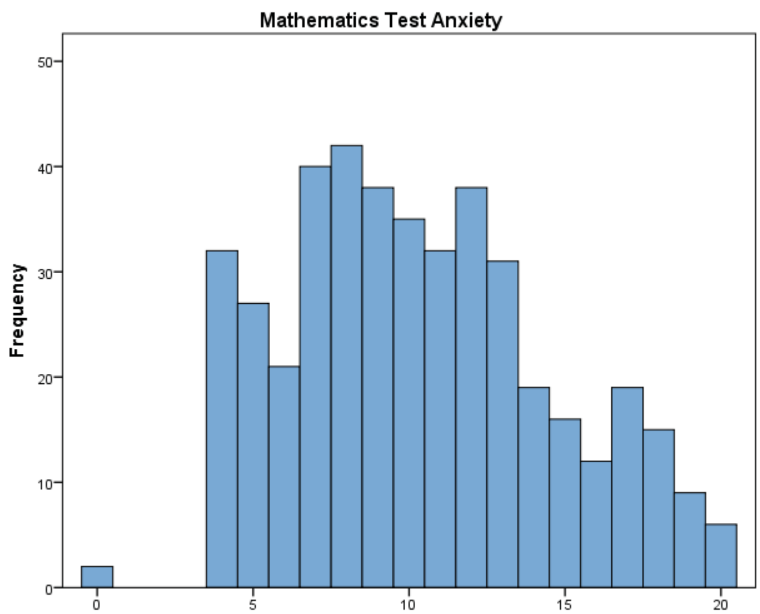

Figure 4.1. Mathematics Test Anxiety

4.2.2 Mathematics Learning Anxiety.

The *Mathematics Learning Anxiety* scores ranged from 0 to 20 (M = 6.82, SD = 3.17). One hundred and thirty-nine participants (32.0%) scored the most common total of 4, indicating that approximately one third of participants reported no bad feelings to do with learning mathematics. Two participants (0.5%) reported the highest possible score of 20.

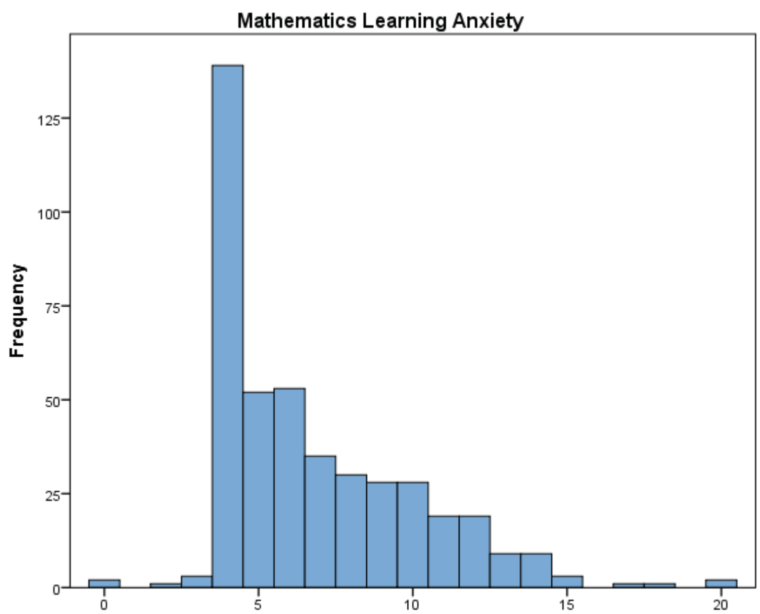

Figure 4.2. Mathematics Learning Anxiety

4.2.3 Total Mathematics Anxiety.

The *Total Mathematics Anxiety* scores ranged from 0 to 39 (M = 17.17, SD = 6.72). Thirty-six participants (8.3%) scored the most common total of 12. The six participants (1.4%) with the highest *Total Mathematics Anxiety* scores (with totals from 33 to 39) were all females. Additional comments in the survey made by these participants included:

- *I feel like when you have anxiety about maths your progress goes backwards;*
- *I get really bad anxiety when it comes to maths but I did like maths until sometime last term;*
- *I don't like maths, it's boring;*
- *I sometimes like to do maths but most of it is hard for me because I have short term memory loss;*
- *I like to do the math things if it's not in front of anyone.*

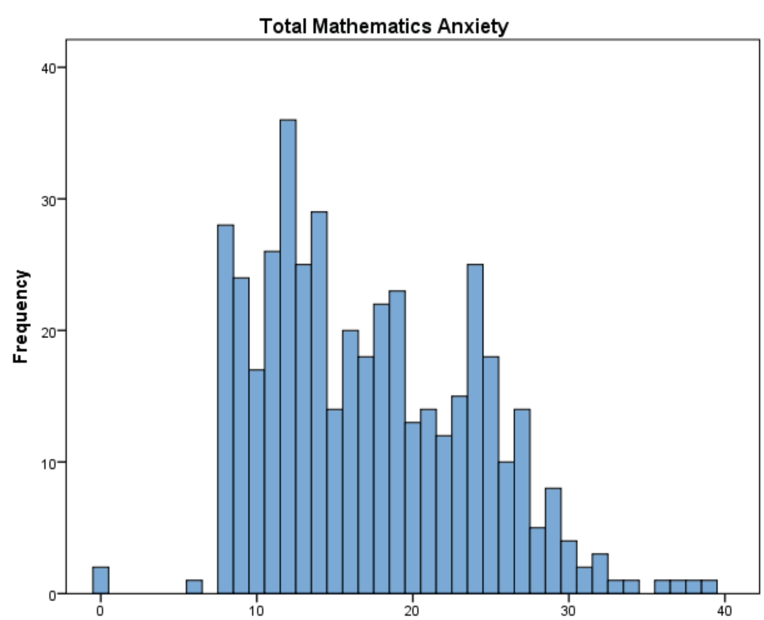

Figure 4.3. Total Mathematics Anxiety

4.2.4 Mathematics Anxiety Groups.

Participants were categorised into three anxiety groups (Low, Medium, High) for each subscale. Following Ashcraft and Kirk (2001), the groups were determined empirically by the overall sample mean and standard deviation, such that Low scores were at least 1 standard deviation below the overall sample mean, and High scores were at least 1 standard deviation above the mean. Scores for the Medium group fell in the 1 standard deviation range centred on the sample mean ±0.5 standard deviations from the mean. Therefore, some participants (between Low-Medium and Medium-High) were unaccounted for in the proportions. This revealed that 21.4% of participants reported high levels of *Total Mathematics Anxiety*.

Table 4.1

Mathematics Anxiety Groups

Anxiety Groups	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Low	18.5%	1.4%	16.6%
Medium	32.3%	27.2%	32.0%
High	17.7%	21.0%	21.4%

For the tables in this chapter, the mean value is stated, with standard deviation in brackets.

4.2.5 Gender.

Female participants reported higher average levels of *Total Mathematics Anxiety* than males (*M* = 18.40 and *M* = 15.95 respectively). This gender difference was statistically significant for all three subscales ($p < .001$ for *Mathematics Test Anxiety* and *Total Mathematics Anxiety*; $p = .020$ for *Mathematics Learning Anxiety*).

Table 4.2

Mathematics Anxiety by Gender

Gender	*n*	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Females	216	11.22 (4.13)	7.18 (3.26)	18.40 (6.66)
Males	218	9.48 (4.13)	6.47 (3.05)	15.95 (6.56)
Total	434	10.35 (4.22)	6.82 (3.17)	17.17 (6.71)

4.2.6 Ethnicity.

The highest average levels of *Mathematics Test Anxiety* were reported by Asian students (*M* = 10.91), and the lowest by Middle Eastern/Latin American/African (MELAA) students (*M* = 6.67). The highest average levels of *Mathematics Learning Anxiety* were reported by Pāsifika students (*M* = 7.92), and the lowest by MELAA students (*M* = 4.67). The largest observed difference between *Mathematics Test Anxiety* and *Mathematics Learning Anxiety* was in European students. However, these comparisons may not be very meaningful when sample size is taken into consideration.

Table 4.3

Mathematics Anxiety by Ethnicity

Ethnicity	*n*	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
European	376	10.48 (4.19)	6.77 (3.06)	17.26 (6.60)
Māori	98	10.38 (4.09)	7.27 (3.41)	17.64 (6.75)
Pacific Peoples	26	10.65 (4.00)	7.92 (4.00)	18.58 (7.22)
Asian	11	10.91 (6.22)	7.55 (4.20)	18.45 (9.96)
MELAA	3	6.67 (2.31)	4.67 (1.16)	11.33 (3.06)
Other	4	7.25 (3.78)	7.25 (4.72)	14.50 (8.19)
Total	434	10.35 (4.22)	6.82 (3.17)	17.17 (6.71)

When comparing students from meaningfully-large ethnic groups (European, $n = 376$, and Māori, $n = 98$), it is observed that European students report higher average levels of *Mathematics Test Anxiety*, whereas Māori students report higher average levels of *Mathematics Learning Anxiety* and *Total Mathematics Anxiety*. However, none of these differences were statistically significant.

Priority learners (i.e., Māori and Pāsifika students) show quite similar results in *Mathematics Test Anxiety* compared with other ethnic groups. However, they display higher average levels of *Mathematics Learning Anxiety* and *Total Mathematics Anxiety* than other ethnic groups (apart from Asians).

4.2.7 School decile.

Participants from low-decile schools reported lower average levels of *Mathematics Test Anxiety* compared with those from high-decile schools ($M = 9.49$ and $M = 11.36$ respectively). Conversely, participants from low-decile schools reported higher average levels of *Mathematics Learning Anxiety* compared with those from high-decile schools (*M* = 7.79 and *M* = 6.92 respectively). However, the only statistically significant difference between low- and high-decile participants was in the *Mathematics Test Anxiety* subscale ($t(154) = 2.609$, $p = .010$).

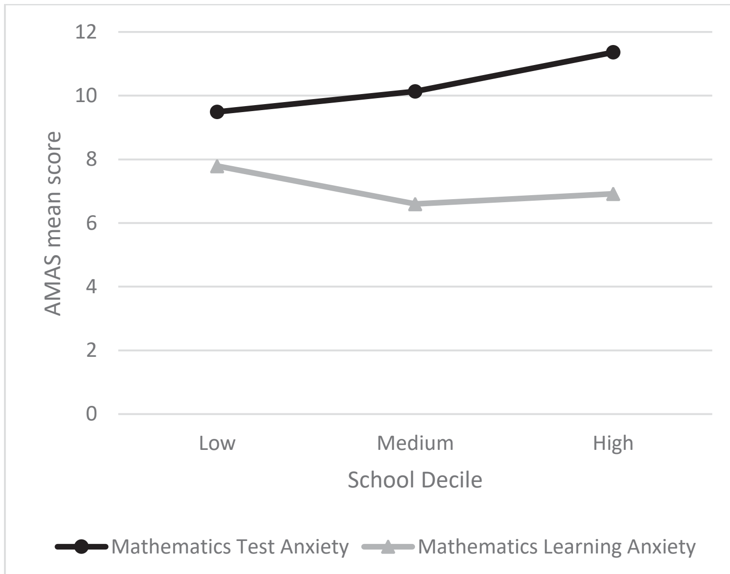

Figure 4.4. Mathematics Anxiety by School Decile

Table 4.4

Mathematics Anxiety by School Decile

School Decile	*n*	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Low				
Female	21	9.14 (4.07)	7.33 (3.25)	16.48 (6.71)
Male	32	9.72 (4.11)	8.09 (3.74)	17.81 (7.35)
Total	53	9.49 (4.06)	7.79 (3.54)	17.28 (7.07)
Medium				
Female	154	11.12 (3.99)	7.03 (3.07)	18.15 (6.38)
Male	124	8.90 (4.03)	6.08 (2.82)	14.98 (6.23)
Total	278	10.13 (4.15)	6.60 (2.99)	16.74 (6.50)
High				
Female	41	12.63 (4.27)	7.68 (3.91)	20.32 (7.37)
Male	62	10.52 (4.19)	6.42 (2.90)	16.94 (6.52)
Total	103	11.36 (4.33)	6.92 (3.38)	18.28 (7.04)
Total				
Female	216	11.22 (4.13)	7.18 (3.26)	18.40 (6.66)
Male	218	9.48 (4.13)	6.47 (3.05)	15.95 (6.56)
Total	434	10.35 (4.22)	6.82 (3.17)	17.17 (6.71)

The highest average levels of *Mathematics Test Anxiety* were reported by high-decile females (M = 12.63), and the lowest by medium-decile males (M = 8.90). Female participants' *Mathematics Test Anxiety* increased with decile rating. The gender difference for *Mathematics Test Anxiety* was very similar for medium- and high-decile participants, but for low-decile participants the observed difference was reversed, with males reporting higher average levels of *Mathematics Test Anxiety* (M = 9.72) than their female peers (M = 9.14), although this difference was not statistically significant (p = .616).

The highest average levels of *Mathematics Learning Anxiety* were reported by low-decile males ($M = 8.09$), and the lowest by medium-decile males ($M = 6.08$). The gender difference for *Mathematics Learning Anxiety* increased with decile. Again, for low-decile participants, the observed gender difference was reversed, with males reporting higher average levels of *Mathematics Learning Anxiety* ($M = 8.09$) than their female peers ($M = 7.33$), although this difference was not statistically significant ($p = .450$).

Females from high-decile schools reported the highest average levels of *Total Mathematics Anxiety* ($M = 20.32$), and medium-decile males the lowest ($M = 14.98$). The gender difference for *Total Mathematics Anxiety* increased with decile.

Overall, females from medium- and high-decile schools reported higher average levels of mathematics anxiety than their male peers, and the differences on the three subscales were all statistically significant. However, no statistically significant gender differences were found for low-decile schools.

4.2.8 School gender type.

Participants in single-sex girls' and boys' schools reported higher average levels of *Total Mathematics Anxiety* than participants in co-educational schools ($M = 20.52$, $M = 16.95$, and $M = 16.60$ respectively). This observed difference between single-sex and co-educational participants was greater for females than for males. Females in single-sex schools reported higher average levels of mathematics anxiety on all subscales compared with females in co-educational schools, and these differences were all statistically significant (*Mathematics Test Anxiety* $p = .002$; *Mathematics Learning Anxiety* $p = .050$; *Total Mathematics Anxiety* $p = .004$). The difference between single-sex males' and co-educational males' levels of mathematics anxiety was only statistically significant on the *Mathematics Test Anxiety* subscale ($t(216) = 2.218$, $p = .028$).

The highest average levels of *Mathematics Test Anxiety* were reported by females in single-sex schools ($M = 12.62$), and the lowest by males in co-educational schools ($M = 9.11$); this difference was statistically significant ($p < .001$).

The highest average levels of *Mathematics Learning Anxiety* were also reported by females in single-sex schools ($M = 7.90$), and the lowest by males in single-sex schools ($M = 6.45$); this difference was statistically significant ($p = .023$).

The highest average levels of *Total Mathematics Anxiety* were again reported by females in single-sex schools ($M = 20.52$), and the lowest by males in co-educational schools ($M = 15.59$); this difference was statistically significant ($p < .001$).

Table 4.5

Mathematics Anxiety by School Gender Type

School Gender Type	*n*	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Single-sex				
Female	58	12.62 (4.18)	7.90 (3.86)	20.52 (7.17)
Male	58	10.50 (4.11)	6.45 (2.85)	16.95 (6.36)
Co-educational				
Female	158	10.70 (4.01)	6.92 (2.98)	17.62 (6.31)
Male	160	9.11 (4.08)	6.48 (3.13)	15.59 (6.61)
Total	318	9.90 (4.12)	6.70 (3.06)	16.60 (6.53)
Total				
Female	216	11.22 (4.13)	7.18 (3.26)	18.40 (6.66)
Male	218	9.48 (4.13)	6.47 (3.05)	15.95 (6.56)
Total	434	10.35 (4.22)	6.82 (3.17)	17.17 (6.71)

4.2.9 School type.

Participants in integrated schools reported higher average levels of mathematics anxiety on all subscales compared with those from state schools. However, these observed differences were statistically significant only on the *Mathematics Test Anxiety* and *Total Mathematics Anxiety* subscales ($p < .001$ and $p = .002$ respectively).

The highest average levels of *Mathematics Test Anxiety* were reported by females in integrated schools (M = 12.73), and the lowest by males in state schools (M = 9.07). The highest average levels of *Mathematics Learning Anxiety* were also reported by females in integrated schools (M = 7.88), and the lowest by males in integrated schools (M = 6.42).

Table 4.6

Mathematics Anxiety by School Type

School Type	*n*	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Integrated				
Female	60	12.73 (4.19)	7.88 (3.79)	20.62 (7.10)
Male	62	10.52 (4.19)	6.42 (2.90)	16.94 (6.52)
Total	122	11.61 (4.32)	7.14 (3.43)	18.75 (7.03)
State				
Female	156	10.63 (3.97)	6.91 (3.00)	17.54 (6.30)
Male	156	9.07 (4.04)	6.49 (3.12)	15.56 (6.55)
Total	312	9.85 (4.08)	6.70 (3.06)	16.55 (6.49)
Total				
Female	216	11.22 (4.13)	7.18 (3.26)	18.40 (6.66)
Male	218	9.48 (4.13)	6.47 (3.05)	15.95 (6.56)
Total	434	10.35 (4.22)	6.82 (3.17)	17.17 (6.71)

Female participants reported higher average levels of mathematics anxiety than their male peers at both integrated and state schools, but particularly so in integrated schools. This gender difference was statistically significant for both school types, and on all subscales, except for the *Mathematics Learning Anxiety* of participants from state schools.

Female participants at integrated schools reported higher average levels of mathematics anxiety than females from state schools on all subscales, and all differences were statistically significant (*Mathematics Test Anxiety* $p = .001$; *Mathematics Learning Anxiety* $p = .050$; *Total Mathematics Anxiety* $p = .002$). The only statistically significant difference between males from integrated schools and males from state schools was on the *Mathematics Test Anxiety* subscale ($t(216) = 2.366$, $p = .019$).

4.2.10 Correlations between types of mathematics anxiety.

In this study, *Mathematics Test Anxiety*, *Mathematics Learning Anxiety* and *Total Mathematics Anxiety* were all significantly, positively and strongly correlated. The strongest correlation was between *Mathematics Test Anxiety* and *Total Mathematics Anxiety* (.93).

Table 4.7

Correlations Between Types of Mathematics Anxiety

Type of Mathematics Anxiety	*1*	*2*	*3*
1. Mathematics Test Anxiety		.64	.93
2. Mathematics Learning Anxiety			.88
3. Total Mathematics Anxiety			

Note. All correlations are significant at the 0.01 level (2-tailed).

4.2.11 AMAS in summary.

In general, the groups which experienced high levels of mathematics anxiety were females, Pāsifika students, females at single-sex schools and those at integrated schools. School decile ratings had an interesting relation to mathematics anxiety, with *Mathematics Test Anxiety* increasing with decile rating and *Mathematics Learning Anxiety* generally decreasing with decile rating.

Table 4.8

Mathematics Anxiety Results in Summary

Category	Mathematics Test Anxiety	Mathematics Learning Anxiety	Total Mathematics Anxiety
Gender			
Highest	**Females**	**Females**	**Females**
Lowest	**Males**	**Males**	**Males**
Ethnicity			
Highest	Asians	Pacific Peoples	Pacific Peoples
Lowest	MELAA	MELAA	MELAA
School Decile			
Highest	**High decile**	Low decile	High decile
Lowest	**Low decile**	Medium decile	Medium decile
School Gender Type			
Highest	**Single-sex females**	**Single-sex females**	**Single-sex females**
Lowest	**Co-educational males**	**Single-sex males**	**Co-educational males**
School Type			
Highest	**Integrated**	Integrated	**Integrated**
Lowest	**State**	State	**State**

Note. Statistically significant differences between category subgroup means are shown in bold.

4.3 Qualitative Findings (Interviews)

4.3.1 Interview participants.

Highly mathematically-anxious students (with high scores on the *Total Mathematics Anxiety* subscale of the AMAS instrument) were invited to participate in focus group interviews to recount their experiences with mathematics anxiety. Three focus group interviews were conducted in each of three different schools. In total, 16 students were interviewed (see Table 3.7 for details relating to participants' gender, ethnicity, school decile, school gender type, and school type).

4.3.2 General initial findings.

The interviews opened with an ice-breaker: "*If maths was the weather, what would the weather be like for you*?" The most common response was "cloudy". However, one participant in each group described their maths weather as stormy, such as this response: "*golf ball-sized hail hurricane.*" Interestingly, about a third of participants described their maths weather as "changeable", depending on the level of difficulty of concepts covered in class.

Participants were then asked to each choose the one word from a list containing synonyms of "anxiety" which best described their feelings towards mathematics: apprehensive; concerned; doubtful; fearful; nervous; panicky; pressured; stressed; uncertain; uneasy; unsure; and worried. The words chosen most commonly were: nervous, panicky, and unsure. The words not chosen at all were: concerned, fearful, and worried.

The interviews provided evidence that male and female students have different perceptions of each other's levels of mathematics anxiety. Some male participants thought that females would have lower mathematics anxiety because "*girls' minds mature like a year earlier than boys and so that probably has something to do with them being smarter at a younger age.*" Some female participants thought that males would have lower mathematics anxiety: "*From experience with my older brothers, and like even in primary school… girls would always get worried about it and boys would kind of just try and block it out or not think about it.*" One female participant reflected that "*guys kind of seem to be more laid back about the sort of things that I worry about*."

When participants were asked to give an example of high mathematics anxiety, their responses centred on algebra, tests, not understanding class work, hard concepts, and falling behind others. When participants were asked to give an example of low mathematics anxiety, their responses centred on primary school, fun activities, easy concepts, Number, understanding class work, and supportive teacher explanations.

The interview participants generally agreed that mathematics was unpredictable and changeable, but potentially enjoyable: "*Most of the time I don't really understand but if I do understand it gets better. It is a lot of fun to do it then.*" However, for some participants, their feelings about mathematics were more negative: "*I have never been very good at maths; I don't know if I ever will be*." Some recall really enjoying mathematics when they were younger, but their enjoyment and/or performance deteriorated over time, while several mentioned the boredom factor with their mathematics: "*It is pretty hard to do something that you are not interested in*."

4.3.3 Emergent themes.

Four main themes emerged from the focus group interviews:

- The importance of teacher quality;
- The detrimental effect of tests and exams;
- The impact of social comparison;
- The “big jump”: Starting secondary school.

4.3.3.1 Teacher quality. Participants explained that their success in mathematics was ultimately due to quality teaching. Effective “ways of teaching” can make mathematics fun, easy and enjoyable. Examples of these effective ways were predominantly about primary teachers and their use of games, a variety of different resources, hands-on practical activities, and explanations using multiple strategies.

Comprehensive explanations by teachers, the students maintained, help students’ understanding. This was of particular importance to participants in a secondary setting in order to gain clarity about their work and therefore reduce their mathematics anxiety. Negative examples of teachers not explaining work sufficiently involved: going too fast, offering only one strategy, leaving students to struggle on their own, or “giving up” on students, such as the following participant’s experience:

> *The teacher just gave me the book and never came back to teach me how to do things. So, I went through and gave the book back after a couple of questions and most of it was wrong, and then she just gave up…. The teachers couldn’t be bothered teaching us or taking some time out and just sitting with us.*

Students desire more one-on-one support and assistance from their teacher: "*When you don't get help you are really frustrated and then you have to do it for homework and you still don't know what to do*." One participant noted that she received out-of-school maths tutoring and "*that really helped because it made me feel like way more confident that I could do it and stuff, so I think that kind of like helped a lot."*

The issue of class size was discussed in detail during the interviews. Most participants wished that their class size was significantly smaller, so they could have more of the teacher's attention:

> *I will put my hand up and I will leave it there for like ten minutes and [my teacher] will come around, I will explain to him my problems, he will be there for like thirty seconds… and then he will leave while I am writing down my answer, but I still have like twenty other questions I have to ask him, but he has gone, so I put my hand up and wait another ten minutes.*

However, some participants thought that a big class size would be better, *"because everyone can help each other and there can be more talking about the maths."*

4.3.3.2 Assessment. Test anxiety is a major component of students' mathematics anxiety: *"I don't mind learning maths; I kind of enjoy it when we learn it, as long as I know what we are doing, but when it comes to tests a lot of things flash through your mind, so it is quite hard to focus*." Most participants, particularly females, described their experiences of panic, mind blanks, and/or feeling overwhelmed in a test situation. Test anxiety appeared to emerge for them in secondary school because they had not sat many tests in primary school: *"[My mathematics anxiety was triggered] just coming into college and having all of these tests all of a sudden, just grading everything*."

The participants acknowledged the value of mathematics for their future, regardless of their career plans: "*Everyone talks about [mathematics] as the one thing you need when you leave school, and I just don't want to like not know things*." Some saw mathematics as a gate-keeper subject: "*I think some parts of maths are pretty pointless, but I understand how it is somewhat necessary, because it is like when you are going for a job interview just because maths might not really be part of your job description, it will still help you get that job if you know maths regardless*." The participants, 18 months away from starting NCEA,[6] anticipated the pressure to achieve in high-stakes tests that have consequences for their future, because "*those tests basically determine what you are going to do for the rest of your life*."

Students have a profound fear of failure: "*I got a 'Not Achieved' and it just kind of like crushed me."* Participants expressed how grades from tests can "make or break" their self-confidence: "*Whenever I get a good grade I feel great and happy and I am like 'yay, I can do this'; but then if I get a bad grade I just completely shut off and I am like 'I am never going to be able to do this'*." Participants feared the judgment from others due to their failure in tests. One participant explained how successive failures on tests had a cumulative effect on his anxiety:

> *There is also like the mental thought of 'okay, so I just failed my test. I got… an 'Achieved minus' on my English test, so if I fail this test then… I am going to be in pretty deep trouble with my dad and my parents because I… would have failed most of my stuff' and that also puts even more anxiety on me—the fact that I have failed too much.*

[6] The National Certificate of Educational Achievement (NCEA) is the main national qualification for secondary school students in New Zealand.

Students questioned the rationale for having timed tests. Participants were aware that "*a lot of people work slower than others*" and gave examples of their panic rising in a test situation as the time counted down.

> *Me and a few of my good friends, we were just trying to see who had finished first because we thought if you finished first then you were like the best.… I don't see why you should have to be timed, like if you can do it quicker than others, what does it prove?*

4.3.3.3 Social comparison. Students provided evidence that they constantly compare themselves to their peers and do not want to be seen to be "the dumbest": "*I feel a little bit of pressure from my friends; it is like I don't really want to have the worst mark out of all of them.*" Participants were divided as to whether they would like to have extra help or tuition (such as a remedial class) in mathematics:

> *I would like to have some tutoring, like one-on-one tutoring. I don't really worry if anyone thinks that you are doing it because you are dumb, but I know a lot of people… wouldn't like go and try to get some help because they, they don't want everyone else to think they are dumb or different.*

Mathematics anxiety appeared to heighten when students felt that they were falling behind their peers. Some participants expressed feeling "left out" when friends or peers talked about understanding mathematics: "*If I come out of a test and like 'oh, that was really hard' and then others are like 'no, it was not, like it was actually really easy' and then I start to like freak out.*" Participants talked about feeling pressure from non-anxious friends or peers: "*The ones who aren't [mathematically anxious], they just like put more pressure on me because like I am trying to be as good as them.*"

In the participants' view, being placed in a low ability group (stream) is highly detrimental to students' social image and self-belief. Participants were almost unanimous in agreement that ending up in the "cabbage class" was to be feared and avoided:

- *"People judge you a lot if you are at the bottom."*
- *"If you are in the bottom one you are just plonked there with the other bad people, and then the people on the top class go on about how good they are at maths and that just makes you feel really, I don't know the word for it, but it just makes you feel bad."*
- *"If you are in a lower class it can be harder on yourself because you are put into a lower class and it might make you feel upset, or like, that is what happened to me, because all my friends were at the higher [class]."*
- *"Once you get like stuck in the bottom [class], if you don't learn the same stuff then you can kind of like 'keep' there."*

However, one participant explained that being in a "top" stream can be a negative experience too:

> *On the day that we had our first maths lessons, I got moved up to the top one, so like in the first place I was like really really nervous because I like thought that I couldn't do it and stuff and then yeah felt like scared.*

Another participant explained why he enjoyed being in a mixed-ability class:

> *The way [my school] does it [with no streaming] is pretty awesome because you can be at a table group and instead of asking the teacher you could ask a*

student or a friend "do you know the answer; can you teach me it" instead of a chaos class.

Students generally feel supported by their parents and want to please them: "*They want me to succeed, and I want myself to succeed, and I also want to impress them, so I get quite a lot of pressure in trying to do the exams and stuff*." One participant explained how he felt pressured because his success or failure reflected upon his parents: "*They feel like they are stuffing up if I am doing bad in school, like they are not doing the right thing and then I just get, feel disappointed if I don't do well*." Some participants expressed that they felt pressure to succeed from their parents, mainly fathers, who were "*really good at maths*." Other participants felt the pressure of comparison and competition with their successful older siblings: "*My brother is really good at maths and so my mum would always like talk to him about how good he was, and then it kind of like set me off because I was like trying to live up to him, but I couldn't do it because I wasn't very good*."

4.3.3.4 School transitions. The emergence of mathematics anxiety typically occurred when the students started secondary school. Participants talked of the "*massive change*" when coming to college, where mathematics is more difficult, complex, and abstract. Some participants commented on their difficulty in coming from a primary school environment with not much mathematics, to daily mathematics lessons in secondary school. Some participants felt that they lacked prior knowledge for the level of mathematics concepts covered in secondary school: "*We were expected to have learned all these things at primary school that I hadn't*." Some participants explained that their mathematics anxiety emerged at an earlier age (in upper primary; Years 5-8), when "*you had to start doing maths properly*", such as times tables; when "*we weren't just counting cookies anymore*."

School transitions can unexpectedly highlight “math gaps” for students and trigger mathematics anxiety. Several participants recalled the difficulties they faced when they shifted primary schools:

> *In my first school… it wasn’t that hard at all and I was one of the smarter kids there. But then when I moved to [my new school] it was just so much harder because they had all been learning more advanced stuff and I struggled then and that is when maths anxiety started kicking in.*

Algebra was overwhelmingly an area of fear and confusion for the students. Most participants talked about not understanding or enjoying algebra at all. Some even attributed algebra as the cause of their mathematics anxiety: “*I was in an algebra exam half way through the year and I looked at the page and I started to cry, I just freaked out.*”

Teaching and learning in primary versus secondary school can be quite different. Participants recalled how their primary teachers made mathematics fun and easy to understand, whereas secondary mathematics teachers tended to make mathematics boring and difficult to understand: “*[I enjoyed primary school maths more] because we actually did activities every so often, or something interesting, other than doing it the same way each time.*” One participant gave an interesting view of her enjoyment in mathematics evolving:

> *I think that at like primary school, maths was more about like just playing maths games and stuff, so that was fun. But I do like it like now, because I feel like I am learning something, and I feel like quite proud and stuff. So, I find that like fun as well.*

4.3.4 Magic wand.

Participants were asked how mathematics could be improved with “the wave of a magic wand”. Most responses were about gaining a comprehensive understanding of mathematical concepts:

- *“Make me soak it up like a sponge so I can learn it easier.”*
- *“To understand maths so instead of being confused; being, be able to do better at maths on my own.”*
- *“You could try to drive everything that we need, like everything about maths, into our brains. That would be amazing because then we wouldn’t have to learn it.”*
- *“A photographic memory. How cool would it be remembering things; that is a dream, just being able to answer the question whenever you want.”*

The next most common response was about having a quality teacher:

- *“I find that with my maths teacher I just get pressured into like having to know it.”*
- *“Change the whole style of teaching and make it more easier.”*
- *“If the teachers explained it a bit more slowly and properly it would help.”*

Some participants wished that mathematics was not so crucial for their future:

- *“Someone that could tell you your future, and then you could… have the opportunity to just study what you are going to need for your future life, instead of having to go through like algebra if you won’t need algebra when you are older, even though you probably still will need it.”*

- *"If [mathematics] wasn't so important to every single thing you have to do in life."*

One participant acknowledged the need for assessment, but wished that tests were not so anxiety-ridden: "*Just make all the tests that we have to do really casual.*" Finally, one participant wished to change people's negative attitudes towards mathematics: "*Change people's thinking. Like some people that I know are really negative towards maths, well, I am too, but it just makes me more like, it just makes me hate maths more because… I get encouraged by other people to be negative about it.*"

4.3.5 Conclusion.

This chapter has presented the quantitative and qualitative findings from the research study.

The survey findings revealed that 21.4% of participants reported high levels of mathematics anxiety. In general, the groups most affected by high levels of mathematics anxiety were females, Pāsifika students, females at single-sex girls' schools and those at integrated schools. School decile ratings had an interesting relation to mathematics anxiety, with *Mathematics Test Anxiety* increasing with decile rating and *Mathematics Learning Anxiety* generally decreasing with decile rating.

The four main themes that emerged from the focus group interview were: the importance of teacher quality; the detrimental effect of tests and exams; the impact of social comparison; and the effect of school transitions.

The following chapter (Chapter 5) discusses the findings in relation to the literature.

Chapter 5: Discussion

5.1 Introduction

The research objectives addressed in this study will form the basis of this discussion:

1. To find out the extent of mathematics anxiety amongst Year 9 students in the region.
2. To explore the relationship between students' levels of mathematics anxiety and their gender, ethnicity, school decile, school gender type, and school type.
3. To determine what aspects of students' experiences contribute to their mathematics anxiety.

5.2 The Extent of Mathematics Anxiety Amongst Year 9 Students

In this study, undertaken in one rural/provincial region in New Zealand, findings revealed that 93 out of 434 participants (21.4%) reported high levels of mathematics anxiety. These findings are consistent with international findings which estimated the prevalence of mathematics anxiety to be roughly 20%, based on Ashcraft and Kirk's (2001) study where 22.7 per cent of participants were categorised into a high-mathematics-anxiety group.

Why are these findings troubling? The United Nations Educational, Scientific and Cultural Organization's (UNESCO) Institute for Lifelong Learning (UIL) has emphasised that mathematics is indispensable for the achievement of the Sustainable Development Goal (SDG) 4: "Quality education", the 10 related targets set out in the Education 2030 Framework for Action, and the other 16 SDGs:

> In today's fast-changing society everyone needs to have a wide set of knowledge, skills and competences, including literacy, numeracy and digital competency at a proficiency level, in order to learn, adapt and participate in

> social, economic, cultural and civic life. The Survey of Adult Skills (PIAAC) indicates that adults with low levels of proficiency in literacy, numeracy and problem-solving in technology-rich environments face a higher risk of unemployment, a higher incidence of poverty and social exclusion, higher health risks and lower life expectancy, while their children face higher risks of educational underachievement. (UIL, 2017, p. 2)

5.3 The Relationship Between Students' Levels of Mathematics Anxiety and Their Gender, Ethnicity, School Decile, School Gender Type, and School Type

In this study, although some comparisons were not statistically significant, findings revealed that the groups most affected by high levels of mathematics anxiety were females, Pāsifika students, females at single-sex girls' schools and those at integrated schools. School decile ratings were associated with mathematics anxiety unpredictably, with *Mathematics Test Anxiety* increasing with decile rating and *Mathematics Learning Anxiety* generally decreasing with decile rating.

5.3.1 Gender.

The 2012 PISA findings (OECD, 2013a) revealed that even when girls achieve as well as boys, they report less perseverance, less motivation, lower self-concept and higher levels of anxiety towards mathematics than boys, and are more likely than boys to attribute mathematics failure to themselves rather than to external factors. High-achieving girls underperformed in mathematics compared to high-achieving boys, largely due to differences in self-belief, self-efficacy and mathematics anxiety. This finding might go some way to explaining the under-representation of females in science, technology, engineering and mathematics (STEM) careers.

Women represent less than 30 per cent of researchers in the STEM fields globally (UNESCO, 2015), and make up an extremely small proportion of the most prestigious awards in the STEM fields, such as the Nobel Prize in Medicine (5.3%), Chemistry (2.4%), Physics (1.0%), and the Fields Medal in Mathematics (1.8%). The average proportion of girls competing at the International Mathematical Olympiad has risen from just 3% to 8% in the last four decades (Libresco, 2015).

Boaler (1997) argues that mathematics education research contributes to the masculinization of norms for mathematics success because it suggests "ways in which girls should change, ways in which they should become less anxious, more confident; in essence, more masculine" (p. 285). Pursuing this point further, Mendick (2006) offers an explanation for the high levels of mathematics anxiety in girls:

> Certain discourses about maths and mathematicians [are] central to the way that students negotiate their relationships with the subject. "Real maths" is different from other subjects; it is certain, rational and hard. "Real mathematicians" are different from other people; they combine the flattering characteristics of geniuses and heroes with the unflattering characteristics of nerds. These discourses are oppositional and gendered; they inscribe maths as masculine. Based on this, boys and girls, and men and women, in doing mathematics are doing masculinity, and so it is more difficult for girls and women to feel comfortable with maths, and so to choose it and to do well at it. (p. 111)

Mendick explains further:

> The strategies which have been adopted for supporting girls and women in maths, such as using non-sexist resources, providing female role models and raising girls' self-esteem, have been largely unsuccessful. Women *are* doing

> better overall educationally than they once did, but this is far more likely to be the result of wider social and economic changes than of educational interventions (Moore, 2004) and they remain under-represented in particular fields. A main reason for the disappointing results of such strategies is that they have attempted to change the girls and women to fit into maths while being happy to leave maths fixed as it is. (p. 141, emphasis in original)

A further explanation given in the literature is the notion of "learned helplessness" which leads to "challenge avoidance" and low self-esteem. However, explanations like learned helplessness tend to position girls as the problem. Solving the problem of girls' low self-esteem then means focusing only on the girls themselves. Well-intended strategies to enhance girls' self-esteem tend to ignore the contexts in which girls are placed. An example of such a discourse is the "Teen Talk Barbie" introduced in 1992. The Barbie doll incorporated voice box phrases including "*math class is tough*!" which was detrimental to the effort to encourage girls to study mathematics. Further, girls with positive self-esteem are more likely to be labelled by society as "arrogant" than boys.

Single-sex environments for girls have been suggested as a way to address the learned helplessness and low self-esteem problem with girls from the argument that such spaces require "less gender category maintenance work" (Mendick, 2006, p. 151).

> In the single-sex environment, girls can be girlish and at the same time be brilliant. They can giggle and tug on split ends and speak in those sing-song Valley Girl cadences, all the while discoursing on such personal specialties as cognitive psychology, phytoplankton, Parkinson's disease and mother-infant attachment among gibbons. (Freedman, 2005, as cited in Mendick, 2006, p. 151)

However, the findings from this study did not support that argument. In particular, girls from single-sex schools reported the highest levels of mathematics anxiety (see Table 4.5).

Cipora, Szczygiel, Willmes, and Nuerk (2015) suggest that gender differences in mathematics anxiety may be modulated by test anxiety. Hembree's (1988) meta-analysis showed that female students in grades 5-10 displayed higher levels of test anxiety than males, with a mean effect size difference of $d = 0.43$. The effect size difference in this study was $d = 0.42$. It has been shown that females perceive a test as a threat, whereas males perceive a test as a challenge (Zeidner, 1998).

5.3.2 Ethnicity.

Like many schools internationally, New Zealand schools are becoming more and more culturally diverse. Achieving equitable access to mathematical achievement "has been a persistent challenge for many education communities. Students may find learning mathematics challenging. However, caring, trusting relationships between participants in education focussed on enhancing learning offer a sound pathway towards maximising motivation and achievement" (Averill, 2012, p. 123).

When analysed according to ethnicity, this study's findings revealed that Pāsifika students had the highest levels of mathematics anxiety, followed by Asian and Māori participants, although these differences were not statistically significant (see Table 4.3).

Turner, Rubie-Davis, and Webber (2015) found that teachers had low expectations of Māori students, citing students' attitudes and home backgrounds as the main reasons for their poor achievement. If Māori students absorb these messages of low achievement, they may create a self-fulfilling prophecy.

In another study, Aoina (2006) explored the experiences of Pāsifika teenage females in New Zealand. She found the main positive influences to be encouragement, enjoyment, development, achievement, and spiritual/cultural identity. Negative influences were judgement from others, fear of failure, strained relationships, and lack of cultural knowledge. Notions of reciprocity, communalism, collectivism, and service were repeated by Hunter et al. (2016a): "By acknowledging and drawing on these values within educational settings, educators can enact culturally responsive pedagogical practices which engage Pāsifika learners and provide them with opportunities to achieve academically" (p. 198).

5.3.3 Socioeconomic status / school decile rating.

Socioeconomic disadvantage "is still a major determiner of student achievement" (Vale, Atweh, Averill, & Skoudoumbis, 2016, p. 101). In New Zealand, "75% of the between-school variation in performance is accounted for by the socioeconomic background of students and schools" (Thomson, De Bertoli, & Buckley, 2013, p. 278). However, Marks (2015) suggests that prior achievement is a bigger factor than school level socioeconomic status on student outcomes. The differences in mathematics performance are closely linked with socioeconomic status and ethnicity, and have not reduced over time despite a discourse of "mathematics for all."

In this study, findings revealed that school decile ratings had an interesting relation to mathematics anxiety, with *Mathematics Test Anxiety* increasing with decile rating and *Mathematics Learning Anxiety* generally *decreasing* with decile rating (see Table 4.4).

In the Australian context, Vale et al. (2016) identify the "duplicitous nature of social disadvantage, as schools serving low socioeconomic communities are often also schools in rural or remote locations, and have significant school populations of Indigenous students or students of other cultural and language backgrounds" (p. 104). Less qualified teachers are disproportionately located in remote, rural, and low socioeconomic urban communities (McKenzie, Weldon, Rowley, Murphy, & McMillan, 2014). Calls have been made to either attract and retain experienced teachers to these locations, or to target professional development initiatives in these schools (Vale et al., 2016).

McConney and Perry (2010) argue that from a social justice perspective, policies that potentially increase social segregation and resource differences between schools (such as the "white flight" to more affluent public schools, or to private schools) should be avoided.

In this study, notable differences occurred between groups of individuals. Such differences might suggest that "social and educational forces, policies, and structures are systematically privileging some groups over others" (Song, Perry, & McConney, 2014, p. 178).

> We are doing something, or probably not doing something, to Māori and Pacific students within our schools *across all decile levels* that is just not connecting with them. It is not socioeconomic differences. Instead, the evidence is pointing more to the *relationships between teachers and Māori students* as the major issue—it is a matter of cultural relationships not socioeconomic resources. (Hattie, 2003, p. 7, emphasis in original)

Scholars are now calling for future research to attend to a more complex understanding of students' mathematics experiences, particularly at the *intersections* between socially constructed identities such as gender, ethnicity and socioeconomic status (e.g., Boaler, 2002; Damarin & Erchick, 2010). Leyva (2017) argues that “there remains much analytical space in the research literature to critically examine how intersections of gender and other vectors of identity further explain students’ achievement, engagement, and identities in mathematics” (p. 418). However, he warns that such insights may not universal because social norms can vary across international contexts.

This research has explored the intersections of gender, ethnicity, school decile, school gender type and school type with regards to mathematics anxiety. In this study, findings revealed that the highest levels of mathematics anxiety were reported by females at integrated schools, followed by females at single-sex schools, and females at high-decile schools.

Praise, affirmations and awards can “encourage and inspire students to work hard and to see themselves as mathematically capable… but these also signal to students what it means to be ‘good at math.’ Unexamined, these messages may communicate a narrow perspective on what mathematical ability is” (Ball, Goffney, & Bass, 2005, p. 4). Recent critical insights from socio-cultural theories have led to reframing persistent “problems” such as the “gender gap” or the “socioeconomic disadvantage” from a perspective that sees “knowledge, power, and identity as interwoven and arising from (and constituted within) social discourses. Adopting such a stance means uncovering the taken-for-granted rules and ways of operating that privilege some individuals and exclude others” (Gutiérrez, 2013, p. 40).

Adopting a socio-cultural stance could mean that the concept of engagement is not measured just by closing the gap, but, perhaps more importantly, by increasing and enhancing students’ relationships and feelings with mathematics. Ball et al. (2005)

argue that “mathematics—and the ways in which teachers teach it—is a key resource for building a socially just and diverse democracy” (p. 2). However, they caution that “some aspects of “good teaching” may unwittingly create, reproduce, or extend inequities among students, differences deeply rooted in the inequalities of our society” (p. 3).

5.4 Aspects of Students’ Experiences That Contribute to Their Mathematics Anxiety

The findings from this study revealed the emergence of four main themes from the qualitative data:

- *The importance of teacher quality.* Quality teaching can reduce students’ mathematics anxiety;
- *The detrimental effect of tests and exams.* Test anxiety is a major component of students’ mathematics anxiety;
- *The impact of social comparison.* Mathematics anxiety is heightened when students feel they are falling behind others (social derogation);
- *The big jump: Starting secondary school.* The emergence of mathematics anxiety typically occurs when students start secondary school.

5.4.1 Teacher quality.

Many researchers agree that quality teaching is the most influential factor on student outcomes (e.g., Alton-Lee, 2003; Biddle, Good, & Goodson, 1997; Darling-Hammond, 1998; Dunkin & Biddle, 1974; Muijs & Reynolds, 2001; Schereens, Vermeulen, & Pelgrum, 1989).

Quality teaching "influences the quality of student participation, involvement and achievement (including social outcomes)" (Alton-Lee, 2003, p. 2). The 2012 PISA findings (OECD, 2013a) found that relationships between teachers and students are strongly associated with students' engagement with and at school, a stronger sense of belonging and a greater intrinsic motivation to learn mathematics.

The variation in mathematics anxiety is much larger within schools than between schools, because teachers have such a powerful influence on their students (OECD, 2013a). Schereens, Vermeulen, and Pelgrum (1989) found the teacher effect (between teacher/class variance) to be 42% for New Zealand Year 9 students, while the school effect was undetectable. A longitudinal study carried out using a New Zealand sample from the Second International Mathematics Study in 1981 revealed that many of the highest "value-added" classes actually had very low pre-test scores, "showing a strong positive teacher effect despite the background and prior knowledge of the students" (Alton-Lee, 2003, p. 3). Garden, Wagemaker, and Moody (1987) provided evidence that "classes with low mean socioeconomic status, low pre-scores and higher proportions of non-Pakeha students are capable of very good progress in mathematics learning" (p. 319).

Effective teacher-student relationships are crucial for indigenous and marginalised students who are often those served less well in mathematics (Averill, 2012). "Teacher-student relationships are a key component of classroom climate: high quality teacher-student relationships help facilitate academic motivation school engagement, academic success, self-esteem, and more general socio-emotional well-being" (Eccles, 2004, p. 129). This study's findings support these arguments: Participants revealed that having a quality teacher was the biggest determiner of their engagement with mathematics; students desire more one-on-one support and assistance from their teacher.

Grootenboer and Marshman (2016) question whether current teaching practices are irrational, unsustainable, and unjust, because of students' levels of mathematics anxiety and disengagement, and fragile mathematical identities. They argue that effective teaching practices that "develop mathematical attitudes, beliefs and emotions that are positive and enabling" (p. 124) could be more conscious and considerate of the affective dimension if "overt attention is paid to students' emotions and their beliefs about themselves as mathematical learners as they engage in their classroom mathematical experiences" (p. 111).

5.4.2 Assessment.

Students' and teachers' mathematical identities are constrained and constructed by the domination of assessment requirements, leading to a vicious circle of inequitable processes. "Reconstructing relationships—both between teachers and pupils and with mathematics—potentially offers a way of breaking out of this cycle" (Hodgen & Marks, 2009, p. 40).

An effective balance between curriculum and assessment is key, and should be a point of discussion amongst practitioners (Alison, 2005). Teachers and researchers have noted with dismay that the tail (assessment) is currently wagging the dog (mathematics education) too much because schools are often under pressure to "perform"—from parents and from government (Winbourne, 2009).

- "32% of principals reported that National Standards drives what the school does" (Bonne, 2016, p. 1);

- "The level at which external assessments are driving classroom practice as opposed to the curriculum and student-centred practices is alarming" (Serow, Callingham, & Tout, 2016, p. 251);
- "The current assessment regime incentivises and rewards teachers to teach (and students to learn) in ways that maximise assessment performance rather than the kinds of teaching and learning called for in national policy documents and generally associated with teaching for understanding frameworks" (Hogan et al., 2013, p. 99).

Ballen, Salehi, and Cotner (2017) showed that high levels of test anxiety impacted the exam performance for females but not males: Female students performed better on non-exam methods of assessment. The authors suggest that "it may be time to reconsider exams as a primary method for evaluating student knowledge" (p. 1), and advocate "active learning" approaches such as group work, case studies, modelling exercises, worksheets, and one-minute papers. "Evaluating students based primarily on high-stakes exams does not nurture individual potential, and its use to assess our increasingly diverse talent pool will perpetuate existing disparities" (p. 11).

Alternative (relational) forms of assessment that "promote learning rather than labelling" (p. 41) have been suggested by Hodgen and Marks (2009): group assessment and formative assessment. For example, R. Hunter's *Developing Mathematical Inquiry Communities* project is a "re-invention" in New Zealand designed to "integrate best pedagogical mathematics practice within culturally responsive teaching" (Hunter, Hunter, Bills, & Thompson, 2016b, p. 59). It uses teacher mentors to support changes in teacher practices "as a way to reverse the persistent underachievement of Māori and Pāsifika and other diverse groups of student[s]" (p. 59).

Findings from this study revealed that a major component of students' mathematics anxiety is test anxiety (see Figure 4.1), which tends to emerge in secondary school. Many of the negative experiences in mathematics expressed by the participants were to do with high-stakes, high-frequency assessments at secondary school, and the implications for their future.

5.4.3 Social comparison.

Individuals often locate the source of their mathematical "deficiencies" within themselves, not within the mathematics itself (Hodgen & Marks, 2009). Students determine their self-perceptions by comparing themselves with their classmates (OECD, 2013a). Ability grouping practices provide fertile ground for this to occur. For example, Hodgen and Marks (2009) found that even relatively high-ability students perceived themselves as failures in mathematics. "By 'imagining' their performance in comparison with other 'clever' students, these otherwise successful students 'learnt' to see themselves as lacking ability in mathematics" (p. 32). Students in high-ability groups are often desperate to maintain their status as having a "clever" positional identity. Many are therefore "discouraged from engaging mathematically [by asking questions or speaking out]" (Hodgen & Marks, 2009, p. 36). Conversely, low-ability students are often taught "a largely remedial (and boring) curriculum, and most students regard themselves as weak mathematically" (Hodgen & Marks, 2009, p. 31). As Anthony and Walshaw (2007) argue, "this pedagogical practice may have a detrimental effect on the development of a mathematical disposition and on students' sense of their own mathematical identity" (pp. 2-3). Alternatively, when classes are heterogeneous (mixed-ability), teachers can tend to teach to the "middle" and may find the spread of abilities too wide to cater for all students' needs (Winbourne, 2009).

5.4.4 School transitions.

Negative experiences with mathematics at school can lead to disengagement, disaffection and a poor sense of mathematical identity. Change and identity are particularly prominent and significant in the adolescent middle school years (Hoy, Demerath, & Pape, 2001). Year 9 can be described as "a critical time when views, beliefs and attitudes can become more entrenched and fixed" (Grootenboer & Marshman, 2016, p. 117). It is therefore concerning that this study's findings revealed that one in five Year 9 students have high levels of mathematics anxiety (see Table 4.1), with girls and disadvantaged students bearing the brunt of these effects.

This study was conducted with Year 9 students who had recently transitioned to secondary school. Starting secondary school is a big step. The major themes from the prospectuses of the participating schools in this study differed:

- The boys-only school stressed individual success and competitiveness. For example, School D's prospectus "encourages boys to have a go at everything, to strive to succeed to the best of their ability and to learn to win with humility and to lose with dignity." The findings from this study revealed that boys in single-sex schools reported higher levels of mathematics anxiety than boys in co-educational schools, particularly in regards to test anxiety (see Table 4.5);
- The girls-only schools aimed to develop girls' self-confidence and leadership. For example, in School E's prospectus, it was noted that "we aim to develop leadership, foster self-confidence and bring out the best in each girl." School F expects to see their students "developing self-efficacy and confidence from full participation in all that is offered in our school." Contrary to these aims, the

findings from this study revealed that girls in single-sex schools reported the highest levels of mathematics anxiety (see Table 4.5);

- The co-educational schools aimed to develop well-rounded people. For example, in School A’s prospectus, it was noted that “by the time students leave us after five years, they must be independent and be responsible for their ongoing learning; be critical and creative thinkers; be able to collaborate and cooperate with others and be able to communicate effectively in words and symbols.” The findings from this study revealed that students in co-educational schools generally reported the lowest levels of mathematics anxiety (see Table 4.5).

5.5 Summary

The findings from this study, which revealed that one in five Year 9 students reported high levels of mathematics anxiety, are consistent with findings from international research. Mathematics anxiety which develops in adolescence can become a lifelong problem for adults and limit their life opportunities.

The findings from this study revealed that females and disadvantaged students reported the highest levels of mathematics anxiety. Researchers argue that well-intended strategies implemented to support these students in mathematics have been largely unsuccessful because they have attempted to change the student to fit the mathematics, rather than the other way around.

The findings from this study revealed the emergence of four main themes to do with students’ experiences with mathematics anxiety: teacher quality, assessment, social comparison, and school transitions. It seems that external factors (largely school-based) have the greatest impact on students’ thoughts and feelings to do with mathematics.

Therefore, the “solution” to the mathematics anxiety “problem” can arguably be found within schools.

Of concern is the finding that for some students, the Ministry of Education’s (2007) whakataukī (proverb) for the Mathematics and Statistics learning area—*Kei hopu tōu ringa ki te aka tāepa, engari kia mau ki te aka matua (Cling to the main vine, not the loose one)*—does not hold true:

> The main vine is not present for many. There may be vines but there is no main vine. The result is confusion. Students become disinterested in mathematics and just see it as an untidy, uncontrollable, impossible to remember, mess of ideas and methods… Having a “main vine” for a teacher is about deep knowledge of learning and mathematics. You know your main vine is flimsy when you cannot describe what you are teaching or apply it to new situations. You know your main vine is dodgy when students are not engaged or over time become disinterested in your classes. (Hogan, 2017, para. 1)

The following chapter (Chapter 6) presents the concluding thoughts for the study.

Chapter 6: Conclusion

6.1 Introduction

The Mathematics Education Research Group of Australasia (MERGA) have included chapters on affective issues within research in mathematics education in the four most recent research periods (from 2000 onwards) because "it is clear that affective issues continue to attract research attention from the mathematics education community" (Attard, Ingram, Forgasz, Leder, & Grootenboer, 2016, p. 74).

> Individuals' attitudes, beliefs and emotions play a significant role in their interest and response to mathematics in general, and their employment of mathematics in their individual lives. Students who feel more confident with mathematics, for example, are more likely than others to use mathematics in the various contexts that they encounter. Students who have positive emotions towards mathematics are in a position to learn mathematics better than students who feel anxiety towards that subject. Therefore, one goal of mathematics education is for students to develop attitudes, beliefs and emotions that make them more likely to successfully use the mathematics they know, and to learn more mathematics, for personal and social benefit. (OECD, 2013b, p. 42)

The most recent MERGA review of mathematics education research (2012-2015) identified that there has only been a small focus on mathematics anxiety research into school-aged students, such as Ng's (2012) study with students in Singapore, and Chaman and Callingham's (2013) study with Indian students. "It will be of interest in the new review period [2016-2019] to see if there is development in anxiety research in mathematics education" (Attard et al., 2016, p. 85). The present study has contributed to that development.

6.2 Limitations

The use of an online survey to get results from a large sample of participants was quick, easy, and inexpensive. Although it took more organisation and effort, the aim of capturing the "voice" of every Year 9 student in the region resulted in a large sample size (N = 434) which added to the validity and reliability of my results. However, participant non-response is a potential disadvantage often associated with questionnaires. In this study, participating schools had different response rates, ranging from 50% (School A) to 100% (School D), with an average response rate of 81%. Further, one large state co-educational school (School G) provided over half (52%) of the responses. It was disappointing, yet understandable, that two schools chose not to participate in this study.

Different levels of mathematics anxiety were reported by participants according to gender, ethnicity, school decile, school gender type and school type. However, in this "chicken-egg" situation it is unclear which factor(s) mediate or moderate the true levels reported: It is unclear to what degree the results of this study are a reflection of ethnicity, or school decile, or school gender type, or school type, or a mix of factors. In pursuing this complexity in more detail, the distribution of ethnic groups within different school deciles, school gender types, and school types are as follows:

- A small proportion of participants who identified as European attended low-decile schools (9.3%), with a quarter at high-decile schools. This pattern was reversed for Māori and Pasifika participants;
- Participants who identified as European were more likely to attend single-sex schools (33.3%) than Māori (13.3%) and Pasifika (19.2%) students;

- Participants who identified as European were more likely to attend integrated schools (29.8%) than Māori (13.3%) and Pasifika (19.2%) students.

In this study, all single-sex schools were integrated and 99.9% of participants from integrated schools were at single-sex schools. The state schools were low/medium decile and co-educational; the integrated schools were medium/high decile and predominantly single-sex. Therefore, this is an issue of multicollinearity, where "there is a strong relationship between two or more predictors in a linear model. Its presence makes parameter estimates for the model less trustworthy, limits the overall fit of the model, and makes it hard to ascertain the unique contribution of predictor variables to explaining variance in the outcome variable" (Field, 2016, p. 423). The complex statistical analyses required to deal with this issue are beyond the scope of this study.

Some types of schools were not available (in the region) to include in the research study. For example, there were no private schools, and not all deciles were available to study (especially deciles 1 and 10). To make inferences to the general population of Year 9 students in New Zealand, it would have been useful to have been able to obtain data from all school types.

Achievement data were intentionally not included because of the focus of the study. Much research literature has already studied the effect of mathematics anxiety on mathematics achievement/performance. It would have been difficult to measure achievement/performance at the Year 9 level as schools use a variety of different assessment measures, such as PAT, e-asTTle, and school-based assessments. In addition, the PISA and TIMSS studies use their own different methods of assessment.

This research study was cross-sectional, not longitudinal and hence no causal claims can be made. Furthermore, research data were self-reported, not observational.

Therefore, only trait anxiety ("being"), not state anxiety ("becoming"), was measured. Heyd-Metzuyanim (2013) argues that questionnaires and interviews—the tools most commonly used in research on affect in mathematics— "are not suitable for studying the minute-to-minute process of learning" (p. 343) to explain *how* affective constructs interact with the development of phenomena such as mathematics anxiety.

Students' recollections may not be entirely accurate: "Narratives of past history change over time… especially in young adolescents" (Heyd-Metzuyanim, 2013, p. 359). Recent memories are more reproductive, but past memories are more reconstructive (Thompson, Skowronski, Larsen, & Betz, 1996). Our autobiographical stories are "built from many different ingredients: snippets of what actually happened, thoughts about what might have happened, and beliefs that guide us as we attempt to remember" (Schachter, 1996, p. 308).

6.3 Implications for Teaching and Learning

The integrated results from the quantitative and qualitative findings in this mixed-methods study have highlighted implications for junior high school teachers and students.

6.3.1 Teacher quality.

Quality teaching can reduce students' mathematics anxiety.

- Teachers should employ effective ways of teaching to make mathematics fun, easy, and enjoyable;
- Teachers should ensure clarity in their approach, by giving comprehensive explanations and offering multiple strategies when solving problems;

- Schools should aim to reduce class sizes so that students can receive more one-to-one assistance from their teachers.

6.3.2 Assessment.

Test anxiety is a major component of students' mathematics anxiety.

- Schools and teachers should revise their assessment practices, with the aim to minimise high-frequency and high-stakes testing. The issue of timed tests is also pertinent;
- Schools and teachers should spend more time in coaching students in how to deal with the inevitable high-stakes examinations which are still the "gold-standard" type of summative assessment. In particular, students need help to reduce feelings of anxiety (cognitive obstructions such as panic and "mind-blanks") in test situations, and feelings of failure when they receive disappointing results;
- Alternative forms of assessment should be utilised, such as investigations, projects, or transparent marking rubrics. In the current educational climate, there seems to be a mis-match between higher accountability requirements (e.g., national assessment reporting) and a shift towards future-focussed teaching and learning principles (e.g., key competencies, the 6 Cs, and 21st century learning skills).

6.3.3 Social comparison.

Mathematics anxiety is heightened when students feel they are falling behind others (social derogation).

- Teachers should be mindful that many adolescents, particularly girls, have a profound fear of failure and consequent judgment from others. Students are constantly comparing themselves with others and do not want to stand out or be seen to be the “dumbest”;
- Schools should examine their ability grouping practices. Most research literature is critical of “streaming” for several different reasons, and this has been reflected in the comments made by participants in this study. Being placed in a low-ability group is detrimental to students’ image and self-belief, whilst being placed in a high-ability group can also be detrimental due to the pressure to maintain “status”. Mixed-ability classes allow for more peer interaction and support;
- Parents should be mindful that some adolescents feel pressure from parents and/or successful older siblings.

6.3.4 School transitions.

The emergence of mathematics anxiety typically occurs when students start secondary school.

- Schools and teachers at primary/intermediate (Year 8) and secondary (Year 9) should collaborate more, to ensure a more seamless school transition. In particular, teaching methods/styles/materials/topics in Year 8 and Year 9 should be more similar, to avoid the “jolt” that students currently experience when entering secondary school. Some students felt that they lacked sufficient prior knowledge in mathematics when starting secondary school, or that school transitions unexpectedly highlighted “math gaps”;

- Teachers should re-examine their teaching of algebra (abstract algebraic expressions)—an area of intense fear and frustration for many students.

6.4 Recommendations for Future Research

The multifaceted nature of mathematics anxiety means that the findings from this research study should be treated with caution and presented as corroboration of previous research findings and emergence of some new understandings. Although this study has answered the research questions that provided the basis for this study, it has also prompted further questions. To gain a greater depth of understanding of the adolescent mathematics anxiety phenomenon, the following recommendations are made for future research:

- Collect the data over an extended period of time (in a longitudinal study), to study how mathematics anxiety develops and evolves over time;
- Analyse mediation, moderation and multicollinearity to understand the effect of other variables more precisely;
- Include a more comprehensive range of participants and school types. In particular, to include more Māori, Pasifika, and Asian students, and schools of all decile ratings and school types (e.g., private schools, charter schools, Māori immersion schools, and home-schools). Further, as the schools in this study were located in a rural/provincial region, urban schools should also be included;
- Investigate participants' home-life factors (e.g., level of parental support, second-language difficulties, and socioeconomic advantages/disadvantages such as poverty or wealth);

- Investigate anxiety in other school subjects to see whether it is just an issue with mathematics or more widespread;
- Investigate participants' learning difficulties (e.g., dyscalculia, dysgraphia, dyslexia etc.) and their effects on mathematics anxiety. This would also provide more information on priority learners;
- Conduct action research to implement some of the findings from this study (e.g., by focusing on improving teacher quality, providing alternative forms of or reducing assessment, talking explicitly with students about their feelings towards mathematics, and carefully managing the primary-secondary transition) to see whether these strategies decrease students' mathematics anxiety.

6.5 Final thoughts

Mathematics anxiety is a serious problem on a global scale. This study has shown that in New Zealand, high levels of mathematics anxiety affect one in five secondary school students. Sufferers of mathematics anxiety have revealed that school factors are the main source of the problem. Therefore, schools are the first place to look for solutions. Given the findings of this study, the time is right to begin addressing this debilitating situation.

References

Adimora, D. E., Nwokenna, E. N., Omeje, J. C., & Eze, U. N. (2015). Influence of socioeconomic status and classroom climate on mathematics anxiety of primary school pupils. *Procedia-Social and Behavioral Sciences, 205*, 693-701.

Alison, J. (2005). *Teachers talk about NCEA: Research report on focus groups with secondary teachers – Summary version*. Wellington: PPTA. Retrieved from http://ppta.org.nz/dmsdocument/141

Alton-Lee, A. (2003*). Quality teaching for diverse students in schooling: Best Evidence Synthesis*. Wellington: Ministry of Education.

Anthony, G., & Walshaw, M. (2007). *Effective pedagogy in mathematics/pāngarau: Best Evidence Synthesis Iteration (BES)*. Wellington, New Zealand: Ministry of Education.

Aoina, A. M. (2006). *Ring of confidence: a thesis presented in partial fulfilment of the requirements for the degree of Master of Arts in Psychology at Massey University, Palmerston North, New Zealand*.

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety and performance. *Journal of Experimental Psychology, 130*(2), 224-237.

Ashcraft, M. H., Krause, J. A., & Hopko, D. R. (2007). Is math anxiety a mathematical learning disability? In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children?* (pp. 329-348). Baltimore, MD: Brookes.

Ashcraft, M. H., & Rudig, N. O. (2012). Higher cognition is altered by noncognitive factors: How affect enhances and disrupts mathematics performance in adolescence and young adulthood. In V. F. Reyna, S. B. Chapman, M. R. Dougherty, J. Confrey, V. F. Reyna, S. B. Chapman, ... J. Confrey (Eds.), *The* *adolescent brain: learning, reasoning, and decision making* (pp. 243-263). Washington, DC, US: American Psychological Association.

Attard, C. (2014). “I don’t like it, I don’t love it, but I do it and I don’t mind”: Introducing a framework for engagement with mathematics. *Curriculum Perspectives, 34*(3), 1–14.

Attard, C., Ingram, N., Forgasz, H., Leder, G., & Grootenboer, P. (2016). Mathematics education and the affective domain. In K. Makar, S. Dole, J. Visnovka, M. Goos, A. Bennison & K. Fry (Eds.), *Research in Mathematics Education in Australasia 2012-2015* (pp. 73-96). Singapore: Springer.

Averill, R. (2012). Caring teaching practices in multiethnic mathematics classrooms: Attending to health and well-being. *Mathematics Education Research Journal, 24*(2), 105-128.

Ball, D. L., Goffney, I. M., & Bass, H. (2005). The role of mathematics instruction in building a socially just and diverse democracy. *Mathematics Educator, 15*(1), 2-6.

Ballen, C. J., Salehi, S., & Cotner, S. (2017). Exams disadvantage women in introductory biology. *Plos ONE, 12*(10), 1-14.

Beilock, S. L., & Willingham, D. T. (2014). Math anxiety: Can teachers help students reduce it? Ask the cognitive scientist. *American Educator, 38*(2), 28-32.

Beilock, S. L., Gunderson, E. Al, Ramirez, G., & Levine, S. C. (2010). Female teachers’ math anxiety affects girls’ math achievement. *Proceedings of the National Academy of Sciences of the United States of America, 107*(5), 1860-1863.

Belfi, B., Goos, M., De Fraine, B., & Van Damme, J. (2012). The effect of class composition by gender and ability on secondary school students' school wellbeing and academic self-concept: A literature review. *Educational Research Review, 7*(1), 62-74.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*(5), 441-448.

Biddle, B., Good, T., & Goodson, I. (Eds.). (1997). *International handbook of teachers and teaching.* Vol. 2. Dordrecht: Kluwer Academic Publishers.

Bieg, M, Goetz, T, Wolter, I., & Hall, N. C. (2015). Gender stereotype endorsement differentially predicts girls' and boys' trait-state discrepancy in math anxiety. *Frontiers in Psychology, 6*: 1404.

Bigler, R. S., & Eliot, L. (2011). *The feminist case against single-sex schools.* Retrieved from http://www.slate.com/articles/double_x/doublex/2011/10/the_single_sex_school_myth_an_overwhelming_body_of_research_show.html

Bishop, R., Berryman, M., & Richardson, C. (2002). Te Toi Huarewa: Effective teaching and learning in total immersion Māori language educational settings. *Canadian Journal of Native Education, 26*(1), 44-61.

Boaler, J. (1997). Reclaiming school mathematics: The girls fight back. *Gender and Education, 9*(3), 285-305.

Boaler, J. (2002). The development of disciplinary relationships: Knowledge, practice and identity in mathematics classrooms. *For the Learning of Mathematics, 22*(1), 42-47.

Boaler, J. (2014). Research suggests that timed tests cause math anxiety. *Teaching Children Mathematics, 20*(8), 469-474.

Bonne, L. (2016). *National standards in their seventh year: Findings from the NZCER National survey of primary and intermediate schools 2016*. Wellington: NZCER.

Bryk, A. S., Lee, V. E., & Holland, P. B. (1984). *Effective Catholic schools: An exploration with a special focus on Catholic secondary schools.* Washington: National Catholic Educational Association.

Buckley, A. P. (2015). Using sequential mixed methods in enterprise policy evaluation: A pragmatic design choice? *Electronic Journal of Business Research Methods, 13*(1), 16-26.

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-Term Memory, Working Memory, and Executive Functioning in Preschoolers: Longitudinal Predictors of Mathematical Achievement at Age 7 Years. *Developmental Neuropsychology, 33*(3), 205-228.

Butin, D. W. (2010). *The education dissertation: A guide for practitioner scholars*. Thousand Oaks, California: Corwin.

Buunk, A. P., & Dijkstra, P. (2014). Social comparison orientation and perspective taking as related to responses to a victim. *Psychology, 5*, 441–450.

Catsambis, S. (1994). The path to math: Gender and racial-ethnic differences in mathematics participation from middle school to high school. *Sociology of Education, 67*(3), 199-215.

Cemen, P. B. (1987)*. The nature of mathematics anxiety*. (Report No. SE 048 689). Stillwater, OK: Oklahoma State University. (ERIC Document No. ED287729.).

Chaman, M., & Callingham, R. (2013). Relationship between mathematics anxiety and attitude towards mathematics of Indian students. In V. Steinle, L. Ball, & C. Vardini (Eds.), *Proceedings of the 36th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 138-145). Melbourne: MERGA.

Chin, E. C., Williams, M. W., Taylor, J. E., & Harvey, S. T. (2017). The influence of negative affect on test anxiety and academic performance: An examination of the tripartite model of emotions. *Learning and Individual Differences, 54*, 1-8.

Cipora, K., Szczygieł, M., Willmes, K., & Nuerk, H.-C. (2015). Math anxiety assessment with the Abbreviated Math Anxiety Scale: Applicability and usefulness: Insights from the Polish adaptation. *Frontiers in Psychology, 6*:1833.

Cole, M. (1996). Cultural Psychology. Cambridge Mass: The Belknap Press of Harvard University Press.

Cook, S. B., Scruggs, T. E., Mastropieri, M. A., & Casto, G. C. (1985). Handicapped students as tutors. *Journal of Special Education, 19(*4), 483-492.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Los Angeles, CA: SAGE.

Creswell, J. W., & Tashakkori, A. (2007). Developing publishable mixed methods manuscripts. *Journal of Mixed Methods Research, 1*(2), 107-111.

Damarin, S., & Erchick, D. B. (2010). Toward clarifying the meanings of gender in mathematics education research. *Journal for Research in Mathematics Education, 41*(4), 310-323.

Darling-Hammond, L. (1998). Teachers and teaching: Testing policy hypotheses from a National Commission report. *Educational Researcher, 27*(1), 5-15.

Dattalo, P. (2008). *Determining sample size: Balancing power, precision, and practicality*. Oxford; New York: Oxford University Press.

Dee, T. S. (2007). Teachers and the gender gaps in student achievement. *The Journal of Human Resources, 42*(3), 528-554.

Dodd, A.W. (1992). Insights from a math phobic. *Mathematics Teacher, 85*(4), 296-298.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology, 7*, 1-16.

Dunkin, M., & Biddle, B. (1974). *The study of teaching*. New York: Holt, Rinehart and Winston.

Durie, M. (1998). *Whaiora: Māori health development* (2nd ed.) Auckland: Oxford University Press.

Eccles, J. S. (2004). Schools, academic motivation, and stage-environment fit. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (2nd ed., pp. 125-154). Hoboken, NJ: Wiley.

Eccles, J. S., Lord, S., & Midgley, C. (1991). What are we doing to early adolescents? The impact of educational contexts on early adolescents. *American Journal of Education, 99*(4), 521-542.

Eden, C., Heine, A., & Jacobs, A. (2013). Mathematics anxiety and its development in the course of formal schooling—A review. *Psychology, 4(*6), 27–35.

Education Review Office (ERO). (2013). *Accelerating the Progress of Priority Learners in Primary Schools.* Wellington, New Zealand: Education Review Office.

Education Review Office (ERO). (2015). *Wellbeing for Young People's Success at Secondary School.* Wellington, New Zealand: Education Review Office.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen & R-L. Punamäki (Eds.) *Perspectives on activity theory* (pp. 19–39). New York: Cambridge University Press.

Engle, R. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*(1), 19-23.

Farrell, E. F. (2006). Taking anxiety out of the equation. *Chronicle of Higher Education, 52*(19), 41-42.

Federici, R. A., & Skaalvik, E. M. (2014). Students' perceptions of emotional and instrumental teacher support: Relations with motivational and emotional responses. *International Education Studies, 7*(1), 21-36.

Field, A. P. (2016). *An adventure in statistics: The reality enigma*. London; Thousand Oaks, CA: SAGE Publications.

Fletcher, C., Lovatt, C., & Baldry, C. (1997). A study of state, trait, and test anxiety, and their relationship to assessment center performance. *Journal of Social Behavior and Personality, 12*(5), 205-214.

Forsey, M. (2012). Interviewing individuals. In S. Delamont (Ed.), *Handbook of Qualitative Research in Education* (pp. 364-376). Cheltenham, UK and Northampton, MA: Edward Elgar.

Fraser Webb, J. (2013). *Driving force?: motivations of senior mathematics students enrolled in National Certificate of Educational Achievement (NCEA) Level III Statistics & Modelling: a thesis presented in partial fulfilment of the requirements for the degree of Master of Education, Massey University, Palmerston North, New Zealand.*

Freedman, S. G. (2005, April 27). Where popular science is called women's work. *The New York Times*. p. 7. Retrieved from http://www.nytimes.com/2005/04/27/nyregion/where-popular-science-is-called-womens-work.html

Friedman, I. A., & Bendas-Jacob, O. (1997). Measuring perceived test anxiety in adolescents: A self-report scale. *Educational and Psychological Measurement*, *57*(6), 1035-1046.

Garden, R., Wagemaker, H., & Mooney, C. (1987). Explaining mathematics achievement. In A. Binns, D. Carpenter, R. Elliffe, J. Irving, & N. McBride (Eds.), *Mathematics achievement in New Zealand secondary schools*. Wellington, New Zealand: Department of Education.

Gibb, S., Fergusson, D., & Horwood, L. (2008). Effects of single-sex and coeducational schooling on the gender gap in educational achievement. *Australian Journal of Education, 52*(3), 301-317.

Gibbons, F. X., & Buunk, B. P. (1999). Individual differences in social comparison: Development and validation of a measure of social comparison orientation. *Journal of Personality and Social Psychology, 76,* 129–142.

Gibson, J. E. (2012). Interviews and focus groups with children: Methods that match children's developing competencies. *Journal of Family Theory and Review, 4*(2), 148-159.

Goetz, T., Bieg, M., Lüdtke, O., Pekrun, R., & Hall, N. (2013). Do girls really experience more anxiety in mathematics? *Psychological Science, 24*(10), 2079-2087.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*(3), 255-274.

Gregor, A. (2005). Examination anxiety - Live with it, control it or make it work for you? *School Psychology International, 26*(5), 617-635.

Grills-Taquechel, A. E., Norton, P., & Ollendick, T. H. (2010). A longitudinal examination of factors predicting anxiety during the transition to middle school. *Anxiety, Stress & Coping, 23*, 493–513.

Grootenboer, P. (2003, July). *The affective views of primary school children.* Paper presented at the 27th International Group for the Psychology of Mathematics Education Conference held jointly with the 25th PME-NA Conference, Honolulu, Hawaii.

Grootenboer, P., & Marshman, M. (2016). *Mathematics, affect and learning: Middle school students' beliefs and attitudes about mathematics education*. Singapore; New York: Springer.

Gutiérrez, R. (2013). The socio-political turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37-68.

Gyuris, E., & Everingham, Y. (2011). Maths anxiety over two campuses in a first year introductory quantitative skills subject at a regional Australian university – Establishing a baseline. In M. Sharma, A. Yeung, T. Jenkins, E. Johnson, G. Rayner, & J. West (Eds.), *Proceedings of The Australian Conference on Science and Mathematics Education* (pp. 73-80). Australia: UniServe Science.

Hart, L. C. (2015). Benefits beyond achievement? A comparison of academic attitudes and school satisfaction for adolescent girls in single-gender and coeducational classrooms. *Middle Grades Research Journal*, *10*(2), 33-48.

Harter, S. (2006). The self. In W. Damon, R. M. Lerner, & N. Eisenberg (Eds.), *Handbook of child psychology* (Vol. 3, 6th ed., pp. 505–570). Hoboken, NJ: Wiley.

Hartley, S. S. (1977). *Meta-analysis of the effects of individually paced instruction in mathematics.* Unpublished Ph.D., University of Colorado at Boulder, CO.

Hattie, J. (2003, February). *New Zealand education snapshot: With specific reference to the yrs 1–13 years*. Presentation at Knowledge Wave 2003 – the Leadership Forum. Auckland, New Zealand.

Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* London; New York: Routledge.

Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Research, 58*, 47-77.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46.

Heyd-Metzuynanim, E. (2013). The co-construction of learning difficulties in mathematics teacher-student interactions and their role in the development of a disabled mathematics identity. *Educational Studies in Mathematics, 83*(3), 341-368.

Hodgen, J. & Marks, R. (2009). Mathematical ‘ability’ and identity: A sociocultural perspective on assessment and selection. In L. Black, H. Mendick, & Y. Solomon (Eds.), Mathematical relationships in education: Identities and participation (pp. 31-42). New York: Routledge.

Hoffman, B. (2010). “I think I can, but I’m afraid to try”: The role of self-efficacy beliefs and mathematics anxiety in mathematics problem-solving efficiency. *Learning and Individual Differences, 20*, 276-283.

Hogan, J. (2017). Thoughts on teaching and learning of mathematics: What is your main vine, and lesson #2 [Web log message]. Retrieved from http://schools.reap.org.nz/advisor/Teaching%20Maths%20Book/TEACHING%20MATHS%20Lesson%202.html

Hogan, D., Chan, M., Rahim, R., Kwek, D., Aye, K. M., Loo, S. K., … Luo, W. (2013). Assessment and the logic of instructional practice in Secondary 3 English and mathematics classrooms in Singapore. *Review of Education, 1*(1), 57-106.

Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). The Abbreviated Math Anxiety Scale (AMAS): Construction, validity, and reliability. *Assessment, 10*(2), 78-182.

Horowitz, J. A., Vessey, J. A., Carlson, K. L., Bradley, J. F., Montoya, C., & McCullough, B. (2003). Conducting school-based focus groups: Lessons learned from the CATS project. *Journal of Pediatric Nursing, 18*, 321-331.

Hoy, A. W., Demerath, P., & Pape, S. (2001). Teaching adolescents: Engaging developing selves. In T. Urdan & F. Pajares (Eds.), *Adolescence and education: General issues in the education of adolescence* (pp. 119-161). Greenwich, CT: Information Age.

Hunter, J., Hunter, R., Bills, T., Cheung, I., Hannant, B., Kritesh, K., & Lachaiya, R. (2016a). Developing equity for Pāsifika learners within a New Zealand context: Attending to culture and values. *New Zealand Journal of Educational Studies, 51*(2), 197-209.

Hunter, R., Hunter, J., Bills, T., & Thompson, Z. (2016b, July). *Learning by Leading: Dynamic mentoring to support culturally responsive mathematical inquiry communities.* Paper presented at the 39th Annual Mathematics Education Research Group of Australasia (MERGA) Conference, Adelaide, South Australia.

Jennison, M., & Beswick, K. (2010, July). *Student attitude, student understanding and mathematics anxiety.* Paper presented at the 33rd Annual Mathematics Education

Research Group of Australasia (MERGA) Conference, Freemantle, Western Australia

Jensen, A., Pond, A., & Padilla-Walker, L. (2015). Why can't I be more like my brother? The role and correlates of sibling social comparison orientation. *Journal of Youth and Adolescence, 44*(11), 2067-2078.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Kalaycioglu, D. B. (2015). The influence of socioeconomic status, self-efficacy, and anxiety on mathematics achievement in England, Greece, Hong Kong, the Netherlands, Turkey, and the USA. *Educational Sciences: Theory and Practice, 15*(5), 1391-1401.

Kumar, R. (2006). Students' experiences of home–school dissonance: The role of school academic culture and perceptions of classroom goal structures. *Contemporary Educational Psychology, 31*, 253−279.

Kuyper, H., Dijkstra, P., Buunk, A. P., & van der Werf, M. P. (2011). Social comparisons in the classroom: An investigation of the better than average effect among secondary school children. *Journal of School Psychology, 49*, 25-53.

Latzman, R., Elkovitch, N., Young, J., & Clark, L. (2010). The contribution of executive functioning to academic achievement among male adolescents. *Journal of Clinical and Experimental Neuropsychology, 32*(5), 455-462.

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and Individual Differences, 19*(3), 355-365.

Leyva, L. A. (2017). Unpacking the male superiority myth and masculinization of mathematics at the intersections: A review of research on gender in mathematics education. *Journal for Research in Mathematics Education, 48*(4), 397-433.

Libresco, L. (2015, July 22). Girls are rare at the International Math Olympiad. *FiveThirtyEight.* Retrieved from https://fivethirtyeight.com/datalab/girls-are-rare-at-the international-math-olympiad/

Liebert, R. M., & Morris, L. W. (1967). Cognitive and emotional components of test anxiety: A distinction and some initial data. *Psychological Reports, 20*, 975-978.

Lim, S. Y., & Chapman, E. (2013). Development of a short form of the Attitudes Toward Mathematics Inventory. *Educational Studies in Mathematics: An International Journal, 82*(1), 145-164.

Liu, W. C., Wang, C. K., & Parkins, E. J. (2005). A longitudinal study of students' academic self-concept in a streamed setting: The Singapore context. *British Journal of Educational Psychology, 75*, 567–586.

Lomas, G., Grootenboer, P., & Attard, C. (2012). The affective domain and mathematics education. In B. Perry, T. Lowrie, T. Logan, A. MacDonald, and J. Greenlees (Eds.), *Research in Mathematics Education in Australasia 2008-2011* (pp. 23-38). Rotterdam: Sense Publishers.

Lowe, P. A., Lee, S. W., Witteborg, K. M., Pritchard, K. W., Luhr, M. E., Cullinan, C. M., … Janik, M. (2008). The test anxiety inventory for children and adolescents (TAICA): Examination of the psychometric properties of a new multidimensional measure of test anxiety among elementary and secondary school students. *Journal of Psychoeducational Assessment, 26*, 215-230.

Lubienski, S. T. (2002, April). *Are we achieving "mathematical power for all?" A decade of national data on instruction and achievement*. Paper presented at the

Annual Meeting of the American Educational Research Association, New Orleans, LA.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*(5), 520-540.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education, 28*(1), 26-47.

Marks, G. (2015). Are school-SES effects statistical artefacts? Evidence from longitudinal population data. *Oxford Review of Education, 41*(1), 122-144.

Marsh, H. W. (1991). Public, Catholic single-sex, and Catholic coeducational high schools: Their effects on achievement, affect, and behaviors. *American Journal of Education, 99*(3), 320-356.

Massey University. (2015). *Code of ethical conduct for research, teaching and evaluations involving human participants.* Retrieved from http://www.massey.ac.nz/massey/fms/Human%20Ethics/Documents/MUHEC%20Code%202015.pdf?497309B983F78ECC2490A4A377F5CBAD

McConney, A., & Perry, L. B. (2010). Socioeconomic status, self-efficacy, and mathematics achievement in Australia: A secondary analysis. *Educational Research for Policy and Practice, 9*(2), 77-91.

McKenzie, P., Weldon, P., Rowley, G., Murphy, M., & McMillan, J. (2014). *Staff in Australian Schools 2013: Main report on the survey.* Camberwell, VIC: Australian Council for Educational Research.

Mead, S. M., & Grove, N. (2001). *Ngā pēpeha a ngā tīpuna = The sayings of the ancestors*. Wellington, New Zealand: Victoria University Press.

Meaney, T., Edmonds-Wathen, C., McMurchy-Pilkington, C., & Trinick, T. (2016). Distribution, recognition and representation: Mathematics education and Indigenous students. In K. Makar, S. Dole, J. Visnovka, M. Goos, A. Bennison & K. Fry (Eds.), *Research in Mathematics Education in Australasia 2012-2015* (pp. 143-164). Singapore: Springer.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*(1), 60-70.

Mendick, H. (2006). *Masculinities in mathematics*. Maidenhead: Open University Press.

Midgley, C., Feldlaufer, H., & Eccles, J. S. (1989). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *Journal of Educational Psychology, 81*(2), 247–258.

Ministry of Education. (2007). *The New Zealand Curriculum*. Wellington: Learning Media.

Morgan, D. L. (1988). *Focus groups as qualitative research*. Newbury Park, CA: SAGE.

Muijs, D., & Reynolds, D. (2001). *Effective teaching: Evidence and practice*. London: Paul Chapman Publishing.

Neighbour, M. (2000). *Developing an understanding of transient pupils.* Whangarei, New Zealand: ASB/APPA Travelling Fellowship Trust.

Ng, L. J. (2012). Mathematics anxiety in secondary school students. In L. Dindyal, P. Cheng, & S. F. Ng (Eds.), *Proceedings of the 35th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 570-577). Singapore: MERGA.

Noble, T., McGrath, H., Roffey, S., & Rowling, L. (2008). *A scoping study on student wellbeing.* Canberra: Department of Education, Employment and Workplace Relations (DEEWR).

OECD. (2013a). *PISA 2012 Results: Ready to Learn: Students' Engagement, Drive and Self beliefs (Volume III).* Paris: OECD Publishing.

OECD. (2013b). *PISA 2012 Assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy*. Paris: OECD Publishing.

OECD. (2017). *PISA 2015 Results: Students' Well-Being* (*Volume III).* Paris: OECD Publishing.

Patterson, M. M., & Pahlke, E. (2011). Student characteristics associated with girls' success in a single-sex school. *Sex Roles: A Journal of Research, 65*(9-10), 737–750.

Primi, C., Busdraghi, C., Tomasetto, C., Morsanyi, K., & Chiesi, F. (2014). Measuring math anxiety in Italian college and high school students: Validity, reliability and gender in variance of the Abbreviated Math Anxiety Scale (AMAS). *Learning and Individual Differences, 34*, 51–56.

Punch, K., & Oancea, A. (2014). *Introduction to Research Methods in Education* (2nd ed.). Thousand Oaks, CA: SAGE.

Putwain, D. W., Daly, A. L., Chamberlain, S., & Sadreddini, S. (2015). Academically buoyant students are less anxious about and perform better in high-stakes examinations. *British Journal of Educational Psychology, 85*(3), 247-263.

Ramirez, G., Gunderson, E., Levine, S., & Beilock, S. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development*, *14*(2), 187-202.

Resnick, H., Viehe, J., & Segal, S. (1982). Is math anxiety a local phenomenon? A study of prevalence and dimensionality. *Journal of Counseling Psychology, 29*(1), 39-47.

Richardson, F. C., & Suinn, R. M. (1972). Mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*, 551-554.

Roth, W.-M., & Radford, L. (2011). *A cultural-historical perspective on mathematics teaching and learning.* Rotterdam, The Netherlands: Sense Publishers.

Roth, W. M., & Walshaw, M. (2015). Rethinking affect in education from a societal historical perspective: The case of mathematics anxiety. *Mind, Culture, and Activity, 22*(3), 217-232.

Ryan, A., & Pintrich, P. R. (1998). Achievement and social motivational influences on help seeking in the classroom. In S. A. Karabenick (Ed.), *Strategic help seeking: Implications for learning and teaching* (pp. 117−139). Mahwah, NJ: Erlbaum.

Ryan, A.M., Sungok, S. S., & Makara, K. A. (2013). Changes in academic adjustment and relational self-worth across the transition to middle school. *Journal of Youth and Adolescence, 42*(9), 1372–1384.

Schachter, D. L. (1996). *Searching for memory: The brain, the mind, and the past*. New York: Basic Books.

Scheerens, J, Vermeulen, C., & Pelgrum, W.J. (1989). Generalizability of instructional and school effectiveness indicators across nations. *International Journal of Educational Research, 13*(7), 789-799.

Schwartz, L. (2000). *A Mathematician Grappling with His Century*. Basel; Boston: Birkhäuser.

Sepie, A. C., & Keeling, B. (1978). The relationship between types of anxiety and under achievement in mathematics. *Journal of Educational Research, 72*(1), 15-19.

Serow, P., Callingham, R., & Tout, D. (2016). Assessment of mathematics learning: What are we doing? In K. Makar, S. Dole, J. Visnovka, M. Goos, A. Bennison & K. Fry (Eds.), *Research in Mathematics Education in Australasia 2012-2015* (pp. 235-254). Singapore: Springer.

Siber, E. M. (2003). *Isolating students with mathematical learning difficulties for teaching purposes: The New Zealand experiences: A thesis presented in partial fulfilment of the requirements for the degree of Master of Education at Massey University*. Retrieved from https://mro.massey.ac.nz/handle/10179/7247

Skourdoumbis, A. (2012). Teach for Australia (TFA): Can it overcome educational disadvantage? *Asia Pacific Journal of Education, 32*(3), 305-315.

Song, S., Perry, L., & McConney, A. (2014). Explaining the achievement gap between Indigenous and non-Indigenous students: An analysis of PISA 2009 results for Australia and New Zealand. *Educational Research and Evaluation: An International Journal on Theory and Practice, 20*(3), 178-198.

Stevenson, H. W., Lee, S., Chen, C., Lummis, M., Stigler, J., Fan, L., & Ge, F. (1990). Mathematics achievement of children in China and the United States. *Child Development, 61,* 1053–1066.

Stodolsky, S. S. (1985). Telling math: Origins of math aversion and anxiety. *Educational Psychologist, 20*, 125-133.

Stoet, G., Bailey, D. H., Moore, A. M., & Geary, D. C. (2016). Countries with higher levels of gender equality show larger national sex differences in mathematics anxiety and relatively lower parental mathematics valuation for girls. *Plos ONE, 11*(4), 1-24.

Strobino, J., & Salvaterra, M. (2000). School transitions among adolescent children of military personnel: A strengths perspective. *Social Work in Education, 22*(2), 95-107.

Tashakkori, A., & Creswell, J. W. (2007). The new era of mixed methods. *Journal of Mixed Methods Research, 1*(1), 3-7.

Tertiary Education Commission. (2015). *Literacy and Numeracy Implementation Strategy 2015-2019.* Wellington, New Zealand: Author.

Thompson, C. P., Skowronski, J. J., Larsen, S. F., & Betz, A. L. (Eds.). (1996). *Autobiographical memory: Remembering what and remembering when*. Mahwah, NJ: Erlbaum.

Thomson, S., De Bertoli, L., & Buckley, S. (2013). *PISA: How Australia measures up? The PISA 2012 assessment of students' mathematical, scientific and reading literacy*. Camberwell, VIC: ACER.

Tobias, S. (1985). Test anxiety: Interference, defective skills, and cognitive capacity. *Educational Psychologist, 20*, 135-142.

Townsend, M. A. R., Moore, D. W., Tuck, B. F., & Wilton, K. M. (1998). Self-concept and anxiety in university students studying social science statistics within a co-operative learning structure. *Educational Psychology, 18*(1), 41-54.

Turner, H., Rubie-Davis, C., & Webber, M. (2015). Teacher expectations, ethnicity and the achievement gap. *New Zealand Journal of Educational Studies, 50*(1), 55-69.

UIL (UNESCO Institute for Lifelong Learning). (2017). *Literacy and Numeracy from a Lifelong Learning Perspective*. Hamburg, Germany: UIL.

UNESCO. (2015). A complex formula: Girls and women in Science, Technology, Engineering and Mathematics in Asia. *Asian Biotechnology & Development Review, 17*(1), 43-61.

Vahedi, S., & Farrokhi, F. (2011). A confirmatory factor analysis of the structure of abbreviated math anxiety scale. *Iranian Journal of Psychiatry, 6*(2), 47-53.

Vale, C., Atweh, B. Averill, R. & Skourdoumbis, A. (2016). Equity, social justice and ethics in mathematics education. In K. Makar, S. Dole, J. Visnovka, M. Goos, A. Bennison & K. Fry (Eds.), *Research in Mathematics Education in Australasia 2012-2015* (pp. 97-118). Singapore: Springer.

White, K. R. (1982). The relation between socioeconomic status and academic achievement. *Psychological Bulletin, 91*(3), 461-481.

Whyte, J., & Anthony, G. (2012). Maths anxiety: The fear factor in the mathematics classroom. *New Zealand Journal of Teachers' Work, 9*(1), 6-15.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210-216.

Wigfield, A., Eccles, J. S., MacIver, D., Reuman, D. A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology, 27*(4), 552-565.

Winbourne, P. (2009). Parents, teachers, children, and ability grouping in mathematics. In L. Black, H. Mendick, & Y. Solomon (Eds.), Mathematical relationships in education: Identities and participation (pp. 58-70). New York: Routledge.

Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin, 76,* 92-104.

Winheller, S., Hattie, J. A., & Brown, G. T. L. (2013). Factors influencing early adolescents' mathematics achievement: High-quality teaching rather than relationships. *Learning Environments Research, 16*(1), 49-69.

Zeidner, M. (1998). *Test Anxiety: The State of the Art.* New York, NY: Kluwer.

Appendix A: Ethics Notification

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Date: 24 June 2016

Dear Lee Mann

Re: Ethics Notification - **SOB 16/16 - Unpacking mathematics anxiety in year 9 students.**

Thank you for the above application that was considered by the Massey University Human Ethics Committee: **Human Ethics Southern B Committee** at their meeting held on **Thursday, 23 June, 2016**.

Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

B J Finch

Dr Brian Finch
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Appendix B: Information and Consent Forms

B1: Principal Information Sheet

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

[Date]

Dear [Name of principal],

My name is Lee Mann. I am a mathematics teacher in the [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project is to examine and explore the extent of mathematics anxiety in year 9 students in the [redacted] region.

'Mathematics anxiety' means bad feelings to do with mathematics, for example: fear, tension, worry, nervousness, negativity, stress. There have been many research studies completed globally in the field of mathematics anxiety. It is an important area to research and has implications for all people in their daily lives and futures. However, many of the research studies have been completed overseas, the majority of which have been conducted with university students or pre-service teachers. However, research has suggested that year 9 is the time in which mathematics anxiety peaks. Therefore, there is currently a gap for a study of mathematics anxiety in New Zealand young adolescents. This work will be an important indicator of the levels of mathematics anxiety in year 9 students and may prompt more research into the area, and/or begin a conversation in schools, classrooms, homes and communities. Hopefully this research will illuminate the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

Project Description and Invitation

The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted].
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.
- Provide a deeper understanding of year 9 students' mathematics anxiety from understandings that emerge from the data.

The first phase will utilise a survey, and the second phase will consist of group interviews.

I invite all of your year 9 students (in 2016) to participate in the survey. My aim is to survey as many year 9 students in the [redacted] as possible, from a range of different schools.

Based on the results, I will then select and invite small groups of students to participate in group interviews. This may or may not involve your school, depending on which students are selected.

Organisation

I will endeavour to come to your school to make the initial approach to students and to explain the research project. If this is not possible, I will enlist the support of the HOD Maths.

The survey will be completed online at school (or in paper form if that is easier). This should take no more than 20 minutes. My hope is to have the survey completed by the end of term 3, 2016.

After the preliminary analysis of the survey has been completed, I may select approximately five students from your school to participate in the follow-up group interview. I will conduct this interview, and will sound record it for future transcription. If possible, the school guidance counsellor would be present as an observer. S/he would need to sign a Confidentiality Agreement.

ESOL students may request assistance from relevant staff within the school.

This research project would require the use of some class time and classrooms:

- If practicable for all, a suitable time and space for me to come in and talk with students about the research project (perhaps at a year 9 assembly or similar);
- 20 minutes of class time (on computers) for students to complete the survey;
- One hour of class time (in a meeting room or similar) to conduct a group interview with selected students (if students are selected from your school).

This research project would also require ongoing support, communication and organisation from your HOD Maths and teachers.

Sample Questions - Survey

Please choose the number that most closely corresponds to how each statement best describes your feelings: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), 5 (strongly agree).

- *I have usually enjoyed studying mathematics in school.*
- *It makes me nervous to even think about having to do a mathematics problem.*

Sample Questions – Group Interview

- *At what age/year did you first begin to worry about maths?*
- *What could teachers/school/friends/parents/you do to help you worry less about maths?*

Data Management

The data collected will be analysed according to the different factors and influences students report as having an effect on their mathematics anxiety. To preserve confidentiality of identity, each student will be given a unique code, only accessible by the researcher and the supervisors. Schools, teachers and students will not be identifiable.

The data will be used solely for the completion of a Masters of Education thesis. A summary of the research findings will be presented to the Board of Trustees for discussion amongst your school community, and will be made available to any participant on request. Following the conclusion of the research project, the supervisor (Professor Margaret Walshaw) will hold all data (electronic and hard copy) for five years.

Participant's Rights

You and your students are under no obligation to accept this invitation. If you and your students decide to participate, you and your students will have the right to:

- decline to answer any particular question;
- withdraw from the study;
- ask any questions about the study at any time during participation;
- be given access to a summary of the project findings when it is concluded.

Consent

Students and parents will be provided with information sheets. I will consult with you further about your preference for parental consent ('opt-in' or 'opt-out' consent).

I request permission from you to:

- enter the school for research purposes; and
- conduct the research study with students, in liaison with the HOD Maths and teachers.

Project Contacts

Researcher: Lee Mann
Mobile: [redacted]
Email: [redacted]

Supervisor: Professor Margaret Walshaw
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Co-Supervisor: Raewyn Eden
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Please contact the researcher and/or supervisor(s) if you have any questions or feedback about the project.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 16/16. If you have any concerns about the conduct of this research, please contact Dr Rochelle Stewart-Withers, Chair, Massey University Human Ethics Committee: Southern B, telephone [redacted], email [redacted]

Thank you for your time in considering this research project. I look forward to hearing back from you.

Lee Mann

B2: Principal Consent Form

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

PRINCIPAL/B.O.T. CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree for this school and its students to participate in this study under the conditions set out in the Information Sheet.

I agree for the researcher to enter the school for research purposes.

I agree to the group interview being sound recorded, should a group interview be held in this school.

Signature: .... **Date:** ....

Full Name - printed ....

Position: ....

B3: Student Information Sheet (Survey)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

STUDENT INFORMATION SHEET

Survey

Researcher Introduction

My name is Lee Mann. I am a mathematics teacher in the [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project will examine and explore the extent and experiences of mathematics anxiety in year 9 students in the [redacted] region. It is intended to show the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

'Mathematics anxiety' means bad feelings to do with mathematics, for example: fear, tension, worry, nervousness, negativity, stress.

Project Description and Invitation

The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted].
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.

The first phase will use a survey, and the second phase will consist of group interviews.

I invite you as a year 9 (in 2016) student in the [redacted] to participate in the **survey**.

The survey will be completed online at school (or in paper form if that is easier). This should take no more than 20 minutes.

ESOL students may request assistance from relevant staff within the school.

Sample Questions - Survey

Please choose the number that most closely corresponds to how each statement best describes your feelings: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), 5 (strongly agree).

- *I have usually enjoyed studying mathematics in school.*
- *It makes me nervous to even think about having to do a mathematics problem.*

Data Management

To preserve the confidentiality of your identity, you will be given a unique code, only accessible by me and the supervisors. Your information will be used solely for the completion of a Masters of Education thesis. A summary of the research findings will be presented to your school and will be made available to you on request.

Following the conclusion of the research project, the supervisor (Professor Margaret Walshaw) will hold all data (electronic and hard copy) for five years.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- not answer any particular question;
- withdraw from the study;
- ask any questions about the study at any time during participation;
- be given access to a summary of the project findings when it is concluded.

If you complete of the survey, it will imply your consent to participate.

Project Contacts

Researcher: Lee Mann
Mobile: [redacted]
Email: [redacted]

Supervisor: Professor Margaret Walshaw
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Co-Supervisor: Raewyn Eden
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Please contact the researcher and/or supervisor(s) if you have any questions or feedback about the project.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 16/16. If you have any concerns about the conduct of this research, please contact Dr Rochelle Stewart-Withers, Chair, Massey University Human Ethics Committee: Southern B, telephone [redacted], email [redacted]

Regards,
Lee Mann

B4: Parent Information Sheet (Survey)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

PARENT INFORMATION SHEET

Survey

Researcher Introduction
My name is Lee Mann. I am a mathematics teacher in the [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project is to examine and explore the extent of mathematics anxiety in year 9 students in the [redacted] region. 'Mathematics anxiety' means bad feelings to do with mathematics, for example: fear, tension, worry, nervousness, negativity, stress.

There have been many research studies completed globally in the field of mathematics anxiety. It is an important area to research and has implications for all people in their daily lives and futures. However, many of the research studies have been completed overseas, the majority of which have been conducted with university students or pre-service teachers. However, research has suggested that year 9 is the time in which mathematics anxiety peaks. Therefore, there is currently a gap for a study of mathematics anxiety in New Zealand young adolescents. This work will be an important indicator of the levels of mathematics anxiety in year 9 students and may prompt more research into the area, and/or begin a conversation in schools, classrooms, homes and communities. Hopefully this research will illuminate the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

Project Description and Invitation
The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted].
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.
- Provide a deeper understanding of year 9 students' mathematics anxiety from understandings that emerge from the data.

My aim is to survey as many year 9 students in the [redacted] as possible, from a range of different schools. Based on the results, I will then select and invite small groups of students to participate in group interviews.

I invite your child as a year 9 (in 2016) student in the [redacted] to participate in the **survey**.

The survey will be completed online at school (or in paper form if that is easier). This should take no more than 20 minutes.

Sample Questions
Please choose the number that most closely corresponds to how each statement best describes your feelings: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), 5 (strongly agree).

- *I have usually enjoyed studying mathematics in school.*
- *It makes me nervous to even think about having to do a mathematics problem.*

Data Management
The data collected will be analysed according to the different factors and influences students report as having an effect on their mathematics anxiety. To preserve confidentiality of identity, each student will be given a unique code, only accessible by the researcher and the supervisors.

The data will be used solely for the completion of a Masters of Education thesis. A summary of the research findings will be presented to the Board of Trustees and will be made available to any participant on request. Following the conclusion of the research project, the supervisor (Professor Margaret Walshaw) will hold all data (electronic and hard copy) for five years.

Participant's Rights
You and your child are under no obligation to accept this invitation. If you and your child decide to participate, you and your child will have the right to:

- decline to answer any particular question;
- withdraw from the study;
- ask any questions about the study at any time during participation;
- be given access to a summary of the project findings when it is concluded.

Consent
Your child has been given a Student Information Sheet about survey.

If I do not hear from you otherwise, it implies your consent for your child to participate in the survey.

Completion of the survey by your child will imply his/her consent to participate.

Project Contacts

Researcher: Lee Mann
Mobile: [redacted]
Email: [redacted]

Supervisor: Professor Margaret Walshaw
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Co-Supervisor: Raewyn Eden
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Please contact the researcher and/or supervisor(s) if you have any questions or feedback about the project.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 16/16. If you have any concerns about the conduct of this research, please contact Dr Rochelle Stewart-Withers, Chair, Massey University Human Ethics Committee: Southern B, telephone [redacted], email [redacted]

Regards,
Lee Mann

B5: Student Information Sheet (Interview)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

STUDENT INFORMATION SHEET

Group Interview

Researcher Introduction

My name is Lee Mann. I am a mathematics teacher in the [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project will examine and explore the extent and experiences of mathematics anxiety in year 9 students in the [redacted] region. It is intended to show the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

'Mathematics anxiety' means bad feelings to do with mathematics, for example: fear, tension, worry, nervousness, negativity, stress.

Project Description and Invitation

The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted].
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.

The first phase will use a survey, and the second phase will consist of group interviews.

I invite you as a year 9 (in 2016) student in the [redacted] to participate in a **group interview**.

The group interview will take place at your school, in class time.
The group interview will also involve about four other year 9 students from your school.
The group interview should take approximately one hour to complete.
The group interview will be sound recorded so that what is said can be typed up later on.

Sample Questions

- *At what age/year did you first begin to worry about maths?*
- *What could teachers/school/friends/parents/you do to help you worry less about maths?*

Data Management

To preserve the confidentiality of your identity, you will be given a unique code, only accessible by me and the supervisors. Your information will be used solely for the completion of a Masters of Education thesis.

You will have the option to receive the transcript (the typed document of what is said) to check that what you have said has been written correctly.

A summary of the research findings will be presented to your school and will be made available to you on request.

Following the conclusion of the research project, the supervisor (Professor Margaret Walshaw) will hold all data (electronic and hard copy) for five years.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- not answer any particular question;
- withdraw from the study;
- ask any questions about the study at any time during participation;
- be given access to a summary of the project findings when it is concluded.

Project Contacts

Researcher: Lee Mann
Mobile: [redacted]
Email: [redacted]

Supervisor: Professor Margaret Walshaw
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Co-Supervisor: Raewyn Eden
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Please contact the researcher and/or supervisor(s) if you have any questions or feedback about the project.

is project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 16/16. If you have any concerns about the conduct of this research, please contact Dr Rochelle Stewart-Withers, Chair, Massey University Human Ethics Committee: Southern B, telephone [redacted], email [redacted]

B6: Parent Information Sheet (Interview)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

PARENT INFORMATION SHEET

Group Interview

Researcher Introduction

My name is Lee Mann. I am a mathematics teacher in the [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project is to examine and explore the extent of mathematics anxiety in year 9 students in the [redacted] region. 'Mathematics anxiety' means bad feelings to do with mathematics, for example: fear, tension, worry, nervousness, negativity, stress.

There have been many research studies completed globally in the field of mathematics anxiety. It is an important area to research and has implications for all people in their daily lives and futures. However, many of the research studies have been completed overseas, the majority of which have been conducted with university students or pre-service teachers. However, research has suggested that year 9 is the time in which mathematics anxiety peaks. Therefore, there is currently a gap for a study of mathematics anxiety in New Zealand young adolescents. This work will be an important indicator of the levels of mathematics anxiety in year 9 students and may prompt more research into the area, and/or begin a conversation in schools, classrooms, homes and communities. Hopefully this research will illuminate the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

Project Description and Invitation

The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted].
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.
- Provide a deeper understanding of year 9 students' mathematics anxiety from understandings that emerge from the data.
-

I will invite all year 9 (in 2016) students in the [redacted] to participate in the initial survey; my aim is to survey as many year 9 students in the [redacted] as possible, from a range of different schools. Based on the survey results, I will then select and invite small groups of students to participate in group interviews.

I invite your child as a year 9 (in 2016) student in the [redacted] to participate in a **group interview**.

The group interview will take place at your child's school, in class time. It will also involve about four other year 9 students from your child's school. The group interview should take approximately one hour to complete. It will be sound recorded in order to be transcribed. The group interview will have a school staff member (e.g. guidance counsellor) present as an observer.

Sample Questions

- *At what age/year did you first begin to worry about maths?*
- *What could teachers/school/friends/parents/you do to help you worry less about maths?*

Data Management
The data collected will be analysed according to the different factors and influences students report as having an effect on their mathematics anxiety. To preserve confidentiality of identity, names will be changed and/or removed.

The data will be used solely for the completion of a Masters of Education thesis. A summary of the research findings will be presented to the Board of Trustees of the school and will be made available to any participant on request. Following the conclusion of the research project, the supervisor (Professor Margaret Walshaw) will hold all data (electronic and hard copy) for five years.

Participant's Rights
You and your child are under no obligation to accept this invitation. If you and your child decide to participate, you and your child will have the right to:

- decline to answer any particular question;
- withdraw from the study;
- ask any questions about the study at any time during participation;
- be given access to a summary of the project findings when it is concluded.

Consent
Your child has been given a Student Information Sheet about the Group Interview, and Consent Form.
If I do not hear from you otherwise, it implies your consent for your child to participate in the group interview.

Project Contacts

Researcher: Lee Mann
Mobile: [redacted]
Email: [redacted]

Supervisor: Professor Margaret Walshaw
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Co-Supervisor: Raewyn Eden
Massey University
Institute of Education
Centre for Research in Mathematics Education
Telephone: [redacted]
Email: [redacted]

Please contact the researcher and/or supervisor(s) if you have any questions or feedback about the project.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 16/16. If you have any concerns about the conduct of this research, please contact Dr Rochelle Stewart-Withers, Chair, Massey University Human Ethics Committee: Southern B, telephone [redacted], email [redacted]

B7: Participant Consent Form (Interview)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

PARTICIPANT CONSENT FORM

Group Interview

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree not to disclose anything discussed in the group interview.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name - printed ....

B8: Chaperone Confidentiality Agreement (Interview)

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

CONFIDENTIALITY AGREEMENT

I ....

(Full Name - printed) agree to keep confidential all information concerning the project

Unpacking mathematics anxiety in year 9 students.

I will not retain or copy any information involving the project.

Signature: .... **Date:** ....

B9: Transcriber's Confidentiality Agreement

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MATĀURANGA

Unpacking mathematics anxiety in year 9 students.

TRANSCRIBER'S CONFIDENTIALITY AGREEMENT

I ………………………………………………………………………. (Full Name - printed) agree to transcribe the recordings provided to me.

I agree to keep confidential all the information provided to me.

I will not make any copies of the transcripts or keep any record of them, other than those required for the project.

Signature: ……………………………………… **Date:** ………………

Appendix C: AMAS Instrument

PsycTESTS®

Abbreviated Math Anxiety Scale
Version Attached: Full Test

PsycTESTS Citation:
Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). Abbreviated Math Anxiety Scale [Database record]. Retrieved from PsycTESTS. doi: http://dx.doi.org/10.1037/t09443-000

Instrument Type:
Rating Scale

Test Format:
Items on the Abbreviated Math Anxiety Scale are responded to using a 5-point Likert-type scale, ranging from 1 (low anxiety) to 5 (high anxiety), with the total score representing a summation of the nine items.

Source:
Hopko, Derek R., Mahadevan, Rajan, Bare, Robert L., & Hunt, Melissa K. (2003). The Abbreviated Math Anxiety Scale (AMAS): Construction, validity, and reliability. Assessment, Vol 10(2), 178-182. doi: 10.1177/1073191103010002008, © 2003 by SAGE Publications. Reproduced by Permission of SAGE Publications.

Abbreviated Math Anxiety Scale
AMAS

Items

1. Having to use the tables in the back of a math book.
2. Thinking about an upcoming math test 1 day before.
3. Watching a teacher work an algebraic equation on the blackboard.
4. Taking an examination in a math course.
5. Being given a homework assignment of many difficult problems that is due the next class meeting.
6. Listening to a lecture in math class.
7. Listening to another student explain a math formula.
8. Being given a "pop" quiz in math class.
9. Starting a new chapter in a math book.

Appendix D: Survey

MASSEY UNIVERSITY
UNIVERSITY OF NEW ZEALAND

Unpacking mathematics anxiety in year 9 students

Welcome to My Survey

Hello,

My name is Lee Mann. I am a mathematics teacher in [redacted], studying part-time towards a Master of Education (endorsed in Mathematics Education). In 2016-2017 I will be writing my thesis in the research pathway of the degree. This research project will examine and explore the extent and experiences of mathematics anxiety in year 9 students in the [redacted] region. It is intended to show the difficulties and anxieties that some students face in mathematics, and offer a starting point for discussing strategies for teachers and families to help to reduce its impact.

The aims and objectives of this research study are to:

- Establish the extent of mathematics anxiety amongst year 9 students in [redacted]
- Investigate the effect of various factors and influences (such as gender, ethnicity, etc.) related to mathematics anxiety.
- Describe the views and experiences of mathematically anxious students.

Your responses will be kept strictly confidential. You, your teachers and your school will not be able to be identified.

Thank you very much for accepting my invitation to participate in this survey. Your views are very important.

This survey should take you no more than 20 minutes to complete.

Which ethnic group(s) do you belong to? Select all that apply to you:

- [ ] New Zealand European
- [ ] Maori
- [ ] Samoan
- [ ] Cook Island Maori
- [ ] Tongan
- [ ] Niuean
- [ ] Chinese
- [ ] Indian
- [ ] Other

(please specify)

Please choose the statement that best describes your feelings about how much you **enjoy** working on mathematics:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I have usually enjoyed studying mathematics at school.	◯	◯	◯	◯	◯
I like to solve new problems in mathematics.	◯	◯	◯	◯	◯
I really like mathematics.	◯	◯	◯	◯	◯
I am happier in a mathematics class than in any other class.	◯	◯	◯	◯	◯
Mathematics is an interesting subject.	◯	◯	◯	◯	◯

Optional – An example to illustrate any of the questions above is:

Please choose the statement that best describes your feelings about your **motivation** in mathematics.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am confident that I could learn advanced mathematics.	◯	◯	◯	◯	◯
I am willing to study mathematics when it becomes an optional subject.	◯	◯	◯	◯	◯
I plan to study as much mathematics as I can during my education.	◯	◯	◯	◯	◯
The challenge of mathematics appeals to me.	◯	◯	◯	◯	◯

Optional – An example to illustrate any of the questions above is:

Please choose the statement that best describes your feelings about your **self-confidence** in mathematics.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Studying mathematics makes me feel nervous.	○	○	○	○	○
I always find mathematics class stressful.	○	○	○	○	○
It makes me nervous to even think about having to do a mathematics problem.	○	○	○	○	○
I am able to solve mathematics problems without too much difficulty.	○	○	○	○	○
I feel a sense of insecurity (self-doubt) when attempting mathematics.	○	○	○	○	○

Optional – An example to illustrate any of the questions above is:

Please choose the statement that best describes your feelings about the **usefulness, relevance and worth** of mathematics in your life.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Mathematics is a very worthwhile and necessary subject.	○	○	○	○	○
Mathematics is very important in everyday life.	○	○	○	○	○
Mathematics is one of the most important subjects for people to study.	○	○	○	○	○
University mathematics lessons would be very helpful no matter what I decide to study in the future.	○	○	○	○	○
A strong mathematics background could help me in my working life.	○	○	○	○	○

Optional – An example to illustrate any of the questions above is:

Please choose the statement that best describes your level of **anxiety** during different situations involving mathematics.

Note: Anxiety can also mean bad feelings / fear / tension / worry / nervousness / negativity / stress

	No anxiety	Some anxiety	Anxiety	Very bad anxiety	Worst anxiety
Having to use the tables in the back of a mathematics textbook.	◯	◯	◯	◯	◯
Thinking about an upcoming mathematics test one day before.	◯	◯	◯	◯	◯
Watching a teacher work out a mathematics problem on the board.	◯	◯	◯	◯	◯
Sitting a mathematics test.	◯	◯	◯	◯	◯
Listening to the teacher giving a mathematics lecture/lesson.	◯	◯	◯	◯	◯
Being given an assignment of many difficult mathematics problems, due the next day.	◯	◯	◯	◯	◯
Listening to another student explain how to do a mathematics problem.	◯	◯	◯	◯	◯
Being given a mathematics quiz without knowing in advance.	◯	◯	◯	◯	◯
Starting a new chapter in a mathematics book.	◯	◯	◯	◯	◯

Optional – An example to illustrate any of the questions above is:

Are there any other comments you would like to make about the things discussed in this survey?

You have now come to the end of the survey. Thanks for participating!

Appendix E: Interview Plan

Introduction:

- Write name labels with coloured pens
- Researcher background
- Research study explanation
- Ethics and consent; introduce role of chaperone (guidance counsellor)

Ground rules:

- You can “pass” if you don’t want to answer.
- Take time to think before you answer.
- Tell me if I don’t understand you, or if you don’t understand me.
- There are no right or wrong answers; say what you want. Different views are important.
- I won’t tell other people what you say. What is said in the group stays in the group.
- Take turns talking.
- No teasing or making fun of others.

Student introductions:

- Name
- Where you live
- Your hobbies
- Favourite kind of chocolate

Questions	Probes
Analogy: "If you could imagine maths as the weather, what would it be (e.g. sunny, stormy)?"	• Has maths "weather" always been like this for you? • Does the maths "weather" change or is it constant? • Can you forecast/predict the maths "weather" in the days or weeks or years ahead? • What factors affect the maths "weather"?
What is mathematics anxiety?	• Which word on this list best describes your maths anxiety? Why? • Can you give an example of when you were most anxious about maths? • Can you give an example of when you were least anxious about maths? • Do you think your parents, siblings or family have been anxious about maths? • Do you think your friends are anxious about maths? • Do you think other students in your class are anxious about maths? • Are you more anxious about learning maths or maths tests? Why? • Are you worried about just maths, or other subjects too?
What causes mathematics anxiety?	• How old were you when you first begin to worry about maths? • Was there a "trigger" to your maths anxiety? • Do you feel pressure to succeed in maths from others (e.g. friends, parents, teachers)? • Do your maths worries change according to your age/school/friends/teacher/topic?
What factors influence mathematics anxiety?	• Do you think there is a difference in the maths anxiety levels of: • Boys and girls? • Students at different kinds of schools • Different ethnic groups? • What do you think of streaming?
How does the transition from primary (year 8) to secondary (year 9) schooling affect mathematics anxiety?	• Were you more or less worried about maths in your previous school? Why? • Did you enjoy maths more or less in primary/intermediate school? Why? • Have the different ways of teaching and learning maths at college affected your maths anxiety?
How does mathematics anxiety affect achievement?	• Do you think you are "good" at maths? • Do you think your maths worries affect your grades, or the other way around?
What strategies help to reduce mathematics anxiety?	• If I could wave a magic wand, what is one thing that could make you feel better about maths? • Have you tried any strategies to reduce your maths worries? • What could teachers/school/friends/parents/you do to help you worry less about maths?
Wrap-up	• "Our purpose was to discuss your experiences around maths anxiety. Do you think we have left anything out?"

Maths anxiety words

I feel…

Apprehensive

Concerned

Doubtful

Fearful

Nervous

Panicky

Pressured

Stressed

Uncertain

Uneasy

Unsure

Worried