Mathematics anxiety and primary school teachers: The histories, impacts, and influences.

A thesis presented in partial fulfilment of the requirements

for the degree of

Doctor of Education

at Massey University, Manawatū, New Zealand

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2022

Abstract

Maths anxiety is understood to be a pervasive and global phenomenon. What is not so well understood is primary teachers' experience of this anxiety. This study sought to provide a clearer understanding of teachers' maths anxiety. Drawing on an interpretivist epistemology, framed by a sociocultural theoretical perspective, and using qualitative semi-structured interviews, the study provides a rich description of the personal histories and professional lives of 12 primary teacher participants who self-reported as experiencing maths anxiety.

Each participant offered a unique, personal history of the development of maths anxiety. It was found to develop from a jumble of interactions from multiple sources and with multiple consequences. The teachers' responses to anxiety around mathematics were wide ranging and included cognitive, affective, physiological, and neural reactions. In attempts to manage their anxiety, participants created specific strategies for particular situations. Amongst these management strategies were distraction and avoidance, eliciting support from trusted individuals, choosing to confine their teaching to lower year-level classes, and lengthy preparation to ensure they, themselves, understood the mathematics.

Participants attempted to keep their anxiety hidden from others during their professional roles. Professional development was found to be a context in which the anxiety intensified. In professional development contexts, rather than focusing on new learnings and understandings, the participants focused on their anxiety. As a result, they failed to enhance their mathematical knowledge and failed to develop understanding of how mathematics might be taught. Their lack of confidence in their own knowledge impacted on their classroom teaching to the extent that, where possible, they scheduled less time for mathematics than other subject areas. Since such anxiety management strategies are not conducive to teacher growth and are likely to have negative consequences for students, this study has demonstrated that a carefully paced and sensitive approach needs to be taken by schools and providers of mathematics professional development courses.

Acknowledgements

Ehara taku toa i te toa takitahi, engari he toa takitini.
My success is not mine alone, but it is the strength of many.

The whakataukī (proverb) above is relevant to me, as I have always felt the strength of many, and have never felt alone, throughout my doctoral journey.

To begin, it is with heartfelt gratitude that I acknowledge my two supervisors, Professor Margaret Walshaw and Professor Glenda Anthony. In changing times, you've been my mathematics education lecturers, my Master's supervisor (Glenda), my work colleagues, and now my doctoral supervisors. You have supported me as I have grown. Your sound knowledge, advice, encouragement, and wisdom have been very much appreciated throughout this doctoral journey. You have walked beside me to answer questions that clarified and focussed my thinking, and you also prodded me when that was necessary … and it was! Not only did you support my professional learning and development, but you also maintained an interest in my personal happenings. I've shared moments of pure joy with you, along with others of despair and grief. Thank you both for your care.

To my participants. Patton (2015) mentions that "listening is a privilege" (p. 505). I was privileged to travel with you as you shared your stories, through which I developed a deeper understanding of the experiences of anxiety around mathematics. I chose the names of strong, female singers as your pseudonyms, not because I enjoy their music, which I do, but because of your strength. You demonstrated strength when you came forward, when you openly shared your experiences, and when you trusted me to write of your experiences that many of you continue to hide. Indicating the importance of these stories being shared, you hoped that a greater awareness and understanding for anxiety around mathematics would be developed in the education field and beyond. Huge thanks go to you, my 12 participants.

I acknowledge my colleagues, both past and present; other doctoral students that I have interacted with along the way; and those in my doctoral cohort. So many have shown support and encouragement in a variety of ways. However, I dare not mention anyone by name. To overlook, even for a millisecond, an individual who assisted in keeping me on my doctoral path would not be positive. However, I will individually thank the Eastern Institute of Technology for the contribution towards the cost of study and for the time away from the office that assisted with the completion of this doctorate.

Friends are an important part of my life, and some of my friends are also cousins or colleagues. I wish to thank each and every one of you who has been a part of this journey with me … you know who you are. The texts, messages, and emails sent, along with your phone calls and unexpected drop-ins (with meals at times), have contributed to my journey hugely. One of you even offered to proof-read and did!

My whānau are essential to my life, and I give huge thanks, much love, and humungous hugs to you all.
My sisters and brothers, and nephews and nieces, along with their connected spouses, have shown interest in and support for my doctoral research. You wondered about what I was doing and why, asked questions about my progress, and shared laughter that helped me along the way. It is essential to individually acknowledge my sister, Jax. Wise words, understanding, encouragement, and support have flowed my way from you, along with proof-reading skills. From the beginning to the end, you have been there for me through thick and thin. My niece, Beth, must also be thanked for our discussions in relation to our respective doctoral research. You also became a proof-reader and my magical number elf near the end, as you ensured that the formatting of my doctorate was precise, and you fixed the skew-whiff numbering that infected the pages!

When I shared with Dad that I had enrolled in my doctorate, he remembered the ‘floppy hat’ that we had talked of at my master’s graduation in 2010. I am sure Mum and Dad would be proud (and possibly relieved) to know that I have finished. When I finally get that ‘floppy hat’ placed on my head, I know that they will be with me, although it will be in spirit for this graduation.

My cherubs are my world. I hope that you, Tim, Amie, and Anna, know the love that I have for each of you, as I have certainly felt your love throughout my doctoral journey. My huge thanks go to you for all that you have done to support me and my crazy idea of further study. Your calming, encouraging words, our discussions with ideas considered, and your texts, phone calls, visits, snapchats, and proofreading skills have helped me to reach this point. During this doctoral journey, my world has grown through you, as new members have been welcomed into our whānau. Josh and Michelle, the outlaws, have joined us, and with you both came further interest and support. And it grew again as my three grandchildren, Matilda, Grace, and Benjamin, arrived. You have boosted my world with smiles and chuckles, mischief and mayhem, wonder and delight … both yours and mine. Long may that continue!

This doctorate is dedicated to my grandchildren, those who are with us and those who may still arrive. May your maths learning be filled with rich questions and discussion, challenges and mistakes, as well as a mixture of learners.
I certainly hope that speed has no part in it.
Believe in your maths selves, for that changes what you can achieve.
With much love,
Gani ☺ xox

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Chapter 1 INTRODUCTION

1.1 Introduction

In my role as a teacher educator in Initial Teacher Education (ITE), I work alongside a diverse group of beginning pre-service teachers in relation to mathematics education each year. Within these classes, I listen to a number of pre-service teachers declare that they hate mathematics, are not good at it, had trouble with mathematics at school, and that they would prefer not to be involved with mathematics learning in our classes. At times, their heads drop to their hands or onto the table, they push their chairs away from where they sit, they sigh and exhibit fearful facial expressions, they become preoccupied with their cell phones or laptops, and sometimes they slap their hands down on the table in front of them while again sharing that maths is impossible for them. At times after these mathematical classes, some of these pre-service teachers have spoken with me in confidence regarding their perceived lack of mathematical skills, knowledge, and understanding; and their hatred of mathematics and the fear it instils in them. I have found that these, sometimes tearful, pre-service teachers benefit from careful nurturing and calm interactions. Their behaviours are not foreign to me, as they present with each new year's cohort of students.

I have witnessed similar behaviours when I, as a primary school teacher, worked alongside younger students. Two specific primary students readily come to mind from my time as a primary teacher. Specific student behaviours became apparent at mathematics time, although these behaviours were not observed at any other time of the school day. The two students were slow to settle to mathematics learning and were quick to pack up near the end of the lesson so that they could quickly transition to a different curriculum learning area. Both students were skilled in the art of avoiding mathematics, as they frequently took time to sharpen pencils; visit the bathroom or fill their water bottles; and fetch their erasers, then rulers, exercise books, various pens, or any other piece of equipment that they thought might be

needed at the time. They showed little confidence in taking part in solving problems individually or with peers, or in the mathematical discussion that was encouraged while problems were being solved. If left to their own devices, they would happily wander the classroom during mathematics without becoming involved in the mathematics activities that surrounded them. At different times, they both shared with me that they were ‘no good’ at mathematics and that they could not do it.

From my master’s degree study, which I had undertaken while teaching, I had learnt of maths anxiety, and much of what I read of how the anxiety manifested itself was mirrored in the behaviours of these two students. My interest in maths anxiety grew from that point, and my research has also continued to focus on maths anxiety and those who experience it. I have used, and continue to use, my understanding of maths anxiety during my mathematics education teaching in ITE. I work to ensure the development of understanding in mathematics content and related teaching practice, and to assist pre-service teachers to become aware of their own maths anxiety, as well as that of others, and to at least minimise, if not overcome, their experience of it. I began to wonder: if pre-service teachers sometimes experience maths anxiety, do some in-service teachers suffer from the same affliction? If they do, there are likely severe consequences for students.

1.2 Statement of the problem

Maths anxiety is a pervasive, world-wide issue (Foley et al., 2017; Luttenberger, Wimmer, & Paechter, 2018), manifesting itself across the global population. Although most commonly reported as being experienced by females (Devine, Fawcett, Szucs, & Dowker, 2012), other research has also reported that males have shown more maths anxiety than females (Abed & Alkhateeb, 2001), or that levels of maths anxiety are similar between males and females (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013). Maths anxiety has been reported to be experienced by children as young as four years of age (Petronzi, Staples, Sheffield, Hunt, & Fitton-Wilde, 2019), and that mild to moderate levels of maths anxiety are felt across most of the adult, English-speaking population within the United States (Hart & Ganley, 2019). Both societal and environmental factors have been identified as sources for maths anxiety (Shields, 2005). However, more than any other factor, negative experiences in the

mathematics classroom have been found to be the origin of much maths anxiety (Stoehr, 2017b). These experiences include negative teacher behaviour (Bekdemir, 2010) and characteristics (Wicks, 2021), along with ineffective mathematical teaching practice (Dole, 2013).

There are many responses to maths anxiety, which include negative self-talk, low self-esteem, increased heartrate, and nausea. It is known that individuals who experience maths anxiety may come to avoid mathematics (Wilson, 2013), they become skilled at rushing mathematical tasks, and they may refrain from enrolling in elective mathematics courses. When mathematical avoidance occurs and thus the opportunities to learn mathematics are reduced considerably, it seems that maths anxiety and low mathematical achievement may go hand-in-hand.

A major concern relating to maths anxiety and low mathematical achievement are the constraints placed on employment opportunities. For example, individuals who experience maths anxiety may not have developed the mathematical competence to enrol in science, technology, engineering, and mathematics (STEM) tertiary education nor to be employed within the STEM sector (Daker, Gattas, Sokolowski, Green, & Lyons, 2021). To increase the number of individuals who are able to be a part of the STEM employment sector, as well as in other fields of employment that require mathematical skills, it is essential that mathematics proficiency is not the sole focus in the classroom. Maths anxiety must also be given specific attention in our schools and tertiary settings (Daker et al., 2021).

In addition, if maths anxiety is likely to limit employment opportunities, it is disconcerting that recent research (Carey et al., 2019) investigating primary and secondary students' experiences of maths anxiety proposed that the United Kingdom appeared to be experiencing a "mathematics crisis" (p. 2). New Zealand may also be facing a similar crisis, as, in a recent Organisation for Co-operation and Development (OECD) PISA report (2013), New Zealand recorded the highest statistically significant change for increased student anxiety towards mathematics between 2003 and 2012. Associated with that change was a high negative correlation between maths anxiety and low mathematics performance.

Given that student maths anxiety is on the increase, it is timely to consider this pervasive phenomenon in relation to primary in-service teachers' experiences. That is the central focus of this study.

1.3 Rationale for the study

It has been known for a considerable time that some teachers do experience maths anxiety. Indeed, the first academic publications on this issue for teachers appeared more than four decades ago (Mihalko, 1978). Further research reports on the issue published in the 1980s have been located (see, for example, Bush, 1989; Trice & Ogden, 1986; Widmer & Chavez, 1982; Wood, 1988), although it was not until more recent times that the international research community has explored the issue more extensively (see, for example, Askew & Venkat, 2017; Gürbüz & Yıldırım, 2016; Hadley & Dorward, 2011; Hughes, 2016; Morton & Dykeman, 2019; Patkin & Greenstein, 2020; Wicks, 2021). While interest in the issue has grown, to date no New Zealand research that investigates teachers' experiences of maths anxiety has been undertaken.

Research in this area with primary in-service teachers is valuable, as the considerable attention given to pre-service teachers who experience maths anxiety suggests that those experiences may influence teaching practices (Brady & Bowd, 2005; Cady, Meier, & Lubinski, 2006; Furner & Berman, 2003; Ganley, Schoen, LaVenia, & Tazaz, 2019; Karp, 1991; Koch, 2018; Swars, Daane, & Giesen, 2006). It is crucial that research with in-service teachers is carried out, as it may assist in understanding how maths anxiety impacts and influences the professional role of teachers and their mathematics teaching in the classroom. And importantly, it may also lead to an understanding of how these teachers either manage or minimise the anxiety that they experience.

1.3.1 The New Zealand primary school context

Any exploration of New Zealand in-service primary teachers requires an initial understanding of the New Zealand primary school context. In New Zealand, schooling is compulsory from the age of six, although most children begin school at

the age of five. The primary level school structure comprises eight years of education and is mostly made up of three types of schools: contributing primary involves Years 1 to 6; intermediate focusses on Years 7 to 8; and full primary encompasses Years 1 to 8.

The National Curriculum, published by the MoE, provides the framework for the school and classroom curricula, and comprises two parallel documents: the New Zealand Curriculum (MoE, 2007), and Te Marautanga o Aotearoa (MoE, 2008). The New Zealand Curriculum is used in schools that teach in English, while Te Marautanga o Aotearoa is utilised in kura kaupapa Māori (Māori medium schools) where the curriculum is taught in and through te reo Māori (Māori language) for more than 51% of the time (MoE, 2019a). Te Marautanga o Aotearoa is not a translation of the New Zealand Curriculum, but a curriculum based on kaupapa Māori (Māori philosophies) (MoE, 2017b).

The New Zealand Curriculum "identifies *values* to be encouraged and modelled and to be explored by students, *key competencies* that students will develop over time and in a range of settings, and *learning areas* that describe what they will come to know and do" (MoE, 2007, p. 37, emphasis in original). There are eight levels of learning in the New Zealand Curriculum, with achievement objectives that represent key learning outcomes for each learning area and level. Levels 1-4 are those most relevant to primary school. The MoE's (2007) vision for students within New Zealand is that they develop to become creative, energetic, enterprising individuals who are "confident, connected, actively involved, and lifelong learners" (p. 8). Classrooms then become spaces where students are engaged and challenged and students are encouraged to develop increased responsibility for their learning (Education Review Office (ERO), 2018b).

Mathematics and statistics (henceforth referred to as mathematics) is one of the eight learning areas within the New Zealand Curriculum, and is made up of three strands: number and algebra, geometry and measurement, and statistics. Mathematics is a compulsory learning area and guidelines indicate that numeracy be given priority, especially in Years 1 to 8 (MoE, 2019c), to assist students to become numerate. Becoming numerate will see students develop "the ability and inclination

to use mathematics effectively in [their] lives - at home, at work, and in the community" (MoE, 2001, p. 1). Mathematics is typically taught by generalist classroom teachers in primary schools who are responsible for planning and delivering all eight areas of the New Zealand Curriculum.

Mathematics classrooms are expected to be "learning communities rather than merely a collection of individuals" (Hodge, 2008, p. 32), which encourage the voicing of mathematical thinking, questioning, explaining, justifying, discussing, and reasoning, with teacher and students engaging together. This depiction of the mathematics classroom connects strongly with what Ernest (1989) conceived as a problem solving view of mathematics learning involving a dynamic inquiry process. This problem-solving approach is evident in some classrooms. For example, Kazemi (2015), an International Quality Assurance assessor, when looking at a cluster of classrooms who were participating in Developing Mathematical Inquiry Communities (DMIC) professional learning, noted that these classrooms provided spaces that focus on problems, thinking, and ideas.

However, the problem solving approach is not visible in many New Zealand primary classrooms where 'drill and practice' (Begg, McChesney, & Jhagroo, 2019) and ability grouping (Anthony & Hunter, 2017) continue to be evident. Drawing on classroom studies, research has provided disconcerting evidence that the classrooms described by ERO (2018b), Hodge (2008), and Kazemi (2015) are not always apparent throughout New Zealand (for example, Anthony, Hunter, & Hunter, 2015; Carnegie-Harding, 2006; Hunter, 2010).

A differentiated emphasis by teachers within the three strands of the mathematics and statistics learning area of the New Zealand Curriculum (MoE, 2007) document is also a concern. It has been revealed that teachers maintain a "focus on numeracy to the exclusion of other strands" (ERO, 2021, p. 3). This revelation is supported by primary students who have noted that number facts and number operations have been a focus of their learning (Anthony et al., 2015); that their knowledge of basic facts is highly valued (Grootenboer & Marshman, 2016); that they do not enjoy grappling with new mathematical ideas and concepts; and that they are averse to "discussing deeper mathematical concepts" (Nicholas & Fletcher, 2017, p. 50). For

many students, across all achievement levels, practising basic facts or completing basic facts worksheets, and playing number games on digital devices, are considered the most enjoyable or interesting of mathematics activities (Nicholas & Fletcher, 2017).

Distinguished Professor Gaven Martin, the chairperson of a Royal Society expert panel, has recently contended that there is a "disjunct between what is promised in the curriculum and what is delivered" (Gerritsen, 2021, February 2, para. 13). A preference for numeracy teaching might go some way to explain why some teachers claim to enjoy mathematics. For example, in a teacher survey undertaken by the Educational Assessment Research Unit (EARU) and the New Zealand Council for Educational Research (NZCER) (2019), respondents were asked to rate the following statements: I think maths is important, I like teaching maths, and I personally enjoy maths. For both Year 4 and Year 8 teachers, 90% or more either agreed or strongly agreed to each of the three statements. This finding would indicate that teachers in New Zealand are highly positive in regard to mathematics and its teaching. However, the same cannot be said for pre-service teachers. Research by Young-Loveridge, Bicknell, and Mills (2012) reported that only 48% of pre-service teachers were positive about mathematics when beginning their qualification.

All areas of the mathematics learning area of the New Zealand Curriculum are intended to be taught, as they enable students to develop skills for "investigating, interpreting, explaining, and making sense of the world in which they live" (MoE, 2007, p. 26). Through learning mathematics, students should "develop the ability to think creatively, critically, strategically, and logically" (MoE, 2007, p. 26). Students will be disadvantaged by a narrow mathematics focus, and, when this occurs, it is reasonable to forecast that students will not develop "a broad range of practical applications" (MoE, 2007, p. 26) that are useful for everyday life, other learning areas and levels, and employment.

Despite the fact that curriculum outcomes are specified for students across their years in school, ERO (2021) has found "evidence of a slippage [in] expectations" (p. 3) in relation to mathematics. This is a concern, as lower teacher expectations may

result in a self-fulfilling prophecy for students, making it doubtful that students will achieve well in mathematics. Timmermans, Rubie-Davies, and Wang (2021) have explained that "[s]tudents do not benefit from low expectations; but all students benefit when they are with teachers who have high expectations for all students" (p. 11).

These findings are concerning in light of the fact that over the period between 2013 to 2018, ERO published more than 10 reports that related to raising or accelerating student achievement, in which specific directives were given for mathematics in primary schools (ERO, 2013, 2014, 2018a). In particular, to lift student achievement, the MoE (2017d) initiated changes to teacher professional development programmes that were aimed to support equity and excellence through a focus on building teacher expertise in both pedagogy and content knowledge (MoE, n.d.-a). Arguably, educational reforms and initiatives can be difficult to implement in schools (Anderson, Boaler, & Dieckmann, 2018), and despite available professional development opportunities many teachers remain committed to long established teaching methods and minimal classroom change occurs (Cuban, 2013). As a consequence and as the evidence suggests, many primary school students are not making the expected yearly curriculum progress and achievement in mathematics (EARU & NZCER, 2019).

However, there is evidence that students with specific attitudes are making the expected progress. From the latest National Monitoring Study of Student Achievement (NMSSA) report (EARU & NZCER, 2019), it was found that those students who held a more positive attitude towards, and were more confident in, mathematics, tended to achieve at a higher level than those who did not, and these associations were stronger in Year 8 than in Year 4 students. Similar findings involving seven to nine-year-old students in New Zealand were reported by Bonne and Johnston (2016) in relation to mathematics achievement levels and beliefs about mathematics ability.

1.3.2 What the data reveal about New Zealand primary school classrooms

In the most recent reported results of the Trends in International Mathematics and Science Study (TIMSS), Rendall, Medina, Sutcliffe, and Marshall (2020) identified that the mean score for New Zealand was lower than that of 38 other countries, and this number included all other predominantly English-speaking countries. Of note, in relation to this study, is that more Year 5 students in New Zealand, compared with their international counterparts, are not confident with mathematics, despite the fact that New Zealand students strongly value mathematics to the same degree as the international average (Mullis, Martin, Foy, Kelly, & Fishbein, 2020).

The harsh reality is that many students are not positive about or confident with mathematics and do not achieve well. Following an investigation into students' progress and achievement "in the context of sustained concern in New Zealand's competitiveness in international assessments of … mathematics" (ERO, 2021, p. 1), ERO has recently presented a briefing report for the Minister of Education that has been described as a "scathing" attack on mathematics teaching and learning (Cooke & Kenny, 2021, June 29, para. 2). The briefing report identifies areas of concern, as well as areas for improvement.

In particular, ERO has concern around teacher capability in mathematics, and points out that there are few specialised mathematics teachers at the primary level. In ERO's view, this phenomenon "limits the quality of teaching and opportunity to learn" (p. 3). While professional development opportunities are undertaken in schools and are showing improved mathematical teaching practice, the professional development undertaken is not considered in regard to improved student outcomes (ERO, 2021). Similarly, schools demonstrate more capability in identifying students who require extra support for mathematical learning than they do in providing the support for those identified students to learn mathematics. As the report points out, "curricular and pedagogical changes [are] the missing link" (ERO, 2021, p. 2) to improved learning. Without the required extra support, it is unlikely that students' achievement in mathematics will improve.

According to the briefing report, because mathematics teaching has lacked "strong direction and clarity," the National Curriculum has been reinterpreted and these reinterpretations have "become embedded over time" (ERO, 2021, p. 3). Along with curriculum reinterpretations, there is "misalignment of curriculum content from various sources" (ERO, 2021, p. 3). Teachers appear to utilise sources of information, such as websites and commercially published resources, that may be misaligned with the curriculum content being taught. In addition, teachers are receiving "mixed messages about pedagogical approaches" (ERO, 2021, p. 3), therefore, it is probable that the ineffective mathematical teaching strategies identified by ERO in 2013 continue to be utilised. When curriculum reinterpretation, misaligned sources, and mixed pedagogical approach messages are added together, then missed student opportunities for learning may occur. A missed opportunity may be described as a deficit in mathematics learning experience as a result of poor teaching (Brewster & Miller, 2020), which often leads to gaps in student understanding.

The Education Review Office (2021) claims that there have been "years now of relative deterioration in New Zealand's performance in international comparative measures of … mathematics achievement" (p. 3). This point has not gone unnoticed by the media, which has been quick to remind us that improvement is essential. For example, headlines include:

- "A generation has been failed in maths: Kiwi kids slide further in maths and science" (Collins, 2020);
- "Can New Zealand turn that around?" (Carroll, 2021);
- "Maths decline: Ministry of Education calls in Royal Society to stop NZ mathematics rapid decline" (Collins, 2021);
- "We should all be worried about New Zealand's woeful performance in maths" (Martin & Hunter, 2021);
- "Kiwi kids flunk maths" (Collins, 2021, February 2); and
- "Education Review Office warns of 'slippage of expectations' in maths teaching" (Cooke & Kenny, 2021, June 29).

Data from the 2016 mathematics National Standards appear to support these concerns. The data showed that, across all primary year levels, between 16 and 32% of students were achieving below or well below expectations (MoE, 2019b). The NMSSA (EARU & NZCER, 2019), which assessed Year 4 and 8 students, showed similar proportions of students not meeting achievement expectations. At Year 4, 19% of students achieved below the expected curriculum Level 2, although Māori[1] (32%) and Pasifika[2] (41%) Year 4 students fared less-well. At Year 8, the percentage of students below the expected curriculum Level 4 had risen to 55%. However, Māori (73%) and Pasifika (76%) Year 8 students again fared less-well (EARU & NZCER, 2019) (percentages are rounded for ease of reading). Notably, there was considerable variation in achievement, as students were working across levels 1 through 4 or above of the curriculum in both Years 4 and 8. Of concern was the finding that approximately 9% percent of Year 8 students were assessed to be working within levels 1 and 2 of the curriculum – a considerably lower level than expected (EARU & NZCER, 2019).

While some students do achieve in mathematics to the highest level in New Zealand, given the "persistent disparities in achievement" (ERO, 2016, p. 9), within the so-called 'long tail of underachievement', there is a major challenge of achieving equity amongst ethnic groups in mathematics education. To address the achievement disparity, Hattie (2008) has suggested the need for a "seismic shift to align the plates" (p. 22). Although there are differences between ethnic group achievement, it is important to acknowledge that "the existence of a relationship between ethnicity and achievement ... does not imply that being classified in a particular ethnic grouping is a cause of poor or good achievement" (Caygill, Singh, & Hanlar, 2016, p. 43).

Other important factors have been found to impact achievement, such as teacher expectations and beliefs (Blank, Houkamau, & Kingi, 2016; Turner, Rubie-Davies, & Webber, 2015), and teacher confidence in their ability to teach mathematics (Caygill

[1] An indigenous person of Aotearoa/New Zealand (Moorfield, 2021).

[2] An umbrella term "used to categorise trans-culturally diverse peoples from the Pacific region who now live in New Zealand but continue to have family and cultural connections to Pacific Island nations" (Ministry of Education, 2018, p. 5).

et al., 2016). Taking on board the impact on students of teacher expectations, teacher beliefs, and teacher confidence, a recent independent survey has identified that there is “the need for fundamental change” (Maharey, Cormick, Wylie, & Verstappen, 2021, p. 4) within our education system. The problem may not simply be a straightforward pedagogical issue, as claimed by ERO (2021).

When considering the evidence included within this rationale, it may be timely to explore the issue of what is occurring in New Zealand primary schools more broadly. Consequently, it is crucial to consider the affective outcomes of teacher mathematical experiences within New Zealand.

1.4 Purpose of the study

The aims of this study are (i) to explore the histories of teachers who self-reported as experiencing maths anxiety, and (ii) to consider how that maths anxiety impacts and influences their professional role and teaching practice.

The research questions guiding this study are:

1. What are the personal histories that influence primary teachers who experience maths anxiety?
2. How does maths anxiety impact the professional role of the primary teacher?
3. How does maths anxiety influence the mathematics teaching in the primary classroom?

It is also hoped that by addressing these questions, this research will produce findings that will contribute to the available, though not extensive, international literature regarding maths anxiety in relation to in-service primary teachers. The research is also intended to raise awareness of the implications and potential supports for those in-service primary teachers experiencing maths anxiety in the mathematics education environment in New Zealand.

1.5 Overview of the thesis

This study is reported in six chapters. This first chapter has introduced the focus of this study. A statement of the problem has been provided. The rationale for this research study has been conveyed and includes supporting information in relation to the primary school setting in the New Zealand context, in particular to mathematics. The purpose of this research study has also been communicated.

Chapter two offers a critical review of the literature that begins within an overview of the affective domain and mathematics, and continues with the review of maths anxiety, maths anxiety and teachers, and maths anxiety and teaching. Spaces in the literature are recognised and concerns in regards the existing literature are identified.

Chapter three describes the research approach undertaken in this study. The research design is outlined, sharing epistemological and theoretical beliefs, and methodology, along with the methods utilised. Ethical considerations are shared, as are the limitations of the study.

Chapter four presents the findings of the research from the semi-structured interviews undertaken. This chapter shares the histories of participants who experience maths anxiety. Findings in relation to the impact of maths anxiety on the professional role and the influence on mathematics teaching are also shared.

Chapter five offers a discussion of the findings presented in the previous chapter. Although with an additional area for focus, the structure of this chapter mostly aligns with the three research questions: the personal histories, the professional role, and teaching mathematics.

Chapter six provides a conclusion to this thesis. A summary of the research is shared, contributions are outlined, along with suggested recommendations for those involved in mathematics education and for future research. This chapter closes with some concluding thoughts in relation to interrupting the maths anxiety cycle.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

A summary of the search strategy utilised to identify relevant literature begins this chapter. To situate the study of primary teachers and maths anxiety, this chapter provides an outline of the importance of the affective domain for mathematics learning and teaching. Maths anxiety is examined from the relevant literature available, most of which is international. Providing an examination of maths anxiety in general is considered essential, as research relating to primary teachers and maths anxiety is somewhat limited. An exploration of maths anxiety, and an overview of the teachers who experience it, are both offered, before a review is provided of the consequences that maths anxiety may have on teaching. The review concludes with an account of maths teaching anxiety, and a clarification of the differences between it and maths anxiety.

2.2 Literature search

This review is based on a wide array of literature regarding maths anxiety. The literature search was conducted using a combination of key words including math*, anxiety, affect, emotion, fear, teach*, as well as derivatives of these words. Databases searched included A+ Education, Discover, ERIC, Google Scholar, JSTOR; and the New Zealand Educational Theses Database. Books relevant to the focus were searched for in the Massey University catalogue. The Mathematics Education Research Group of Australasia (MERGA) website was also accessed; along with the websites of the ERO, the MoE, and Education Counts. Although the search was set at post 2000, pertinent articles outside the parameter were found and some are included. Items that were available for electronical download were stored systematically in a literature folder that now contains over 1,800 sources of literature.

2.3 Mathematics and the affective domain

While some may consider mathematics to be a mechanistic, neutral, logical, and objective activity, engaging with mathematics typically induces a variety of affective responses from individuals. Responses, or characteristics, may include ‘aha’ moments, anxiety, attitudes, beliefs, engagement, fear, frustration, fun, motivation, panic, self-confidence, self-efficacy, and values (Attard, 2016; Cretchley, 2008; Leder & Grootenboer, 2005; McCoach, Gable, & Madura, 2013; Roth & Walshaw, 2015; Zollman, Smith, & Reisdorf, 2011). These responses and characteristics are part of the affective domain, which involves the feelings and emotions that people may experience (Anderson & Bourke, 2000). Leder and Grootenboer (2005) have emphasised that the affective domain, rather than being a straightforward entity, is complex and multi-dimensional. An awareness of the importance of the affective domain to mathematics education emerged in the 1970s (McCoach et al., 2013), and as such has been an object of interest for a relatively short period of time within the research community.

Teacher attitude, confidence, and expectations have been explored as elements within the affective domain and have been shown to impact on student learning in the mathematics classroom in a variety of ways. Teacher attitude towards mathematics may influence their expectations of students and their beliefs in themselves as mathematics teachers, as well as influence the attitudes of students towards mathematics (Bonner, 2006). By and large, as a relatively recent study found, Year 4 and 8 teachers in New Zealand indicated that they enjoy mathematics and like teaching it (EARU & NZCER, 2019).

Teacher confidence in mathematics plays a part in the outcomes of teaching and learning. It influences teaching choices and decisions, and may enthuse, inspire, and promote joy in learning. It also enables flexibility in teaching, and promotes engagement from and independence in students (McCulloch, 2016). New Zealand Year 5 teachers indicate that they have high or very high confidence in their mathematics teaching ability (Caygill et al., 2016). Likewise, most Year 4 and 8 teachers feel confident or very confident in their mathematics teaching, having the

highest confidence in teaching number, and the least confidence in teaching algebra, at both year levels (EARU & NZCER, 2019).

Professional learning and development also plays a part in the outcomes of teaching and learning, as it is likely to lead to teacher learning and improved teaching practice in the classroom (Eun, 2019). New Zealand teachers have indicated that they engage in professional development (EARU & NZCER, 2019), which may include a variety of approaches. One approach is Communities of Learning | Kāhui Ako, similar to Wenger's communities of practice (1998), which "allow time for teachers to work together on meeting the achievement challenges, drawing on each other's skills, knowledge and experience" (MoE, 2020, para. 5). Teachers may also engage in professional development through interactive professional development modules, mathematics associations, universities, teaching as inquiry either as individuals or in groups, and private consultancy services that involve commercial professional development providers, funded by contracts with the MoE (Begg et al., 2019). The Education Review Office (2018a) has reported that teacher professional development for mathematics in New Zealand is usually "focused on both developing content knowledge and teaching practice" (p. 7).

Although New Zealand primary teachers voiced confidence and claimed that they engage in professional development in the EARU & NZCER (2019) survey, a report from ERO (2018a) indicated lower confidence levels, as teachers feel that they had not been taught mathematics well. As a consequence, teachers rush through mathematical concepts and skim over, or even omit, sections of the mathematical learning area in the New Zealand Curriculum (ERO, 2018a).

Just as attitude and confidence may influence teaching and learning, so too may expectations. More than three decades ago, Brophy (1983) described how expectations held by teachers may become a self-fulfilling prophecy for students as teacher expectations lead to different behaviour from teachers, and these, in turn, may affect student motivation, self-concept, achievement, and ambition. In relation to teaching mathematics, students who are expected to have difficulty with learning are likely to be given less wait time to answer questions, receive more criticism for mistakes and less praise for their work. They are also given the answers, are asked

to respond less, and have less demand placed on them than other students (Brophy, 1983). A more recent review of research that spanned 20 years confirmed that teacher expectations of students are known to impact student achievement (Good, Sterzinger, & Lavigne, 2018)

Within the Accelerated Learning in Mathematics (ALiM) (MoE, 2017a) initiative in New Zealand, which aims to support students within their mathematics classroom who are not meeting expectations, high teacher expectations are seen as a way to improve both student achievement in and attitudes with mathematics (Neill, Fisher, & Dingle, 2010). While a teacher may believe that she or he holds high mathematics expectations for students, after participating in professional development she or he may then recognise their expectations were low (Alton-Lee, Hunter, Sinnema, & Pulegatoa-Diggins, 2012). Research indicates that New Zealand teachers may have lower expectations for Māori and Pasifika students (Rio, 2017; Rubie-Davies et al., 2012; St. George, 1983; Turner et al., 2015). Turner et al. (2015, p. 67) contend that teachers hold "seemingly prejudiced, stereotypical and deficit beliefs" for Māori and Pasifika students. There appears to be a "dominance of a deficit discourse among teachers" (Bishop, 2010, p. 130) for Māori students, which contributes to lower expectations for Māori (Blank et al., 2016).

For students, it has been identified that the affective domain has an influence on learning. In her mathematical research, Walls (2001) noted compelling links between affect and learning, and asserted that the dimensions of cognition and affect in learning are inseparable (Walls, 2003). McCoach et al. (2013) suggest that students tackle any task with both affective characteristics and cognitive behaviours. Roth and Walshaw (2015) agree and explain that "[a]ffective responses are vital elements of, and are intrinsic to, classroom life" (p. 1), and go so far as to say that every aspect of mathematics is saturated by the affective domain. Askew and Venkat (2017) reiterate this idea when stating that "the intellectual endeavors of mathematics teaching and learning [are] inseparably bound up with the emotional aspects of these endeavors" (p. 340). The dominant role of affect is evident when considering that, when asked, individuals are unlikely to recall much of the mathematics in any particular learning event, though are likely to recall their affective responses to the mathematics learning event (Fennema, 1989; Middleton & Jansen, 2011).

Anderson and Bourke (2000) argued that any characteristic of the affective domain must meet the criteria of intensity, direction, and target. Intensity is the strength of the response, direction is the positive or negative orientation of the response, and the target is the activity, idea or object that is responded to. When considering these criteria in relation to anxiety, the intensity may be thought of as how anxious an individual might be or become; the direction is a negative orientation, as anxiety most often has a negative connotation, and the target is whatever the anxiety is directed towards – mathematics, for instance.

2.4 Maths anxiety

Maths anxiety has been of interest to mathematics educators for a considerable time. Browne (1906) wrote of an affective tone when working with numbers; Schonell (1937, p. 81) considered that "backwardness in arithmetic" was due to both emotional and intellectual factors; while Gough (1954) wrote of mathemaphobia, describing it as a disease that was self-defining. Dreger and Aiken (1957) completed the first empirical research to investigate emotional reactions to arithmetic and mathematics, then tentatively termed "Number Anxiety" (p. 334).

Since the work of Dreger and Aiken (1957), research about and interest in maths anxiety has continued, with increased attention in recent years (Dowker, Sarkar, & Looi, 2016; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). Publications relating to maths anxiety are varied, and include:

- Post-graduate research (for example, Lange, 1992; Mann, 2017; Smith, 2010);
- Journal articles (for example, Finlayson, 2014; Ho et al., 2000; Wigfield & Meece, 1988);
- Reviews of research (for example, Ashcraft & Ridley, 2005; Stodolsky, 1985; Suárez-Pellicioni et al., 2016);
- Meta-analysis of research (for example, Hembree, 1990; Ma, 1999; Zhang, Zhao, & Kong, 2019);
- Chapters within books (for example, Attard, Ingram, Forgasz, Leder, & Grootenboer, 2016; Chinn, 2016; Schuck & Grootenboer, 2004)

- Chapters within handbooks (Haase, Guimarães, & Wood, 2019; Maloney, 2016; for example, Moore, McAuley, Allred, & Ashcraft, 2015); and
- Published books (for example, Mammarella, Caviola, & Dowker, 2019; Tobias, 1993; Wicks, 2021).

2.4.1 Maths anxiety defined and assessed

Prior to defining maths anxiety, it is important to consider general anxiety, which has been categorised by some researchers as either trait or state. Trait anxiety describes the vulnerability to stress that an individual brings to a situation, which prompts that vulnerability across all types of circumstances (Miller & Bichsel, 2004; Sorg & Whitney, 1992). State anxiety refers to the actual situational stress experienced, which is specific to personally stressful or fearful circumstances (Miller & Bichsel, 2004; Sorg & Whitney, 1992). A number of researchers (Beilock & Maloney, 2015; Jenßen, Dunekacke, Eid, & Blömeke, 2015) conceptualise maths anxiety as a trait anxiety, whereas others (Brady & Bowd, 2005; Devine et al., 2012) consider it a state anxiety. Still others (Buckley, Reid, Goos, Lipp, & Thomson, 2016; Buckley et al., 2021; Roos et al., 2015) support Hembree's (1990) contention that maths anxiety is associated with both trait and state anxiety.

Although a number of definitions for maths anxiety have been shared, there is no one agreed upon definition for maths anxiety. Indeed, maths anxiety is considered difficult to define (Baloğlu, 1999; Hembree, 1990; Wood, 1988). One definition frequently utilised is that offered by Richardson and Suinn (1972, p. 551): "Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of problems in a wide variety of ordinary life and academic situations." This definition focuses on the impact of anxiety on performance with mathematics, whereas other definitions tend to a focus on responses. For example, "feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics" (Fennema & Sherman, 1976, p. 326), or "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Tobias & Weissbrod, 1980, p. 65) or "a state of anxiety in response to situations involving mathematics which are perceived as threatening to self-esteem" (Cemen,

1987, Abstract). Recent research (Pizzie & Kraemer, 2017) compares maths anxiety to a phobia, such as snakes or spiders, as it operates in a similar way. Being briefly exposed to mathematical stimuli may create a behavioural disengagement bias to a fear-conditioned stimulus. Shields (2005) goes so far as to define maths anxiety as "a conditioned fear that develops into a fatalistic attitude, which becomes a self-fulfilling prophecy that reinforces one's belief about an inability to perform mathematically" (p. 326).

Although there is no one definition, and different researchers emphasise components of maths anxiety in varying degrees (Bursal & Paznokas, 2006), irrespective of the definition, there is evidence that maths anxiety is a genuine anxiety reaction (Ashcraft, 2002) and may be considered a separate construct distinct from trait and state anxiety (Suárez-Pellicioni et al., 2016).

In this research, maths anxiety is deemed to be a negative response specific to anticipation of or involvement with mathematics that interferes with performance.

As well as various definitions of maths anxiety, there is also a variety of measures in which maths anxiety may be more formally recognised. This variance in measurement tools may be due to the wide range of ways in which the construct of maths anxiety is defined (Cipora, Artemenko, & Nuerk, 2019).

Ashcraft (2019) provides a useful overview of five models or constructs of maths anxiety – personality, cognitive, and sociocultural, along with the role of gender and a neuro-biological construct. The personality construct involves factors such as mathematics avoidance, and attitudes, including enjoyment, self-confidence, motivation, and the usefulness of maths. The cognitive construct involves mental processing, more specifically the greater load that working memory carries when maths anxiety is present. The sociocultural construct involves influences due to social and cultural factors that surround and individual. Ashcraft considers maths anxiety and the role of gender and provides ideas for why females are reported as having higher anxiety than males, despite there being little difference in mathematics achievement across these two genders. These ideas include the tendency for females to exhibit higher levels of anxiety generally, that females are more willing to discuss their anxiety than males, an activation of a negative stereotype threat

prompted by the words of others, and, finally, that the mathematical myth that males are better than mathematics than females has been internalised by females. The last model is a neuro-biological construct that involves a possible biological or genetic base for maths anxiety. This idea is supported by the work of Wang et al. (2014) that found roughly 40% of the variation in maths anxiety was accounted for by genetic factors in a study involving a total of 514 12-year-old twin siblings.

Just as there is not one definition or construct for maths anxiety, there are different factors identified as comprising maths anxiety also. Cipora et al. (2019) proposed a way in which these different factors may be combined in the creation of assessments for maths anxiety. To begin, two factors have been identified as comprising maths anxiety that involve using maths in everyday (learning) situations and maths evaluations (Richardson & Suinn, 1972). Maths anxiety has also been identified as having three factors of anxiety, being maths tests, numerical tasks, and maths courses (Alexander & Martray, 1989). Similarly, another three-factor group includes maths evaluation, everyday/social maths, and maths observation (Hunt, Clark-Carter, & Sheffield, 2011). More recently, in a study involving 491 university students, Pletzer, Wood, Scherndl, Kerschbaum, and Nuerk (2016) identified six factors of maths anxiety that include: taking maths exams, thinking of upcoming maths exams, learning maths, everyday numerical maths, performance, and social responsibility. Another recent study involving 106 ethnically and linguistically diverse first-grade students also identified that maths anxiety in younger children was a multidimensional construct with factors of negative reactions, worry, and numerical confidence (Harari, Vukovic, & Bailey, 2013).

The lack of agreement in defining maths anxiety, alongside the constructs and factors of maths anxiety has resulted in numerous models of assessment for maths anxiety. Now numbering more than 20, the main form of assessment of maths anxiety is the pencil-and-paper self-report questionnaire where individuals agree or disagree with a series of statements about mathematical situations (Avancini & Szűcs, 2019). These assessments for maths anxiety most often provide a low, medium, or high result for individuals.

Although a modified anxiety assessment tool was utilised to measure maths anxiety (Dreger & Aiken, 1957), the first assessment tool specific to maths anxiety was the

Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972), with numerous ensuing modifications. For example, MARS-A (adolescent) (Suinn & Edwards, 1982), MARS-E (elementary) (Suinn, Taylor, & Edwards, 1988), sMARS (shortened) (Alexander & Martray, 1989) , and MARS-R (revised) (Plake & Parker, 1982). There are also many other pencil-and-paper self-report assessments, including the AMAS (Hopko, Mahadevan, Bare, & Hunt, 2003), MAQ (Wigfield & Meece, 1988), SIMA (Núñez-Peña, Guilera, & Suárez-Pellicioni, 2014), and SEMA (Wu, Barth, Amin, Malcarne, & Menon, 2012).

Although not as well-established as the pencil-and-paper assessment type, there is also a range of behavioural, physiological, and neuroscientific methods that assess maths anxiety (Cipora et al., 2019). Behavioural assessments mostly have a focus on reaction time and accuracy when individuals are involved with mathematical activities. These assessments have shown that speed and accuracy are dependent on maths anxiety level (Ashcraft & Faust, 1994). Physiological assessments may involve the measurement of heart rate, blood pressure, cortisol secretion, and temperature, with increases being shown to be commensurate with maths anxiety level (Cipora et al., 2019; Dowker et al., 2016). Neuroscientific assessment involves the use of brain imaging through functional magnetic resonance imaging (fMRI), EEG (electroencephalogram), and non-invasive brain stimulation (Cipora et al., 2019; Dowker et al., 2016). These assessments investigate the neural correlates of maths anxiety, with non-invasive brain stimulation being a potential treatment of maths anxiety (Dowker et al., 2016). It is important to remember that these assessment types are not yet well established and may be best utilised in conjunction with self-descriptive questionnaires and rating scales. Cipora et al. (2019) point out that, just as there is difficulty in defining maths anxiety. “there is no perfect method for assessing the underlying construct of maths anxiety (p. 28).

As a consequence of the variance in definitions, constructs, factors and assessments, the literature has attributed maths anxiety to “multiple causes [with] multiple effects, interacting in a tangle that defies simple diagnosis and simplistic remedies” (Martinez & Martinez, 1996, p. 2). There is nothing that is simple about maths anxiety. However, we know that it may be a learned condition (Hembree, 1990; Morris, 1981) that can be unlearned (Mutodi & Ngirande, 2014). Furthermore,

given the difficulty in defining maths anxiety, the numerous definitions available, the various constructs and factors discussed, along with the range of assessments utilised, it may be conjectured that maths anxiety is not static, but erratic, and impacts and influences individuals in many ways also. These variations suggest that maths anxiety should be considered as distinctive within and between individuals. In the experience of maths anxiety, it is likely to differ from one individual to that of another.

2.4.2 Prevalence of maths anxiety

Maths anxiety "affects a considerable portion of the population" (Ashcraft & Moore, 2009, p. 197) and is a pervasive, world-wide phenomenon (Chang & Beilock, 2016; Foley et al., 2017; Organisation for Co-operation and Development, 2013). While it may be agreed that maths anxiety is widespread, it is difficult to ascertain specific prevalence as efforts to quantify maths anxiety depend on the assessment utilised, the participant sample, and the criteria that judges one to be maths anxious. Chinn (2009) reported that between 2-6% of secondary students in England are often anxious about mathematics. In a survey of 40 Year 8 Australian male students, Jennison and Beswick (2009) uncovered that 20% of participants recorded high ratings of maths anxiety. Approximately 30% of apprentices in England demonstrate a noticeable response to maths anxiety, while a further 19% tend to be anxious with mathematics to a lesser degree. These findings are very similar to those within the remainder of the English population (Johnston-Wilder, Brindley, & Dent, 2014). In America, Blazer (2011) reported that more than 90% of adults in America have indicated they experience some level of maths anxiety. More globally, the Organisation for Co-operation and Development (2013) noted a prevalence of maths anxiety amongst students. Based on the 2012 PISA results, the OECD revealed that 30% of 15-year-old students across 65 countries experienced maths anxiety.

In New Zealand, there is a paucity of research that shares information regarding the prevalence of maths anxiety. Most recently, a survey determined that 21% of 434 Year 9 students experienced high levels of maths anxiety (Mann, 2017). The results of the 2012 PISA assessment are one further source that identified information specific to New Zealand. PISA findings report that New Zealand showed the greatest

increase in maths anxiety between 2003 and 2012 when compared with 38 other countries with comparable results, and was one of only 13 countries where maths anxiety increased significantly (Organisation for Co-operation and Development, 2013). Parallel to this increase in maths anxiety, a deterioration occurred in mathematics self-efficacy, self-concept, (Organisation for Co-operation and Development, 2013) and performance (May, Cowles, & Lamy, 2013). In relation to mathematics performance, greater anxiety coincided with an average OECD drop of 34 score points, though the score point drop was highest in New Zealand at almost 50 (Organisation for Co-operation and Development, 2013).

While we know that a considerable number of the worldwide population experience maths anxiety, research considering the prevalence in females or males is less clear. Research provides conflicting information. Much research has found higher levels of maths anxiety in females than males (Ashcraft, 2002; Beilock, Gunderson, Ramirez, & Levine, 2010; Devine et al., 2012; Hembree, 1990). In the great majority of countries that participated in PISA 2012, females reported greater mathematics anxiety than males (Organisation for Co-operation and Development, 2015). In direct contrast, Abed and Alkhateeb (2001) found males reported significantly higher scores on maths anxiety than females. This result may be due to the cultural context of the United Arab Emirates (UAE), where the study was carried out. In three countries that participated in PISA 2012, including the UAE, males reported greater anxiety than females (Organisation for Co-operation and Development, 2015). Still other research reports maths anxiety levels as similar for both females and males (Chinn, 2009; Goetz et al., 2013; Kazelskis et al., 2000; Tapia & Marsh, 2004). The 2012 PISA results reported that no gender difference was demonstrated for maths anxiety in nine countries (Organisation for Co-operation and Development, 2015).

There is a range of explanations given for these varying gender results. Inconsistent results may well be related to the varying assessments utilised and participant groups involved, as tools for the assessment of maths anxiety number more than 20, and participant groups vary by, for example: age, gender, school and university type, education and occupation type. Research findings suggest that although females report greater maths anxiety they may not experience greater maths anxiety than males (Bieg, Goetz, Wolter, & Hall, 2015; Goetz et al., 2013). Competence beliefs

(Goetz et al., 2013); gender stereotype threat endorsement (Ashcraft & Ridley, 2005; Bieg et al., 2015; Tomasetto, 2019); along with females being socialised to talk about their feelings more than males, and so being more willing to admit their anxieties (Shields, 2006; Zettle & Houghton, 1998), may all play a part in the reported higher levels of maths anxiety in females.

As well, the gender bias that contributes to different experiences for female and male students in previous mathematics learning may also impact the level of maths anxiety experienced (Jackson & Leffingwell, 1999; Tiedemann, 2002). In the research of Jackson and Leffingwell (1999) involving 157 participants who were taking a required mathematics course for teacher certification, a gender difference was evident in the responses to the question regarding the worst or most challenging mathematics learning experience. Gendered experiences were evident through: females being told that girls do not need mathematics or should not take mathematics classes; females, more than males, being overtly ridiculed when asking for clarification; females being laughed at by teachers when asking a question; and females being helped less during mathematics class than males (Jackson & Leffingwell, 1999). In more recent research, a belief that mathematics is more suited to males than females remained evident (Bieg et al., 2015; Forgasz, Leder, Mittelberg, Tan, & Murimo, 2015; Haase et al., 2019; Van Mier, Schleepen, & Van den Berg, 2019).

2.4.3 Onset of maths anxiety

There is no definitive foundation age for maths anxiety. However, it has been suggested that the typically positive attitudes of young children (Steele & Arth, 1998) declined towards the approaching adolescent period (Martinez & Martinez, 2003; Scarpello, 2007), and that maths anxiety increased between the ages of eleven to thirteen, peaked near the ages of fourteen to fifteen, then levelled off from age sixteen and beyond (Hembree, 1990). This suggestion was based on extensive research involving children from nine years old through to adults, which may have influenced these ideas. Few studies, until recently, were carried out with younger children. More recent research results are challenging ideas that have been held previously (Harari et al., 2013; Lu, Li, Patrick, & Mantzicopoulos, 2021; Maloney,

2012; Moore et al., 2015; Petronzi et al., 2019). A number of researchers have begun to investigate the earlier onset of maths anxiety in younger children (Aarnos & Perkkilä, 2012; Harari et al., 2013; Krinzinger, Kaufmann, & Willmes, 2009; Y. Lu et al., 2021; Petronzi et al., 2019; Ramirez, Gunderson, Levine, & Beilock, 2013; Wu et al., 2012). For example, Maloney and Beilock (2012) have found evidence that maths anxiety may be evident at the beginning of formal schooling. Aarnos and Perkkilä (2012) have identified maths anxiety in children between six and eight years, while Petronzi et al. (2019) have found that children as young as four may experience maths anxiety. Maths anxiety is now considered "a severe problem over entire life spans" (Luttenberger et al., 2018, p. 319). Further to this, research has found that the dimensions of maths anxiety that present in young children are characteristic of that presented in older children and adults (Harari et al., 2013).

2.4.4 Origins of maths anxiety

Origins of maths anxiety identified in research include both societal and environmental factors (Martinez & Martinez, 2003; Shields, 2005). Although society and the home may influence the development of maths anxiety at any stage, as teachers are at the centre of this research this review focuses on the classroom and the teaching of mathematics. Starting school with limited foundational mathematics skills (Maloney, 2016) may contribute to maths anxiety for some children. However, students who start school with a well-developed informal competence in mathematics (Clarke, Cheeseman, & Clarke, 2006), sometimes above expectations (Lee & Lomas, 2015), are confident with and interested in mathematics (Perlmutter, Bloom, Rose, & Rogers, 1997) and are "powerful mathematics students" (Perry, MacDonald, & Gervasoni, 2015), may later experience maths anxiety.

It has been claimed that this later experience of maths anxiety has its roots in teaching and teachers (Martinez, 1987; Vinson, 2001; Williams, 1988), and a strong argument has been made to the effect that the beginnings of maths anxiety may be traced back to negative classroom experiences (Newstead, 1998). Minimal published research has been found to disprove this claim, and more recent research continues to confirm that teachers play a significant role in the development of maths anxiety

(Ashcraft, Krause, & Hopko, 2007; Beilock & Maloney, 2015; Buckley et al., 2016; Sloan, 2010; Stoehr, 2017b; Whyte & Anthony, 2012; Wicks, 2021).

Numerous studies involving pre-service teachers have found that they identify the main contributor to the development of their maths anxiety to be previous school experiences (Uusimaki & Nason, 2004). Although a variety of classroom experiences may be considered as antecedents for maths anxiety, disturbingly, Bekdemir (2010) reported that maths anxiety was "substantially caused" (p. 325) by the behaviour and teaching approach of teachers in junior high school. Furthermore, 50% of participants in Uusimaki and Nason's (2004) study specifically identified primary school teachers as instrumental in the development of their maths anxiety. Wicks (2021) has also reported that the characteristics of the teacher and the teaching strategies utilised may contribute to the development of maths anxiety. Kelly, Romero, Morrow, Denton, and Ducking (2020) reported that specific instructor misbehaviours may also promote maths anxiety. These instructor misbehaviours are antagonism, involve behaviours that intimidate or threaten students, and lecturing, which involves poor teaching practices such as a drone-like delivery and reading a digital presentation.

A recent precursor for maths anxiety has been identified by Brewster and Miller (2020) as being missed opportunity. Missed opportunity may involve poor mathematics teaching, or absences from mathematics classes, that result in a lack of "opportunity to learn the foundational knowledge in mathematics that is required to further learn higher levels of mathematics" (p. 7). Missed opportunity may help explain why some students achieve well in other academic subjects though not in mathematics.

The outlier study by O'Leary, Fitzpatrick, and Hallett (2017) contrasts with that previously discussed. Their research did not find evidence to support previous research that has reported that teacher behaviour, such as insensitivity, criticism, hostility (Jackson & Leffingwell, 1999), humiliation, disrespect and fear-based instruction (Schmidt, 2005), may heighten the maths anxiety levels of students.

Since maths anxiety may be initiated by the way mathematics is taught (Dole, 2013), and contrasting research is limited, it is likely that the mathematics primary

classroom is a place where maths anxiety may emerge and escalate. One of the concerns of this study is how teachers who themselves are maths anxious may promote or limit maths anxiety in classrooms.

2.4.5 Impact

Maths anxiety may impact individuals in a variety of ways, including their response to mathematics, avoidance of mathematics, and mathematical performance. Overall, there is agreement that maths anxiety may take multidimensional forms (Ashcraft et al., 2007; Ma, 1999). Responses have been found to be cognitive, affective, physiological, and neural. The cognitive response is intellectual, with characteristics such as negative self-talk, avoidance, and 'blanking out' (Freiberg, 2005). The affective response is emotional (Wigfield & Meece, 1988), with characteristics such as distrust of ability, fear of looking stupid, and loss of self-esteem (Freiberg, 2005). The physiological response involves bodily function, and has a large number of characteristics such as changes in breathing, nausea, raised heartrate, sweating, and tightness in the chest (Shields, 2005). More recently, Lyons and Beilock (2012) have also identified a neural response: the anticipation of mathematics for individuals with high levels of maths anxiety "increases activity in regions associated with bodily threat detection and the experience of visceral pain itself" (p. 6) joined with the inability to regulate this response effectively. It is not the mathematics itself that creates the pain, but the anticipation of mathematics and the inability to control one's response to that anticipation.

Maths anxious individuals are known to avoid mathematics (Lyons & Beilock, 2012; Wilson, 2013). They may do this by rushing activities to reduce involvement with, and time given to, mathematics (Ashcraft & Moore, 2009) and to avoid the pain threat that mathematics may activate (Lyons & Beilock, 2012). Students with maths anxiety may also choose not to enrol in mathematics courses beyond those that are compulsory (Ramirez et al., 2013), which subsequently limits career choices. Teachers with maths anxiety may also demonstrate avoidance of mathematics. Maths anxiety may prompt teachers to spend less time teaching mathematics than their less anxious colleagues (Engelhard Jr, 1990). Consequently, this reduces

mathematical learning opportunities for their students (Dowker, 2019; Maloney, 2016).

Maths anxiety and mathematics performance correlate. This point has been confirmed by numerous research projects (Ashcraft & Kirk, 2001; Ma, 1999; Moore et al., 2015; Organisation for Co-operation and Development, 2013; Ramirez et al., 2013). There is, however, conflicting research regarding the causal direction between maths anxiety and poor lower maths performance. Some research indicates that maths anxiety may lower future performance in mathematics: the Debilitating Anxiety Model, while other research reports that poor performance may instigate maths anxiety: the Deficit Theory (Carey, Hill, Devine, & Szücs, 2016).

There are two schools of thought in regards the Debilitating Anxiety Model: disrupted working memory and avoidance. This model proposes that maths anxiety impacts working memory (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Ramirez et al., 2013; Witt, 2012). When attention is given to intrusive thoughts and worries (Maloney, 2016) this “disrupts the on-going, task-relevant activities of working memory, slowing down performance, and degrading its accuracy” (Ashcraft & Kirk, 2001, p. 236). For example, in timed tests, high-anxious students solved fewer problems, used retrieval less often and procedure more often, compared with their low-anxious peers, indicating less efficient problem solving in the former group than in the latter (Imbo & Vandierendonck, 2007).

Just as maths anxiety may result in disrupted working memory, maths anxiety may also influence the interactions that individuals choose to have with mathematics. Carey et al. (2016), Dowker (2019) and (Maloney, 2016) suggest that individuals who experience maths anxiety tend to avoid mathematics. As they avoid mathematics, individuals reduce the opportunity for learning and it may be difficult to increase understanding when they reduce opportunities of having to engage with mathematical processing. It has also been suggested that maths performance of those who experience maths anxiety may be lowered due to rushing to complete work with mathematics (Carey et al., 2016).

In contrast, the Deficit Theory suggests that poor mathematical performance leads to maths anxiety. It may be that the fear of failure, brought on from repeated failure with

mathematics, leads to maths anxiety (Dowker, 2019). For example, research has suggested that difficulties with early mathematics may lead to maths anxiety (Maloney, Ansari, & Fugelsang, 2011; Núñez-Peña & Suárez-Pellicioni, 2014).

A third theory offered to address the causality dilemma proposes rather than there being a unidirectional causality between maths anxiety and achievement, that the causality is reciprocal: The Reciprocal Theory (Carey et al., 2016). It is suggested that each promotes the other, with the correlation being a bidirectional relationship (Ashcraft et al., 2007; Carey et al., 2016; Hannula, 2012; Maloney & Beilock, 2012).

2.5 Maths anxiety and teachers

As there is thought to be a significant sector of the general population who experience maths anxiety, one might presume that there is also a significant sector of primary teachers who experience maths anxiety. However, research relating to maths anxiety and in-service primary teachers is scarce, with no research within New Zealand, and minimal international research (McAnallen, 2010), located. As the focus of this research is in-service primary (elementary) teachers, these are the teachers that are being referred to when the terms ‘teacher’ and ‘teachers’ are used. Information relating to pre-service teachers is utilised when information relevant to in-service teachers was not available. When this occurs, pre-service teachers are identified.

2.5.1 Prevalence

Just as in the general population, there are varying figures to indicate the prevalence of maths anxiety with teachers. In their study involving 230 participants, Widmer and Chavez (1982) found that 16% of these teachers experienced maths anxiety, though another United States study involving 691 participants reported that 33% of these teachers identified as maths anxious (McAnallen, 2010). A study by Gürbüz and Yıldırım (2016) that involved 559 teachers in Turkey found that all participants had some level of maths anxiety, mostly “anxious a little” (p. 540), though anxiety was highest around mathematical self-efficacy/competence and when dealing with a mathematical problem. In another study involving 111 teacher participants in Canada, Adeyemi (2015) reported that all participants experienced some level of

maths anxiety: approximately 17% experienced a low level, 64% experienced moderate, and 19% experienced a high level.

Similar to research involving the general population, research investigating maths anxiety and teachers relating to gender also indicates that maths anxiety is reported more often by female than male teachers. Widmer and Chavez (1982) found that 17% of female teachers, though only 8% of males, identified as maths anxious in their study with 230 participants in the United States. Gürbüz and Yıldırım (2016) again found that scores for maths anxiety were higher for females than males for teacher participants in Turkey, and similar results were reported in a study involving 692 teachers in the United States (Hadley & Dorward, 2011). In the research of Adeyemi (2015), data from 107 teacher participants in Canada showed that maths anxiety was also greater in female teachers compared with that of males.

Considerable searching located only one research study that involved teachers who reported higher maths anxiety in males than females. This study involved 68 in-service primary teachers in Trinidad and Tobago, 40 of whom were working towards a Bachelor of Education degree and 28 who had already gained this qualification (Jaggernauth & Jameson-Charles, 2015). These results were described as unexpected and were explained as resulting from sampling bias.

This preponderance to higher reported levels of maths anxiety in female teachers may be due to minimal maths anxiety reported by male teachers, or because of their ability to cover up their emotions and not easily reveal any weaknesses (Liu, 2008). Given the predominance of female teachers (females constitute 85% of the teacher population (MoE, 2019d) in New Zealand), the higher incidence of reported maths anxiety for females than males is a concern.

2.5.2 Origins

Teachers who have reported maths anxiety readily identify experiences that have contributed to the development of that maths anxiety. In McAnallen's (2010) study involving 691 teacher participants in the United States, 258 (37%) responded to a question requesting information about previous life and academic experiences that were thought to have contributed to maths anxiety. Maths anxiety was attributed to

previous negative interactions with teachers about mathematics and poor mathematics teaching practices. Negative interactions had left participants feeling embarrassed, ridiculed, humiliated, and hurt. Poor teaching practices involved a focus on speed with instructions, expected responses, and the development of understanding, as well as a lack of response to questions asked of teachers, a focus on memorisation of rules and basic facts with little attention to underlying concepts, and teachers themselves lacking conceptual knowledge of the mathematics being taught. Participants also noted that in upper grades, the abstract teaching of algebra and geometry also contributed to maths anxiety. Along with the teacher and teaching, their own lack of conceptual mathematical knowledge was identified by participants in McAnallen's study as contributing to maths anxiety.

Another study involving teachers reported similar results in relation to past mathematics classroom experiences. Based in Canada, Adeyemi (2015) found that the teaching strategies utilised by previous teachers, along with their insensitive comments and 'mean' behaviour, contributed to the maths anxiety of four participants who were interviewed as part of a mixed methods study involving 111 in-service teachers. Again, the fast pace of instruction was raised by participants as a contributor to maths anxiety. Other actions of teachers attributed to the development of maths anxiety included previous mathematics concepts not being reviewed; teaching to students who were strong in mathematics, which left others behind; and participants also identified that their own lack of understanding of mathematics concepts contributed to their maths anxiety.

The findings of McAnallen (2010) and Adeyemi (2015) are consistent with previous studies that identify contributors of maths anxiety and the impact that teachers and teaching strategies have (Arem, 2003; Bekdemir, 2010; Brady & Bowd, 2005; Gresham, 2007; Jackson & Leffingwell, 1999; Perry, 2004; Shields, 2006). Geist (2010) has cautioned that when teachers use strategies that encourage "correct answers over concept development, competition and speed over understanding, and rote repetition over critical thinking" (p. 28), then maths anxiety may be initiated and intensified. Just as previous studies do, the work of McAnallen (2010) and Adeyemi (2015) also indicate that maths anxiety is not inherently attributed to the mathematics itself, but rather to the attitudes of, and interactions with, teachers and the way

mathematics is taught in classrooms (Jackson & Leffingwell, 1999; Stuart, 2000; Williams, 1988).

2.5.3 Changes

From research, (for example, Artemenko, Masson, Georges, Nuerk, & Cipora, 2021; Bekdemir, 2010; Brady & Bowd, 2005; Brown, Westenskow, & Moyer-Packenham, 2011; Bursal & Paznokas, 2006; Gresham, 2007; McGlynn-Stewart, 2010; Olson & Stoehr, 2019), we know that many pre-service primary teachers experience maths anxiety. However, there are varying results from research (Adeyemi, 2015; Artemenko et al., 2021; Gresham, 2018; Gürbüz & Yıldırım, 2016) relating to the stability of maths anxiety across increased teaching experience. Importantly, a recent research study involving both pre-service and in-service elementary teachers from Germany (n=131) and Belgian (n = 127), suggests that maths anxiety may "not fade away (or build up) with increasing teaching experience" (Artemenko et al., 2021, p. 18).

Similar to Artemenko et al. (2021), Adeyemi (2015) found no significant difference between maths anxiety scores for beginning, experienced, and very experienced teachers. Although research was completed from a slightly different approach, Widmer and Chavez (1982) reported results similar to Adeyemi (2015) from their investigation of maths anxiety levels of primary mathematics teachers who had completed recent training in mathematics compared to those whose training was more distant. No significant difference was found between the two teaching groups, though no evidence of a non-significant trend was found either (Widmer & Chavez, 1982).

Gresham (2018) reported a slight change in maths anxiety levels for teachers after gaining teaching experience. Her research study with female teachers during both their pre-service education and their in-service teaching employment found that their maths anxiety did not disappear when starting in the teaching profession and had decreased only slightly after five years of teaching. All 10 teacher participants identified daily mathematics struggles within themselves, and reported that throughout their five years of teaching their maths anxiety was "consistently evident in their mathematics classroom" (p. 95). While these teachers felt that their maths

anxiety had decreased during their time of teaching, they felt the need to work to demonstrate a positive attitude towards mathematics continued, while, simultaneously, they made efforts to "*hid[e]* their negative feelings regarding mathematics" (p. 96, emphasis in original).

In contrast, Gürbüz and Yıldırım (2016), also investigating levels of anxiety during teaching tenure, found that maths anxiety may reduce over an extended period of teaching. In their study, those teachers who had been teaching for only 1-5 years scored the highest total on a maths anxiety scale, while teachers who had been teaching for 21 years or more scored the lowest. In acknowledging this reduction in maths anxiety, it is interesting to note that there was no statistically significant difference in the total maths anxiety scores within the 1-5 year teaching group and the 6-10 year teaching group, and this lack of statistical significant difference was repeated across the 11-15, 16-20, and 21 and more years teaching tenure groups. However, there was a significant difference between the teachers who had 1-10 years of teaching experience and those who had taught for 11 or more years.

The endurance of maths anxiety throughout one's teaching career (Adeyemi, 2015; Artemenko et al., 2021; Widmer & Chavez, 1982) is a cause for concern given evidence of correlation between those teachers who have higher levels of maths anxiety and those who have decreased enjoyment of mathematics (McAnallen, 2010). Research also suggests that teachers who experience higher levels of maths anxiety have also shown low teacher efficacy about teaching mathematics and high mathematics avoidance (Jaggernauth & Jameson-Charles, 2015), along with negative beliefs (Haciomeroglu, 2013; Uusimaki & Nason, 2004), negative attitudes (Geist, 2010; Maloney & Beilock, 2012), and low confidence to teach mathematics (Adeyemi, 2015). This is concerning overall, as teachers are expected to engender an excitement for learning mathematics in their students, though surely "[t]hey cannot be expected to generate enthusiasm and excitement for a subject for which they have fear and anxiety" (Mihalko, 1978, p. 36).

2.6 Maths anxiety and teaching

While we know that teachers experience maths anxiety, it is important to consider these teachers, their teaching, and the students they work alongside. To this end, the following will be discussed: situations in which maths anxiety may be accentuated; instructional strategies that may be utilised; how maths anxiety may be managed; possible consequences for students who work alongside teachers who experience maths anxiety; and the anxiety of teaching mathematics that teachers may experience.

2.6.1 Situations for maths anxiety

Lukowski et al. (2019) discussed literature involving both child and adult participants that indicated three situations that promote experiences of maths anxiety. These situations are mathematics testing, performing mathematical calculations, and social settings, such as the classroom. No literature was located that was specific to the situations in which teachers experience maths anxiety as part of their teaching – be it planning, teaching, professional development, or community involvement. However, research with pre-service teachers gives some indications. For example, Uusimaki and Nason's (2004) semi-structured interviews with 18 self-identified maths anxious third year pre-service teachers reported that having to communicate their own mathematical knowledge, whether through testing or explaining their understanding, promoted the most maths anxiety; while the teaching of mathematics also prompted considerable anxiety, due to the fear of making mistakes or being unable to reach a correct mathematical solution.

2.6.2 Instructional strategies

There are contrasting reports regarding the impact that maths anxiety may have on mathematics instructional strategies. There is a body of research that suggests that teachers who experience maths anxiety may not exhibit instructional strategies characteristic of effective mathematics teachers. For example, they may focus on basic skills rather than concepts (Finlayson, 2014; Shields, 2005), and may rely on the teaching of algorithms while overlooking cognitive thought processes and

reasoning (Lu, 2015). Little time may be given for questioning, discussion, and developing understanding, which may portray the teacher as the provider of mathematical information, with the student as the receiver who is unlikely to challenge teacher authority (Finlayson, 2014).

Notably, in light of current calls for reforms in mathematics education, Ganley et al. (2019) suggest that maths anxiety may be a barrier to implementing student-centred teaching by teachers. Research by Karp (1991), involving four primary teachers across two different levels, found that mathematics teaching for these participants was based on rules and memorisation. Teaching involved teachers demonstrating and explaining the one correct way to solve a problem; student dependency on the teacher who held the mathematical authority that resulted in learned helplessness among students; a reliance on worksheets that promoted practice; and limited time for active involvement, discussion, and questions by students (Karp, 1991). Itter and Meyers's (2017) study of 152 pre-service teachers in Australia who were in their third year of a four year degree found that fear and anxiety "constrained their capacity to teach mathematics innovatively, and limited their pedagogical choices to 'mundane worksheet classes'" (p. 132).

However, an American study by Bush (1989) involving 31 teachers who experienced maths anxiety found that they did not teach significantly differently to those teachers who did not experience maths anxiety, though there was a slight tendency to utilise traditional instructional strategies more. For example, they gave more time to seatwork and whole-class instruction; taught more skills and fewer concepts; and gave less time to small-group and individualised instruction, problem solving, and utilisation of interactive maths games. These non-traditional mathematics activities require teachers to take both mathematical and management risks, which these maths anxious teachers tended not to do (Bush, 1989). In short, teachers who experience maths anxiety may be more likely to utilise traditional instructional strategies (Brady & Bowd, 2005; Cady et al., 2006; Furner & Berman, 2003; Ganley et al., 2019; Karp, 1991; Koch, 2018; Swars et al., 2006). Traditional instructional strategies fit with the transmission orientation for mathematics teaching, which tend to characterise less effective teachers (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997).

In addition to the use of traditional instructional strategies, research involving either pre-service or in-service teachers suggests that maths anxiety may correlate with a range of factors that influence teacher effectiveness; factors such as low mathematics teaching self-efficacy (Adeyemi, 2015; Bursal & Paznokas, 2006; Gresham, 2009; Jaggernauth & Jameson-Charles, 2015; Liu, 2016), negative beliefs (Haciomeroglu, 2013; Uusimaki & Nason, 2004), negative attitudes (Ashcraft, 2002), and mathematics avoidance (Jaggernauth & Jameson-Charles, 2015; Trice & Ogden, 1986). When considering these relationships with maths anxiety it may not be maths anxiety on its own that is impacting instructional strategies, as self-efficacy (Bonner, 2006; Gresham, 2018; McCulloch, 2016; Sasser, 2010; Swars et al., 2006), and beliefs (Hughes, 2016; Muijs & Reynolds, 2015; Voss, Kleickman, Kunter, & Hachfeld, 2013) have been found to influence instructional strategies also. One might conjecture that when maths anxiety and any of the aforementioned characteristics combine in an individual, the reliance on traditional instructional strategies may be boosted.

Although many research studies report that maths anxious teachers embody a dependence on traditional instructional strategies, research also provides contrasting findings. In particular, for some, anxiety may be motivational. Various reasons for this have been offered, and it may be that pre- and/or in-service teachers who experience maths anxiety:

- are more motivated to try harder with their mathematics teaching to improve it (Hadley & Dorward, 2011; Smith, 2010);
- understand that reform mathematics teaching involving real-life situations and the use of manipulatives (Swars et al., 2006), as well as discussion, asking questions, mistake making (Stoehr, 2017a) and a positive learning environment (Gresham, 2009), may motivate students and enhance their understanding of mathematical concepts (Swars et al., 2006);
- are able to attribute their maths anxiety to identified traditional instructional strategies and therefore utilise different instructional strategies to reduce the likelihood of maths anxiety developing in their own students (Adeyemi, 2015; Chavez & Widmer, 1982);
- downplay the importance of mathematics in their profession (Olson & Stoehr,

2019), or may see primary mathematics as basic and have a limited idea of the depth and content that is required to teach mathematics in a primary classroom, though this may be said of many primary teachers (Ball & Bass, 2000; Bulmahn & Young, 1982; Smith, 2010); and

- may want their students to be motivated and interested in mathematics, and not to learn to dislike mathematics as they did (Adeyemi, 2015; Gresham, 2009; Ng, Lopez-Real, & Rao, 2003).

Teachers report various beliefs in relation to their instructional practice, similar to those outlined above. However, although there may be consistency between espoused beliefs and classroom practice (Stipek, Givvin, Salmon, & MacGyvers, 2001), it has also been found that what is espoused does not always occur in the classroom (Ng et al., 2003; Raymond, 1997; Walshaw & Anthony, 2007).

2.6.3 Managing maths anxiety

Limited research is available that describes how teachers who experience maths anxiety might manage that anxiety. Adeyemi's (2015) one-to-one interviews with four teachers revealed that a common strategy was to reach out for help and ask colleagues for assistance. Being fully prepared for teaching was another strategy identified as worthwhile, and this included researching and actively studying the mathematics topic prior to planning for a mathematics lesson. Perseverance, or 'sticking with it', seemed to be another strategy useful for managing maths anxiety, as one teacher participant in the study of Adeyemi (2015) emphasised: "do not give up, that's the last thing you want to do, it's not gonna be good for anybody" (p. 109).

Another strategy identified involved two ideas relating to improvement with mathematics. First, there was a focus on their own mathematical understanding, through reading and video watching mathematics related resources (Adeyemi, 2015). The other involved professional learning for teaching, including postgraduate study (Gresham, 2018), that was not only centred on the teaching of mathematics, but involved addressing maths anxiety also. Buckley et al. (2021) have reported that it is essential to address maths anxiety directly in professional learning so that the causes and effects of maths anxiety are managed. While Buckley et al. (2021) and Gresham (2018) believed that maths anxiety must be addressed in professional

development. Pair, Johnson, Lee, and Sawyer (2019) suggest an intervention that may be useful to addressing maths anxiety. They suggest that promoting a growth mindset and challenging unproductive beliefs are likely to reduce maths anxiety, though noting that a "shift in mindset, beliefs, and anxiety is not a quick nor single event" (Pair et al., 2019, p. 7). Although their intervention was designed for pre-service teachers, the ideas may be useful to include in regular professional development or staff meetings with teachers.

Research completed by Jaggernauth (2010) that involved 68 teachers showed that higher levels of maths anxiety brought an avoidance of mathematics teaching. Sloan (2010) has raised statistics from 1983 that suggested teachers who do not find mathematics enjoyable [perhaps the majority of teachers who experience maths anxiety] spend 50% less time teaching mathematics than those who do feel comfortable with mathematics.

Trice and Ogden (1986) completed research of 40 first year teachers that involved the administration of the Revised Mathematics Anxiety Rating Scale (R-MARS; Plake & Parker, 1982), three classroom observations, lesson plan analysis, as well as a debriefing interview. It was found that teachers who experienced higher levels of maths anxiety scheduled less time for mathematics teaching and learning each day compared with those who were less anxious about mathematics. Not only was less time scheduled for mathematics each day, but not all of this time was focussed on mathematics, as highly maths anxious teachers focussed on mathematics for 63% of the scheduled mathematics teaching time compared with their colleagues who focussed on mathematics for approximately 91% of the scheduled mathematics time (Trice & Ogden, 1986). During observations, it was also found that the teacher who experienced higher levels of maths anxiety were 10-15 lessons behind their colleagues with their mathematics curriculum delivery (Trice & Ogden, 1986).

Other research has also reported that maths anxiety may prompt pre-service teachers to spend less time teaching mathematics than their less anxious colleagues (Dunkle, 2010; Engelhard Jr, 1990; Gresham, 2007, 2008), avoid teaching mathematical concepts that are difficult for them (Allen, 2001; Itter & Meyers, 2017), or focus on learning procedures rather than fostering reasoning (Olson & Stoehr, 2019). Martinez (1987) proposed that teachers might avoid mathematics in several

ways, such as a) allowing time to be given to such things as gathering lunch money, promoting class projects, or sharing announcements; b) relying on a 'do and mark' approach that gives little time to discussion; and c) reducing time given to discussion and clarification by referring to an answer resource for teachers. All of these activities reduce the time for mathematics teaching, allowing teachers to "'take cover' and protect themselves from struggling with mathematical teaching situations that create anxiety for them" (Stoehr, 2017a, p. 120), so avoiding mathematics.

Although avoidance of mathematics teaching may be considered as another strategy for managing maths anxiety, there is a paucity of research to support this. In contrast to anecdotal evidence, Golds (2014), in a New Zealand study that involved eight teachers, suggested that this may be because the majority of teachers may not be willing to admit that they do not consistently teach mathematics; they may keep their practices hidden.

An alternative to avoiding mathematics per se, maths anxious teachers may make a choice to limit their year level of teaching. Ganley et al. (2019) and Leung and Cohen (2004) indicate that teachers may choose to teach at a lower level to avoid teaching mathematics content that promotes their maths anxiety. Similarly, Adeyemi (2015) reported that teachers have identified that they do not have the capability to teach mathematics at a higher level.

2.6.4 Consequences for students

There are potential consequences for students when they are working with teachers who experience maths anxiety, both in terms of promotion of student maths anxiety and/or the impact of missed opportunities to learn. As discussed above (section 2.6.2), teachers who experience maths anxiety may often utilise instructional strategies that promote maths anxiety for students.

Additionally, maths anxious teachers may transmit their anxiety to the students they work alongside. Literature to support the suggestion that maths anxiety is transmitted to students spans a wide timeframe (Adeyemi, 2015; Brady & Bowd, 2005; Bulmahn & Young, 1982; Furner & Berman, 2005; Geist, 2010; Hembree, 1990; Koch, 2018; Ma, 1999; Martinez, 1987; Sloan, Daane, & Giesen, 2002; Wood, 1988). Bulmahn

and Young (1982) describe maths anxiety as a communicable disease, and Liu (2008) goes so far as to identify it as contagious. The transmission of maths anxiety has been described as an intergenerational effect (Herts, Beilock, & Levine, 2019), as the cycle of maths anxiety continues when the anxiety is transmitted to the next generation (Beilock et al., 2010; Brady & Bowd, 2005; Burns, 1998).

As discussed previously (section 2.6.3), teachers who experience maths anxiety may often avoid teaching mathematics. A consequence of any teacher avoidance of mathematics teaching is that students lack optimal opportunities for learning mathematics (Allen, 2001), which may have “serious ramifications for students” (Martinez, 1987, p. 120), for example, negatively impacting their mathematics achievement level.

Numerous research studies have investigated the relation between teacher maths anxiety and student achievement. Both qualitative (Bryant, 2009; Furner & Berman, 2003; Hembree, 1990; Karp, 1991; Martinez, 1987; Sloan et al., 2002; Vinson, 2001) and quantitative (Beilock et al., 2010; Hadley & Dorward, 2011; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015) research indicate that teachers who experience maths anxiety negatively impact their student achievement. This may be more apparent in relation to female teachers and the female students they teach.

From research with 17 early primary teachers in the United States, Beilock et al. (2010) found that the higher the level of maths anxiety of female teachers the more likely it was that their female students would support the commonly held stereotype that ‘boys are good at maths, and girls are good at reading’ and the lower the mathematics achievement was for these female students (Beilock et al., 2010). The maths anxiety demonstrated by these female teachers influenced gender-related mathematical beliefs, decreased the mathematical ability confidence, and reduced achievement levels of their female students (Beilock et al., 2010), as students are found to be more sensitive to same-gender teacher influence and sex-roles, and model behaviours believed to be gender-typical (Serbin & Sprafkin, 1986). As gender-appropriate behaviours are learned by children from same-gender adults, and children are inclined to separate themselves from the behaviours of opposite-gender adults (Bussey & Bandura, 1984; Perry & Bussey, 1979), it is not surprising that male students had not been influenced by the commonly held stereotype, nor

were their achievement levels assessed at year end influenced (Beilock et al., 2010). This finding by Beilock et al. (2010) is concerning given that, in New Zealand, females make up 85% of that primary teacher population (MoE, 2019d).

Given the association between maths anxiety and student achievement it is likely that for teachers who experience mathematics anxiety, there is a lack of confidence or mathematical knowledge. From a study involving both secondary and elementary pre-service teachers, Kalder and Lesik (2015) found that across three groupings (negative, neutral, and positive), elementary pre-service teachers made up the negative group entirely, and experienced both maths anxiety and low confidence with mathematics. This finding is also supported by previous research (Brady & Bowd, 2005; Bursal & Paznokas, 2006; Gresham, 2008; Sloan, 2010), with Bursal and Paznokas (2006) pointing out that preservice teachers experiencing higher maths anxiety "believe that they will not be able to teach mathematics effectively" (p. 177).

As previously asserted, mathematical knowledge may be lacking in teachers who experience maths anxiety. Peker (2009b) reported that an inadequate mathematical knowledge has been linked to maths anxiety in a study of pre-service elementary teachers. Furthermore, research studies involving teachers have also provided similar results (Adeyemi, 2015; Leung & Cohen, 2004; McAnallen, 2010). This is a concern, as "[h]ow well teachers know mathematics is central to their capacity to use instructional materials wisely, to assess students' progress, and to make sound judgements about presentation, emphasis, and sequencing" (Ball, Hill, & Bass, 2005, p. 14). Walshaw (2012, p. 181) proposes that knowledge and skill of the teacher are "at the heart of effective teaching." With a combination of maths anxiety and lack of confidence or mathematical knowledge, student achievement may well be negatively impacted.

2.6.5 Maths teaching anxiety

Up until this point, maths anxiety has been the focus, though there is another mathematics specific anxiety that requires consideration. As a relatively recent focus of research, this form of anxiety relates to the teaching of mathematics and is termed in different ways within the literature. These terms include: anxiety towards teaching

mathematics (ATTM; Liu, 2008); anxiety about/for teaching mathematics (ATM; Ganley et al., 2019; Hadley & Dorward, 2011; Levine, 1996); and mathematics teaching anxiety (MTA; Brown et al., 2011; Haciomeroglu, 2014; Olson & Stoehr, 2019; Peker, 2009a; Peker & Ertekin, 2011; Peker & Ulu, 2018; Unlu, Ertekin, & Dilmac, 2017). From this point forward, this anxiety will be termed maths teaching anxiety.

To define maths teaching anxiety, we must first consider teaching anxiety generally. Gardner and Leak (1994) conceptualised teaching anxiety as anxiety relating to preparing teaching activities and executing them in the classroom. Levine (1996) associated this anxiety with mathematics to infer that maths teaching anxiety reflected a real or perceived lack of mathematical content knowledge and teaching skills, along with memories of past failure with mathematics or with maths anxiety. Peker (2009a) considered maths teaching anxiety more specific to the actual teaching when he described it as the anxiety that occurs for teachers "during the teaching of mathematical concepts, theories and formulas, or during problem solving" (p. 100). Brown et al. (2011) gave a broader view of maths teaching anxiety, describing it as the anxiety experienced by a teacher "about their ability to *teach* mathematics" (p. 2, emphasis in original), and explaining mathematical ideas clearly enough so that students would understand. From the variances in definitions outlined, it can be considered that different researchers emphasise components of maths teaching anxiety in varying degrees.

In this research, maths teaching anxiety is deemed to be a negative response specific to anticipation of or involvement with activity relating to mathematics teaching, or to the beliefs held in relation to perceived competence with teaching mathematics

Maths teaching anxiety differs from maths anxiety. Maths anxiety is considered to be internally focused, as it reflects the view of mathematical confidence and the perceived or real lack of mathematical content knowledge held by an individual (Brown et al., 2011); the doing of mathematics by oneself (Ganley et al., 2019). However, maths teaching anxiety has an external focus and reflects how a teacher may view her or his ability to engage students with mathematics and its learning (Brown et al., 2011); the teaching of mathematics by oneself (Ganley et al., 2019).

Many might assume that maths teaching anxiety commences with maths anxiety. Levine (1996) associated maths teaching anxiety with previous failure and anxiety with mathematics, though later research (Brown et al., 2011) found that maths teaching anxiety may be independent of a weak mathematics background of an individual. Brown et al. (2011) completed a qualitative study involving 55 pre-service teachers and found several blends involving these two distinct anxieties that clearly did not support the assumption that maths anxiety and maths teaching anxiety went hand-in-hand. Results showed that 40% of participants experienced neither maths anxiety nor maths teaching anxiety; 21% experienced both of these anxieties; 19% experienced maths anxiety but no maths teaching anxiety; and 17% did not experience maths anxiety though did experience maths teaching anxiety, while 4% did not fit the dichotomous framework of the research (percentages have been rounded for ease of reading). The results indicate that 36% of these pre-service teachers challenge the traditional assumption that these two anxieties necessarily go hand-in-hand. Likewise, the results from the research of Adeyemi (2015) again challenged the traditional assumption, as 43% of the teacher participants opposed this assumption. From these results it might be inferred that the relationship between maths anxiety and maths teaching anxiety is unpredictable.

The research of Brown et al. (2011), Adeyemi (2015), and Olson and Stoehr (2019) found evidence that suggests maths anxiety and maths teaching anxiety are correlated but are not redundant. While Hadley and Dorward (2011) also found a correlation, they reported that it was more evident when levels of maths anxiety were lower, and that higher levels of maths anxiety had no specific relationship to maths teaching anxiety. This lack of correlation resulted from varying levels of maths teaching anxiety experienced by the teachers who experienced higher maths anxiety; experiences of low, moderate, or high levels of maths teaching anxiety were found (Hadley & Dorward, 2011). In contrast to Hadley and Dorward (2011), Adeyemi (2015) and Olson and Stoehr (2019) reported a correlation between high maths teaching anxiety and high maths anxiety. No matter the differing correlations, Olson and Stoehr (2019) provided a reminder that there is a “great deal of continuity and overlap between the experiences” (p. 79) of maths anxiety and maths teaching anxiety.

When considering research relating to maths teaching anxiety, interesting findings that indicate similarities and differences between maths anxiety and maths teaching anxiety were reported:

- Teachers who experienced maths teaching anxiety tended to utilise more traditional instructional strategies than those teachers who experienced maths anxiety only (Hadley & Dorward, 2011);
- As more teaching experience was gained, there was a decline in maths teaching anxiety (Adeyemi, 2015; Hadley & Dorward, 2011; Patkin & Greenstein, 2020), though there are contrasting findings in relation to greater teaching experience prompting a decline (Gresham, 2018; Gürbüz & Yıldırım, 2016; Patkin & Greenstein, 2020) or not (Adeyemi, 2015; Hadley & Dorward, 2011), in maths anxiety;
- It is possible to reduce both maths anxiety (Finlayson, 2014; Furner & Duffy, 2002; Gresham, 2018; Gürbüz & Yıldırım, 2016) and maths teaching anxiety (Adeyemi, 2015; Hadley & Dorward, 2011; Peker, 2009a; Ural, 2015); and
- No relationship was found between maths anxiety and student achievement, though higher levels of maths teaching anxiety related to lower student achievement (Hadley & Dorward, 2011).

2.7 Summary

Maths anxiety is just one part of the affective domain within mathematics education, and this chapter has demonstrated that affect may impact the relationship that individuals have with mathematics and, hence, may impact their mathematical identity. Individuals may experience maths anxiety from a young age. In the primary classroom, it is not the mathematics itself, but more so the teacher and the teaching practices utilised in the classroom that serve to promote maths anxiety. It is known that individuals who experience maths anxiety may limit the choices they make in regards continuing their mathematics education, and so employment opportunities may be also limited. Notwithstanding the importance of mathematics in both every day and professional lives, individuals carry maths anxiety with them as they move through life, and for those who choose to become a teacher, into the teaching profession.

The hypothesis of this current research is that teachers who experience maths anxiety do not leave it behind when they enter the school gate; it travels with them throughout each day, accompanying them to the classroom, the staffroom, the professional development setting, and beyond. To this end, maths anxiety potentially: interferes with the instructional strategies that teachers utilise; requires teachers to develop strategies so that it can be managed; penalises students who work with teachers who experience it; and extends to teachers becoming anxious towards teaching mathematics.

Although maths anxiety may negatively impact individuals who experience it, there is little research that specifically explores primary teachers' lives and their maths anxiety, and no New Zealand research undertaken to date. The study reported here intends to provide information to narrow this gap. It has been specifically designed to explore the histories of primary teachers in New Zealand who self-report as being maths anxious.

Chapter 3 RESEARCH APPROACH

3.1 Introduction

The aim of this research was to explore the personal histories of primary teachers who experience maths anxiety, and to investigate how that maths anxiety influences or impacts their role as a primary teacher and their mathematics teaching. To achieve this aim, the following research questions were developed:

1. What are the personal histories that influence primary teachers who experience maths anxiety?
2. How does maths anxiety impact the professional role of the primary teacher?
3. How does maths anxiety influence the mathematics teaching in the primary classroom?

This chapter will explain the research design, which involves the epistemology and theoretical perspectives, along with the methodology and research methods. The research methods will share details in relation to the research participants, and the data collection and analysis processes. Finally, the chapter will describe the ethical considerations kept in mind throughout, as well as the limitations of the study.

3.2 Research design

Research design is the basic structure of a research project that supports the specific direction and systematic preparation for research (Creswell & Creswell, 2018; Flick, 2018). Crotty (1998) identifies the basic elements of research design as: epistemology, theoretical perspective, methodology, and methods. The elements of epistemology, theoretical perspective, and methodology will each be outlined, while the methods will be discussed in three sections: participants, data collection, and data analysis. This research focuses on the phenomenon of maths anxiety and the experiences of teacher participants. Through the use of the chosen research design,

the world of teachers who experience maths anxiety may be made visible and understood.

3.2.1 Interpretivist epistemology

Epistemology is defined as “the theory of knowledge embedded in the theoretical perspective and thereby in the methodology” (Crotty, 1998, p. 3). This study aligns to the interpretivist epistemology, which has as its central endeavour understanding “the world of human experience” (Cohen, Manion, & Morrison, 2018, p. 19). The interpretivist argues that the individual and society are inseparable entities (Crotty, 1998; O'Donoghue, 2007), and that social action is inherently meaningful (Schwandt, 2000). These inherently meaningful actions are not imprinted on individuals, but are formed through interaction with others, as well as through the historical and cultural norms that operate in the lives of the individuals (Creswell, 2013; Crotty, 1998). The interpretivist researcher aims to understand the experiences of individuals, while recognising that there may be many interpretations and perspectives of reality (Cohen et al., 2018; Wahyuni, 2012). Knowledge is seen as personal, subjective, and unique, as individual participants bring their own experiences to changing social contexts (Cohen et al., 2018; Wahyuni, 2012).

Connecting these interpretivist ideas to this research, it is important to consider the mathematics classroom context. Different perspectives will occur in mathematics classrooms due to the differing experiences of each student and the teacher; each individual experiences a different reality based upon her/his prior knowledge and understanding, skill level, attitude towards mathematics, and the individual teacher-student relationship (Deieso, 2016), as well as the student-student relationship. Therefore, those who carry their experiences of maths anxiety with them will have a different perspective of reality that may influence their interaction with mathematics in the classroom and beyond.

It is the individual’s active participation in constructing knowledge and meaning that holds the attention of the interpretivist researcher and it is this active participation that must be interpreted and understood (Gall, Gall, & Borg, 2010; O'Donoghue, 2007). The purpose of interpretive research “is to find out and describe how

something works, why it happens or what makes some group of people tick" (O'Toole & Beckett, 2013, p. 38). The choice of the interpretive approach will enable me to discover and describe, with as little disturbance or interference as possible, how maths anxiety works, why it happens, and what makes teachers who experience maths anxiety 'tick'.

3.2.2 Sociocultural theoretical perspective

A theoretical perspective is considered to be "the philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria" (Crotty, 1998, p. 3). Vygotsky's sociocultural theory guides the theoretical perspective in this research. This theory, which aligns with the interpretivist epistemology, is grounded in the understanding that mental activity emerges not within the consciousness of the individual, but from outside of the individual, through participation and social interaction in shared cultural actions (Rogoff, 1998). Rather than the concepts of learning and development being conceived of as individual constructions, sociocultural theory understands both as a social, cultural, and historical process (Cobb & Yackel, 1996) from which "reasoning emerges through practical activity in the social environment" (Walshaw, 2016, p. 15). The process has been described by Vygotsky (1978, p. 57, emphasis in original) as: "Every function in the [individual]'s cultural development appears twice: first, on the social level, and later, on the individual level; first *between* people (*interpsychological*), and then *inside* the [individual] (*intrapsychological*) … All the higher functions originate as actual relations between human individuals."

Applying this sociocultural view to the classroom, it may be said that "*every* social activity performed by the teacher, from environmental provision to explanations, and so forth, as part of a larger matrix of practice, has the potential to foster or hinder conceptual thinking in students" (Walshaw, 2017, p. 295, emphasis in original). Consequently, any "activity within the mathematics classroom has a direct bearing on the kinds of mathematical thinking that students might experience and the kinds of proficiencies to which they might aspire" (Walshaw, p. 295). While Walshaw (2017) focusses on student thinking and proficiencies in the mathematics classroom, we have seen from the literature review that teacher activity, notably those

associated with maths anxiety, may hinder the development of the student as a mathematician, as well as the mathematical identity developed by the student. With this in mind, it is important to remember that the mathematics teacher, who was previously a student, may also be further impacted by any activity.

The previous discussion relates the sociocultural theory to student learning and development. However, it also relates to teachers as they too are learning and developing. While students might focus on gaining new knowledge and beliefs, the sociocultural perspective sees teacher learning as developing teacher identities through altering participation in social practices (Goos, 2013).

3.2.3 Basic qualitative/interpretivist methodology

Linking to both the epistemology and theoretical perspective, the methodology is the overall approach to research; it is "the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Crotty, 1998, p. 3). The educational world of teachers is often a "messy place, full of contradictions, richness, complexity, connectedness, conjunctions, and disjunctions" (Cohen et al., 2018, p. 288), therefore careful consideration of methodology was necessary prior to reaching a decision. The methodology chosen for this research is consistent with the theoretical framework. I utilised a qualitative/interpretive approach, which seeks to answer the question: "How are events, processes, and activities perceived by the participants?" (Ary, Jacobs, Sorensen Irvine, & Walker, 2019, p. 391). This methodological choice is appropriate, as it is "inductive, with the purpose of describing multiple realities, developing deep understanding and capturing everyday life and human perspectives" (Trumbull & Watson, 2010, p. 62).

Although explanations of maths anxiety have often been individually focussed, Vygotsky's theory suggests that "social practices [are] pivotal to the development" of maths anxiety (Mann & Walshaw, 2019, p. 102). In this research study, it is essential that the social practices relating to maths anxiety are shared, which makes the teacher participants' thoughts, feelings, knowledge, opinions, perceptions, and experiences imperative (Patton, 2015). Through this methodology, the need for the voices of the teacher participants that share their histories of maths anxiety is met.

The choice of the qualitative/interpretive methodology enhances this research study in a number of ways that Patton (2015) has previously described. Specifically, this methodology enabled me, as the researcher, to:

- capture stories to understand the experiences of people who live with maths anxiety;
- develop an understanding of the context of mathematics classrooms from the perspective of those who experience maths anxiety;
- elucidate how mathematics classrooms function and the possible consequences for the lives of people who experience maths anxiety, and for those who become teachers;
- identify unanticipated consequences for people who experience maths anxiety, and for those who become teachers; and
- make comparisons between the stories of my teacher participants to discover patterns and themes.

3.2.4 Methods

The basic elements previously identified have informed each other. They also inform the methods, which are "the techniques or procedures used to gather and analyse data related to some research question" (Crotty, 1998, p. 3). As previously outlined, this section will discuss participants, data collection, and data analysis.

3.2.4.1 Participants

There are three reasons that neither population nor representative sample will be identified in this study. First, there has been no New Zealand literature located relating to teachers who experience maths anxiety, therefore neither a population nor a sample can be identified. Second, as a qualitative study, the uniqueness and exclusive distinctiveness of the individuals who are its participants, representing only "themselves, and nothing or nobody else" (Cohen et al., 2018, p. 223) is emphasised. Lastly, it is unlikely that these individuals are representative of the wider teacher population, and therefore the information cannot be generalised to that population. Representation and generalisability are less useful for this study, as the focus was to explore the histories of, and impacts and influences for, teacher

participants who live with maths anxiety. In studies such as this, rather than population and sample being important, it is “more fitting to talk about a group, or individuals” (Cohen et al., p. 223).

There are no clear rules about the number of individual participants required for this study, as there is “considerable disagreement about what is an acceptable minimum” (Bryman, 2016). “[F]itness for purpose” (Marshall & Rossman, 2016, p. 108) informed the number of participants required to ensure the study was both possible and “rich in relevant information” (Flick, 2018, p. 182). After consideration and discussion, a decision to involve up to 15 teacher participants was made. It was thought that the involvement of up to 15 teacher participants would enable the sharing of both varied and detailed information regarding maths anxiety experiences.

Before participants were located, research questions were considered and specific dimensions (Flick, 2018) for possible individual participants were established. Boundary conditions (Tuckman & Harper, 2012) were set as being teachers who self-reported as experiencing maths anxiety; were registered and certificated teachers; and were working in a primary school within New Zealand. The boundary condition of *self-reporting* as experiencing maths anxiety was essential to this study, and although it is likely, when considering international figures, that many more New Zealand teachers experience maths anxiety, it would have been difficult to locate or access teachers who were not open to outwardly identifying that they experience maths anxiety.

It is important to clarify the meanings of registered and certificated teachers, as definitions have recently changed in relation to these. A registered teacher is one who has satisfactorily trained to teach; is committed to the Code of Professional Responsibility (Teaching Council of Aotearoa New Zealand, 2017); has a satisfactory police vet; is fit to be a teacher; is able to competently communicate in English and/or te reo Māori; and is committed to develop and practise te reo me ngā tikanga Māori (Māori language and protocols). A practising certificate may be at three levels: provisional, subject to confirmation, and full; and includes all that is required for registration, as well as the necessity to have met, or be likely to meet, the Standards for the Teaching Profession (Teaching Council of Aotearoa New Zealand, 2017).

As access to participants was likely to be difficult, a volunteer approach (Cohen et al., 2018) was utilised to locate individuals with the possibility of becoming participants. Cohen et al. (2018) describe this approach as relying “on volunteers, for example, personal friends, or friends of friends, or participants who reply to a newspaper advertisement” (p. 222). Rather than a newspaper advertisement, two different methods to access potential participants were utilised. The first involved a social network site, and the second included one visit to each of a limited number of primary schools within a region of New Zealand.

The use of social network sites has previously been utilised in research studies to locate survey participants and provide the opportunity to complete online surveys, providing a fast and free location and completion approach (Denscombe, 2014). As participants would not be able to click a link to complete an interview, a slightly different approach that involved Facebook was taken for this study. Two Facebook groups were chosen that were relevant to primary teachers in New Zealand. These groups were the NZ Teachers (Primary) group, and the Maths Co-Teaching|Co-Learning group. Along with these two groups, my own Facebook page was included also, as it was thought that posting across these three different Facebook spaces enabled the research information to be shared widely, enhancing the potential to locate participants.

A message was crafted and posted to these Facebook spaces that shared initial information about the research; a link to the research information sheet; and an invitation to make contact. The link to the research information sheet was included, as it was thought individuals may like detailed information about the research prior to making contact. A screenshot of one of these posts is shown in Figure 3-1. As can be seen, individuals who saw the post were encouraged to share the information with others who may have been interested in the research, encouraging a snowball effect that is useful when used for small-scale research studies (Denscombe, 2014).

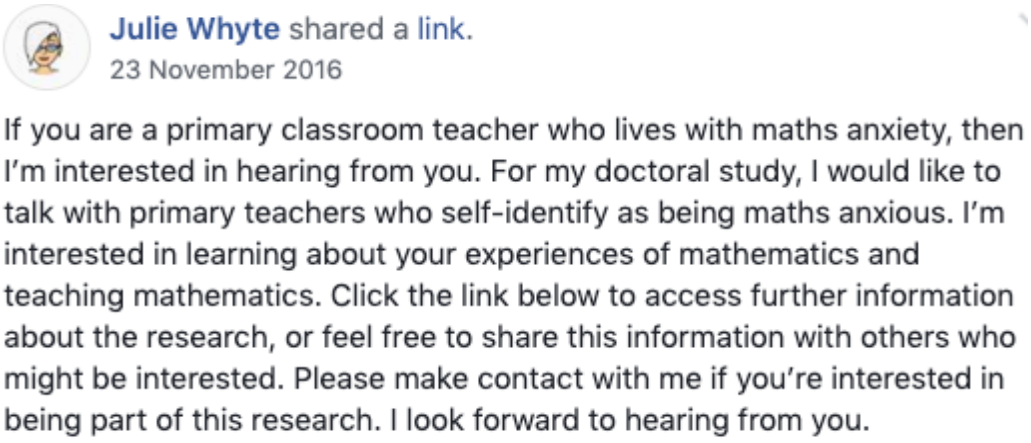

Figure 3.1 Facebook post inviting participation

As responses to the original post were somewhat limited, further posts were made to Facebook. A decision was made to omit the link to the research information sheet for these posts, as the information contained therein may have been too profuse for individuals to consider at first contact. These subsequent posts, as seen in Figure 3-2, gained greater Facebook 'traffic', along with private message contact. After this contact and 'chatting' about the study, the research information sheet was then provided to those who had made the decision to be a participant or to those who required further information prior to making a participation decision.

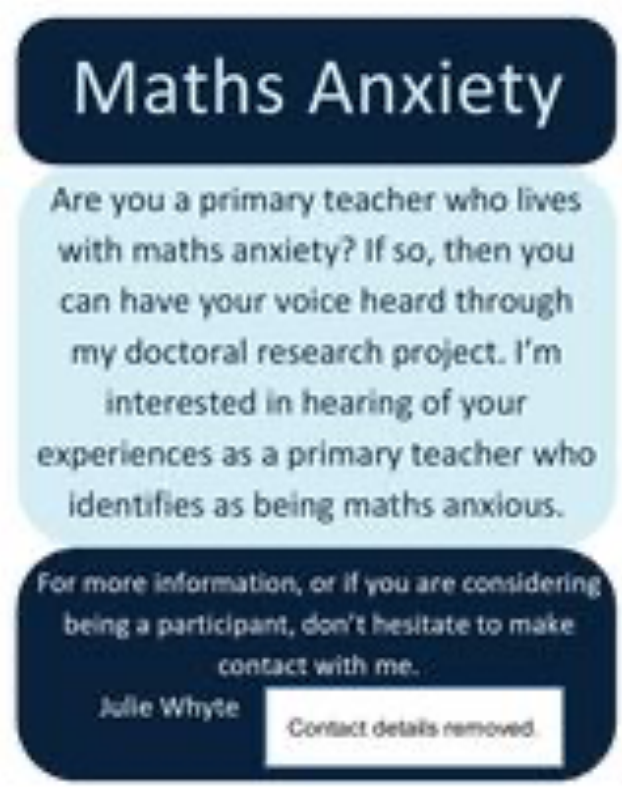

Figure 3.2 A subsequent Facebook post.

Although Facebook contact in regards the research study increased, the second method to access potential participants was undertaken. This involved making a visit to a primary school in each council area of the Hawke's Bay region, where I am based. These council areas were Central Hawke's Bay, Hastings, Napier, and Wairoa.

Utilising information from the Number of Schools database (MoE, 2015), a search was made for each of the council areas named above using the following criteria:

- Urban.
- Full primary (Years 0-8).
- School roll over 100 students.
- No affiliation for me as the researcher, therefore:
    - No personal connection to the school.
    - The school would not be a partnership school for the Bachelor of Teaching (Primary) (BTP), Eastern Institute of Technology, Taradale at the time of my visit, as I am a Teacher Educator working within the BTP.

It was important that I had no connection, either personally or professionally, with any of the identified schools, as I did not want to influence participation in the research. Each of the four council areas of the Hawke's Bay region had at least one urban, full primary school. However, one council area had only one full primary school, which I had a strong personal connection to; as well, its roll stood below the minimum required. Consequently, a decision was made to approach the largest contributing school in that specific council area of Hawke's Bay to avoid the personal connection and to meet the roll size criteria.

After a school in each council area of the Hawke's Bay region was identified, telephone contact was made, and travel was undertaken to each school to hold a brief meeting with either the principal or deputy principal. During the meeting, an outline of the study was discussed and a poster, similar to that seen in Figure 3.2, was shared with the understanding it would be displayed in the staffroom for teachers to access. Three of the four individuals visited also indicated that they would acknowledge the poster and share information about the research in their next staff meeting. Information for each school in relation to the criteria is shown in Table

3.1. Although these visits were made, it was evident from the participants that, due to an explanation of how each had heard about the research, no one had learned about this research study from the four visits made.

School Type	School Roll
Contributing (Year 1-6)	237
Full (Year 1-8)	286
Full (Year 1-8)	321
Full (Year 1-8)	336

Table 3.1 Information of schools approached

From these different approaches to locate volunteers for the study, 12 confirmed participants were located. The participants lived in regions throughout New Zealand. Eleven participants identified as female and one male. Due to the ratio of male to female participants, no comparison has been made concerning male and female participants. Eight of the 12 participants had more than 10 years of teaching experience, and the large majority held full teaching certificates. Teaching experience is spread across all year levels of the New Zealand primary school sector. Detailed participant information is shown in Table 3.2.

Ethnicity	Identified Gender	Age range	Highest teaching qualification	Certification level	Years of teaching experience	Year levels with most teaching experience
Pākehā[3]	F	50-54	Post Grad Dip	Provisional	3.5 (relieving)	NE-2
Pākehā	F	45-49	Bachelor's	Full	16	NE-2
Pākehā	F	45-49	Bachelor's	Full	25	NE-2
Pākehā	F	45-49	Bachelor's	Full	15	NE-2/5-6
Pākehā	F	55-59	Bachelor's	Full	38	NE-2/5-6
Pākehā	F	35-39	Bachelor's	Subject	14	3
Pākehā	M	30-34	Master's	Provisional	1.5	3-4
Polish	F	35-39	Master's	Full	15	3-4
Māori	F	45-49	Grad Dip	Full	4	5-6
Pākehā	F	45-49	Bachelor's	Full	7	6-8
Pākehā	F	50-54	Bachelor's	Full	17	7-8
Pākehā	F	55-59	Master's	Full	35	7-8

Table 3.2 Participant demographic information

3.2.4.2 Data collection

Qualitative interviews are more than a data-collection opportunity, but a social, interpersonal encounter that enable both interviewees and interviewers "to discuss their interpretation of the world in which they live, and to express how they regard situations from their own point of view" (Cohen et al., 2018, p. 506). Brinkmann and Kvale (2015, p. 4) suggest that the interview to be "an inter-view, an inter-change of views between two persons conversing about a theme of mutual interest," whereby "knowledge is constructed in the inter-action between the interviewer and the interviewee." Two different metaphorical approaches to interviews have been shared by Brinkmann and Kvale (2015). One sees the interviewer as a 'miner' who digs for nuggets of knowledge buried within the interviewee, while the other considers the

[3] Pākehā – New Zealander of European descent (Moorfield, 2021)

interviewer as a ‘traveller’ who wanders with the interviewee, asking questions and encouraging them to “tell their own stories of their lived world” (Brinkmann & Kvale, 2015, p. 58).

I worked to be a traveller, with the understanding that “the social world alters human thought and behavior” (Schoen, 2011, p. 12), using the semi-structured interview as my method for travel. Punch and Oancea (2014) explain that these interviews “are guided by a set of questions and prompts for discussion, but have in-built flexibility to adapt to particular respondents and situations” (p. 184). Semi-structured interviews provided me “some latitude to ask further questions” (Bryman, 2016, p. 201). This chosen method fostered opportunities for interaction about participant experiences of maths anxiety, and enabled me to ask questions and encourage the sharing of ideas by participants – “what they think or how they feel” (Fraenkel, Wallen, & Hyun, 2012, p. 451) about maths anxiety. Not only did semi-structured interviews enable the sharing of ideas, but they also ensured that the participants had the opportunity to develop ideas and speak more widely to extend issues raised by me (Denscombe, 2014).

Closed questions (Appendix II) gained demographic information. Open-ended questions that provide “the fullest answers” (Brinkmann & Kvale, 2015, p. 160) were mostly utilised in regards maths anxiety to probe for sociocultural influences and past experiences. I needed to listen carefully to what participants were saying when answering these questions (Creswell, 2013), which, in turn, allowed both the participants and me to “grasp for meaning together” (Forsey, 2012, p. 372). The sociocultural perspective is “concerned with how individual, social, and contextual issues influence human activity, especially learning and behavior” (Schoen, 2011, p. 12). As maths anxiety related experiences may not be present during an observation (Cohen et al., 2018), the open-ended questions (Appendix III) in the semi-structured interview assisted me in constructing understanding of these experiences.

Much discussion with my research supervisors occurred in relation to both the demographic and maths anxiety related questions, with several iterations of both being created. The interview questions were piloted to examine how well they worked “‘in the field’ with real participants” (Denscombe, 2014, p. 165). To locate individuals to pilot the interview questions, an email was sent to teaching colleagues

at my workplace. In less than 24 hours, a considerable number of responses to the email were received, and interviews were arranged with six individuals for the pilot.

Piloting the interview questions provided the opportunity to “reveal ambiguities, poorly worded questions, [and] questions that [we]re not understood” (Fraenkel et al., 2012, p. 401). Piloting also provided a sense of the time required to complete an interview (Creswell & Creswell, 2018). As early questions may set the tone of an interview, the order that questions were to be asked was also important (Cohen et al., 2018). At the completion of each of the six pilot interviews, suggestions were encouraged in regard the quality, reaction to, and order of the questions. It was thought that it would be useful to interview six individuals so that questions could be adapted from suggestions provided by the interviewees of the pilot interviews. Overall, the suggestions prompted some slight adaptations to the wording and the order of some questions. By the fifth and sixth interviews, no further changes were suggested or made. Piloting the interview questions ensured that questions were understood, individuals were willing to open up to talk about maths anxiety from the questions asked, and a sense for the length of time interviews would take was gained.

As it is important for the participant “to feel at ease before sharing his or her experiences” (Moser & Korstjens, 2018), the demographic questions were completed, and a question that related to the reasoning behind being a part of the study, were asked prior to questions relating to maths anxiety. The open-ended questions aimed to prompt detail from participants, though it was important to “ask follow-up questions or encourage telling more details by using probes and prompts or keeping a short period of silence” (Moser & Korstjens, 2018, p. 14). Hennink, Bailey, and Hutter (2010) refer to these ideas as probes, and all the types of unplanned probes (Harding, 2019) outlined in Table 3.3 were utilised during the interviews.

Type of probe	Purpose	Typical words used
Motivational probe	To show that the interviewer is listening and encourage a respondent to say more	'Ah-ha,' 'Mmm' or 'Yeah'
Amplification probe	To encourage a respondent to provide more detail	'Can you tell me a little more?' or 'Can you give me an example?'
Exploratory probe	To explore a respondent's feelings about a situation they have discussed	'How did you feel when …' or 'Why did you think it was important to …'
Explanatory probes	To encourage the respondent to explain opinions, feelings or behaviour	'What exactly made you feel …' or 'Could you tell me why you believe …'
Clarification probe	To provide greater clarity in areas such as the order of the events that a respondent is discussing or the definition of a term they are using	'Could you just confirm …' or 'Would you mind just explaining to me …'

Table 3.3 Types of probes (Harding, 2019, p. 74).

Although the semi-structured interview "is a powerful tool for researchers" (Cohen et al., 2018, p. 506), interviews also have their disadvantages. These disadvantages include time to organise and complete, along with travel and accommodation costs. Attempts were made to overcome these disadvantages, which, whether successful or not so successful, are discussed in the limitations section of this chapter.

Prior to interviews starting, permission was gained from individual participants that enabled notes to be recorded and interviews to be audio recorded. As the interview audio recordings were likely to be irreplaceable, it was essential to back up the audiotaped interviews. Data were saved in three different locations that were all password protected.

3.2.4.3 Data analysis

As raw data is worth little, it is important to analyse the data to gain understanding from it. Thematic analysis, which enables identification, analysis, and interpretation (Braun & Clarke, 2006; Clarke & Braun, 2017), was chosen as the method for analysing the data in this study. Through thematic analysis, an inductive approach was evident as I was immersed in, and engaged with, the data to ensure meanings

were established and relationships identified (Mertens, 2015). This inductive approach, which lends itself to the interpretivist underpinnings of the study, saw me exploring, reflecting on, describing, and analysing the data (McAteer, 2013). There is no recipe to follow when analysing qualitative data (Yin, 2015), therefore the work of various authors was accessed to gain a deeper understanding of thematic analysis (Braun & Clarke, 2006; Bryman, 2016; Clarke & Braun, 2017; Harding, 2019; Moser & Korstjens, 2018; Punch & Oancea, 2014; Saldaña, 2011; Taylor, Bogdan, & DeVault, 2016; Yin, 2015).

Even though there is no universal agreement about the usefulness of computer assisted qualitative data analysis (CAQDAS) (Bryman, 2016), its use was considered as it is "valued for its code and retrieve functions" (Harding, 2019, p. 110). The NVivo analysis software (QSR International, n.d.) was the chosen programme and a workshop was attended that involved working with NVivo and a sample data set. Knowing that the programme is only a tool to assist with data analysis and acknowledging that the data set to be analysed was small, the choice to use CAQDAS was discarded.

To begin and to use time wisely, the interview audio files were transcribed by a university recommended transcription service. A representative of this service completed and signed a confidentiality agreement (Appendix IV). The interviews were saved both as Word and Google documents, the latter for ease of accessibility no matter what my location. Saving the data in this way would enable searches for individual words or phrases. Following this, it was essential that I came to know the subtleties of the interview data; I needed to gain "[d]ata intimacy" (Saldaña, 2011, p. 95). The interview transcripts were read in conjunction with listening to the interview audio files, as this ensured that the transcripts were accurate (Moser & Korstjens, 2018). Reading and rereading of the interview transcripts followed, so that I not only knew my "data inside and out" (Taylor et al., 2016, p. 162), but to ensure that my theoretical prior knowledge and the research questions guided the reading of the transcripts also (Schmidt, 2004).

Although there is a suggestion that qualitative data will always be coded, it is important to remember that coding is not helpful to everyone and that it is a choice (Harding, 2019). I chose not to code my interview data, as I did not want to be

“struggling with the mechanics of the coding process rather than being able to think deeply about the data” (Yin, 2015, p. 200). Instead of coding, I identified segments from the original transcripts, marked similar pieces of information that had related ideas, and recorded comments on the documents. Although data analysis may be completed “the old-fashioned way (cut and paste pieces of paper)” (Mertens, 2020, p. 459), the creation of google documents enabled the derived notes to be organised and the original data was brought together in a different order (Yin, 2015).

The data were grouped into initial broad themes that were mostly based around interview questions. However, through continued rereading it became apparent that the themes were not specific to any one question and contained various categories also, therefore data were combined across themes or shifted into new themes; and placed into categories where appropriate. To manage this task, I ensured that I cited the data transcripts precisely to enable confirmation or checking of the materials in my derived notes (Yin, 2015). This extensive process resulted in individual documents that provided the theme; categories or sub-themes; and interview data for individuals that included relevant page numbers from the transcriptions. A sample of the ‘step way’ management strategy is provided in Appendix V.

3.3 Ethical considerations

Ethical considerations are deemed to be a fundamental feature of all research. To ensure the research of today is not involved in research atrocities that have been known to have occurred in history, it is essential that ethics are central to both the planning and implementation process of research, not perceived as an afterthought (Creswell, 2015; Denscombe, 2014; Mertens, 2015). Prior to this study commencing, approval from the Massey University Human Ethics Committee was sought. Approval was granted (Appendix VI) and, during the study, the principles outlined in the code of ethics handbook (Massey University, 2015) were followed.

Providing informed consent, and voluntary participation, is essential for individuals (Creswell & Creswell, 2018; Fraenkel et al., 2012), and also the researcher. Gaining informed consent ensured individuals were provided with information pertaining to the study, its purpose, and what would be required from them (Creswell & Creswell;

Fraenkel et al.). Providing an information sheet (Appendix VII) enabled individuals to make a rational judgement about their participation (Denscombe, 2014), and enabled each participant to sign a consent form (Appendix VIII) prior to data collection. There was no coercion around participation, and individuals were informed that they were able to withdraw from the study at any point, prior to the end of data collection, if they so wished (Massey University, 2015). No individual chose to withdraw from the study at any point after signing the consent form. However, four individuals, who had indicated that they would be a part of this study, changed their decision prior to signing the consent form, as they either could not or would not talk about their experiences of maths anxiety.

Fraenkel et al. (2012) identify three core principles that must be addressed by any researcher: participants must be protected from harm, confidentially of research data must be ensured, and deception of subjects should always be questioned. As participants were fully aware of the study, deception was not a concern, though protection from harm and confidentiality needed to be addressed.

It was essential that all participants were protected from harm, and this responsibility rested with me, the researcher (Denscombe, 2014; Fraenkel et al., 2012). Fraenkel et al. assert that if serious or lasting harm is likely then the research should not be executed. It was not considered that any participant would experience any serious or lasting harm, though it was important to deliberate lesser harm. As the study involved participants in interviews, there was no involvement that gave cause to physical harm. However, participants were involved in discussing their experiences with maths anxiety during the interviews, and so the notion of psychological harm was considered due to potentially sensitive issues being touched on (Denscombe, 2014). As all participants had voluntarily come forward and were open to discussing their experiences with maths anxiety, the potential for psychological harm was rejected. No psychological harm was evident during the interviews, and in many interviews, participants acknowledged the importance of the research, that it was good to openly discuss their experiences with maths anxiety with someone, and that they hoped their involvement would assist others. For example, one participant ended her interview by stating that, “I think the more people that know that there are people in this world who do find maths to be an anxiety inducing thing the better

really," while another shared that "being a part of anything that can help with the understanding of that phenomenon for teachers, I'm very happy to contribute, because it's my experience."

To ensure participants were comfortable with the information they provided during the interview, phase member checking (Fraenkel et al., 2012) occurred. After transcription was complete, the documents were emailed to participants to provide the opportunity for ensuring the transcript was accurate and that each participant was satisfied with the content, as well as to identify if any additions were required. At the end of each interview, I had clarified that interview transcriptions would be emailed. While some participants were open to this process, others were reluctant to receive the emails. Through discussion, it was agreed that emails would be sent, and that they could choose to read them and confirm their content and accuracy, or they could choose to ignore them and that would be taken as approval of the transcript. Copies of emails sent relating to the interview transcripts are available in Appendix IX for face-to-face interviews and Appendix X for Skype interviews.

Confidentially of research data is vital (Punch, 2009). Anonymity of participants was maintained in a number of ways. Pseudonyms were utilised during both analysis and reporting of data (Creswell, 2015), and as the great majority of participants were female, a decision to choose only the names of female singers was made. All participants have been referred to as female for reporting purposes to assist with anonymity and avoid potential identification for the male participant.

Care was taken to keep gathered data secure and protected from others, with interview transcripts saved within three environments that each required a different password. All interview files and analysis documentation were saved under pseudonyms to ensure participants would not be able to be identified even if someone did gain access to these environments. I did not print any interview transcripts for analysis, and no identifying features of participants are included during reporting.

3.4 Limitations

The challenges in designing a sound research study means that limitations must be recognised and discussed (Mertens, 2020). This research comprised a small-scale study. It had only 12 participants, which makes it “bounded and situated” (Marshall & Rossman, 2016, p. 85) to those 12 participants. Since it is improbable that any conclusion of this study will have universal application, the findings of the study will not be able to be generalised. However, the study will offer some evaluation of existing knowledge (Denscombe, 2014), and will “produce understanding which can be shared, related, and interrogated” (McAteer, 2013, p. 123), thereby informing similar situations in other settings.

Given my extensive personal and professional investment in education, and teacher education in particular, it is unlikely that I, or indeed any participant in the study, were detached and impartial when approaching the study. Each of us had a vested interest in the findings (Denscombe, 2014). I was working towards a doctoral qualification, and the participants were discussing both their personal and professional experience of maths anxiety, and mathematics learning and teaching. As an interpretivist researcher, I see myself as being entwined with the research world (Schwartz-Shea & Yanow, 2012). As such, I cannot remove myself, or become detached, from the research (Cohen et al., 2018; Walshaw, 2010), and to expect me to be neutral or an automaton is unrealistic (Rubin & Rubin, 2005). I carry with me my own prior knowledge gained from personal, cultural, social, and historical experiences, and this shaped what I focussed on, what I saw, and how I understood (Cohen et al., 2018). Consequently, it is essential to recognise that my knowledge may have impacted the data that were gathered and the analysis of that data (Cohen et al., 2018; Creswell & Creswell, 2018; Schwartz-Shea & Yanow, 2012).

Because I was not neutral, it was crucial for me to be both reflexive and reflective. Reflexivity ensured that I interrogated myself, and reflectivity involved critically reflecting on my own decisions and actions (Mutch, 2013), especially in respect to the understandings that I held in regards maths anxiety, along with my personal beliefs and perceptions. Although I was reflexive and reflective, it is essential to acknowledge that another researcher may have analysed the data in a different way

and may have identified themes and sub-themes that have not been accessed by myself.

This research study involved participants who self-reported as experiencing maths anxiety, therefore it is important to acknowledge that participants may have inaccurately recalled experiences. Their recall of previous anxious experiences may be somewhat distorted, as individuals who experience anxiety may recall these experiences in a negative way as they are more likely to focus on negative events rather than positive (O'Leary et al., 2017).

Due to the criteria chosen when defining the schools to be visited to locate volunteer participants, no rural school was approached for potential participants. Kura kaupapa Māori[4] were also not approached, as the majority of these were composite schools with students from Year 1-15. While one such school did include students from Year 1-8, teachers from the school did not qualify for participation in the study because the school role was below 50 at the time of locating participants. However, it is known that none of the participants who were a part of this study came forward because of my visits to schools in Hawke's Bay. Therefore, participants may have come from schools in rural areas or from kura kaupapa Māori.

The semi-structured interviews for this study were completed either face-to-face or via an online video connection, namely Skype. Although face-to-face interviews may be considered "the gold standard" (McCoyd & Kerson, 2006, p. 390) for qualitative interviewing, there are potential limitations. While face-to-face interviews may maximise the quality of the data collected, they often take significant time to organise and complete (Cohen et al., 2018; Newby, 2014). This was true of the seven face-to-face interviews that were completed as part of this study. Facebook messages, emails, texts, and telephone calls were repeatedly utilised as communication tools to organise interviews. The interviews themselves were of varying lengths; the range was 33 – 75 minutes with a mean of 52.5 minutes.

Not only do interviews take significant time, they may also be costly (Cohen et al., 2018; Newby, 2014). To begin, there was the intention that all interviews would be

[4] Kura kaupapa Māori are schools operating under Māori custom and immersed in Māori language.

completed face-to-face. Interviews were completed from Auckland to Wellington, and this involved significant travel and overnight accommodation costs, along with the driving between interview destinations being time costly also. To reduce these costs, it was decided that no travel would be undertaken to the South Island of New Zealand, and Skype interviews were completed for participants from this area. A decision was also made to the effect that participants based in the North Island might choose to complete a Skype interview at their convenience. In all, face-to-face interviews were completed with seven participants, and five interviews were completed via Skype.

Another limitation of face-to-face interviews is the expectation that may be held for participants to "give an answer on the spot" (Lavrakas, 2008, p. 259). This may mean that the response is not thought out. During some interviews, it was noticed that participants looked to be in a hurry to answer at times. When this was observed, I attempted to ensure participants that there was no rush and wait time was available for thinking. I may not always have observed this 'hurry', therefore this may be considered a limitation of this study.

Face-to-face interviews involve power asymmetry (Anyan, 2013; Brinkmann & Kvale, 2019; Cohen et al., 2018; Edwards & Holland, 2013) that create limitations for the research. It is the interviewer who organises the interview and its timing, who determines the focus, asks the questions; and decides if the data are acceptable or useful, how they will be utilised, and who they will be shared with (Brinkmann & Kvale, 2019; Cohen et al., 2018). However, the participants also have some control over the interview process. They decide what information will be shared, and may choose to withhold information, shift the focus of the interview, or even conclude the interview if they believe that is warranted (Anyan, 2013; Brinkmann & Kvale, 2019). These power asymmetries were possible for the interviews in this research, though actions prior to and within the interviews were intended to assist in the power being shared between researcher and participants. To share the power between myself and the participants and reduce any perceived "'positionality' (social status and identity)" (Edwards & Holland, 2013, p. 79) of me as a tertiary lecturer, I chose not to hold any interviews at the tertiary institute where I work. Locations for face-to-face

interviews were chosen by participants, and I chose to utilise a smaller room in my home for Skype interviews.

I had anticipated that interviews would take approximately 40 minutes, though some interviews took considerably longer than this. Although I was in a position to shorten the response time to questions, that power was seldom utilised, as I wanted the participants to have control over the length of their responses. While I asked the questions, participants would sometimes choose to answer a specific question in a variety of ways with loosely, though still, connected information, and again I did not interrupt to tell them that it was time to move on or that their response was better suited to a question that would be asked later in the interview. Despite my efforts and intentions, it is unlikely that power was shared equally within and across all interviews.

Although the online video connection interviews via Skype may have all "the benefits and drawbacks of the face-to-face interview[s]" (Cohen et al., 2018, p. 540), other limitations may be evident. First, there is a need for participants to be or become familiar with Skype (Cohen et al., 2018). In this study, all participants had previously utilised Skype and had their own Skype accounts, though some participants were more familiar with Skype than others. The next limitation involves the use of a camera, as those in the Skype interview may "feel embarrassed or nervous to be on camera" (Hay-Gibson, 2009, p. 42). As the researcher, I attempted to hide my own nerves about appearing on someone's screen somewhere in New Zealand. Other than the participant, I wondered who else may also have been looking at me. At the beginning of several interviews, participants shared that they were feeling somewhat nervous talking through a computer with a camera. To reduce their nervousness, as well as my own, I shared that I felt nervous also. Sharing this usually brought some light laughter and we were able to progress with the interview. As we moved through the interviews and conversed about the questions and responses, I felt that the nervousness of both the participants and me reduced as we became more comfortable with each other and this form of communication. However, I do not believe it entirely disappeared.

A further limitation of a Skype interview may be the quality of the internet connection (Bryman, 2016). This occurred infrequently during the Skype interviews in this study.

At infrequent times, two interviews became a little disrupted due to poor internet connections, so questions or responses needed to be repeated so that the Skype participants could hear and be heard. A disruptive environment may interfere with concentration and data gathering (Deakin & Wakefield, 2014), and this occurred for two participants in this study. They found that they needed to ask family members for quiet and closed the door of the room they were utilising. These actions brought the focus back to the questions and responses of the interview without further interruption.

It is important to consider empathetic elements within the limitations of this study, as Cohen et al. (2018) have expressed that there are researchers who contend that empathy must be "held in check" (p. 236) by the researcher due to this emotion being "unscientific and a threat to rigour" (p. 236). However, Brooks (2011) argues that empathy is not a scientific barrier, but an emotion that may enrich, enhance, and deepen human understandings. Empathy enables "feeling one's way into the experience of another" (Riess, 2017, p. 75). In the sense of support and acceptance, empathy is not considered a limitation (Scriven, 1993), as it is something that enabled me to "establish a bond, a connection or a rapport" (Cohen et al., 2018, p. 236) between myself and the participants in this study.

3.5 'Big-tent' criteria

Eight 'big-tent' criteria for excellent qualitative research have been identified by Tracy (2010), and these criteria underpin this research. The eight criteria for quality include "(a) worthy topic, (b) rich rigor, (c) sincerity, (d) credibility, (e) resonance, (f) significant contribution, (g) ethics, and (h) meaningful coherence" (p. 837). Further information regarding each of these criteria is available in Appendix I. Tracy (2010) identifies these criteria as "core values" (p. 838) and the "end goal" (p. 838) for qualitative research. These 'core values' underpin this research, and the 'end goal' has been met.

Each core value will be discussed in relation to this research study. To begin, the topic of this research is 'worthy' (Tracy, 2010), as information regarding maths anxiety and New Zealand primary teachers is not available at present. Furthermore, although there has been a weakening in mathematics performance by New Zealand

students over a period of years (Education Review Office, 2021), teachers and maths anxiety are not known to have been considered in relation to this weakened performance. Therefore, this research is relevant, timely, significant, and should be of interest to many in the New Zealand mathematical education field.

This study has ‘rich rigour’ (Tracy, 2010) at its base. It is built on appropriate and strong theoretical constructs. From this theoretical foundation, a set of individuals, and the means by which they were located, is described. Additionally, from the semi-structured interviews completed where participants took the opportunity to share their histories, impacts, and influences of maths anxiety, a rich dataset has been collected and analysed, and now reported. ‘Sincerity’ (Tracy, 2010) features, as the study is characterised by researcher reflexivity regarding subjective values, biases, and inclinations. As well, the methods utilised, along with challenges, or limitations, for this research are transparent and described in full

‘Credibility’ (Tracy, 2010) permeates through the study, given that there is concrete detail regarding the research design, limitations, and ethical considerations; as well as thick and rich description from the voices of the participants. It is likely that the evocative representation of the teacher participants’ histories, impacts, and influences of maths anxiety will affect, influence, and/or move readers or a variety of audiences. Therefore, it is anticipated that this study will have ‘resonance’ (Tracy, 2010) with others.

The information and experiences that have been shared by participants and reported here, and likely previously only known and understood anecdotally, are now given expression and supported by empirical research. Also, this study is likely to stimulate an awareness and interest regarding teachers who experience maths anxiety, and may well incentivise individuals and audiences to understand this phenomenon. In addition, as an alternative to assessments for maths anxiety that provide a low, medium, or high result for individuals, this study has uncovered that maths anxiety is not a stable experience but one that may fluctuate considerably. Therefore, this research study makes both a heuristically and theoretically ‘significant contribution’ (Tracy, 2010).

Ethical considerations were not an afterthought for this study. Ethics appropriate to this research, in particular the procedural ethics of working with human participants, were considered during the planning stages of the study, and research consent was gained from the Massey University Human Ethics Committee. Furthermore, ethical planning was not discarded during the implementation of this research, as it was acted upon. Therefore, this study can be considered 'ethical' (Tracy, 2010). This research has achieved what it intended to. The thesis reports and discusses the participants' experience of maths anxiety in relation to their personal histories, its impact on their professional roles, together with its influence on their mathematics teaching. Throughout the reporting and discussion, meaningful interconnections between and across literature, the research focus, the findings, and the interpretations are made clear.

Given all these points, this study meets the eight 'big-tent' criteria for excellent qualitative research identified by Tracy (2010).

3.6 Summary

This chapter has outlined the research design within which the study has been conducted. The interpretivist epistemology provided the underlying theory of knowledge. The sociocultural theoretical perspective was used to explore the personal histories of primary teachers who experience maths anxiety, and to investigate how that maths anxiety has influenced or impacted their role as a primary teacher and their mathematics teaching. A qualitative/interpretivist methodology was the overall approach so that the events, processes, and activities perceived by the participants would be the focus of this study. A description of the ways in which participants were located has been explained. The collection of data through semi-structured interviews, and the analysis of the data through themes has been clarified.

Essential ethical considerations were applied during the study and included the requirements of gaining ethical consent, protecting participants from harm, and ensuring both confidentially of research data and anonymity of participants was maintained. Collectively, these considerations assisted the research to be undertaken in an ethically responsible fashion. Limitations of this study have been

carefully considered, and while some of those may be evident, others have been put aside as not impacting this research study. Lastly, the eight ‘big-tent’ criteria for excellent qualitative research (Tracy, 2010) have been discussed in relation to this study. This discussion has demonstrated that this study’s ‘core values’ and ‘end goal’ meet the criteria of excellent qualitative research.

Chapter 4 FINDINGS

4.1 Introduction

The purpose of this study was to explore the personal histories that influence primary teachers who experience maths anxiety, and how that maths anxiety has influenced or impacted their role as a primary teacher and their mathematics teaching. This chapter reports the findings of this research sharing the experiences and perspectives of the 12 participants. There are seven themes in this chapter: onset, origins of maths anxiety, maths anxiety fuelled responses to mathematics, situations for maths anxiety, management strategies for maths anxiety, hidden lives, and efficacy.

4.2 Onset of maths anxiety

The participants in this study were able to identify the onset of their experience of maths anxiety with little, if any, prompting. As can be seen in Table 4.1, five participants first experienced maths anxiety in the primary school setting, six participants identified their learning in secondary school as the onset of their anxiety, while the twelfth participant acknowledged that it was during her tertiary study that maths anxiety was experienced for the first time.

	Primary	Secondary	Tertiary
	5	6	1
Bic		*	
Bonnie		*	
Joan		*	
Lorde		*	
Macy			*
Mariah	*		
Marianne	*		
Meghan	*		
Miranda	*		
Pat		*	
Suzi	*		
Tracy		*	

Table 4.1 Onset of maths anxiety

4.3 Origins of maths anxiety

All twelve participants in this research study appeared to begin school with a positive mathematics mindset, though were able to indicate two or more reasons for the origin of their maths anxiety. Forty responses were given that related to the origins of maths anxiety, and only three of these related to parents. Table 4.2 provides an overview of the responses provided by participants. From the responses shared, two themes have been identified: teaching practice, and teacher and parent behaviour.

		Teacher								Parent
		Teaching Practice				Behaviour				
		Pace	Presentation	New ways	Position in class	Interactions & actions	Personal characteristics	Connections	Missed opportunity	Interactions & actions
	40	6	8	3	4	7	3	4	2	3
Bic	3		*		*			*		
Bonnie	4	*	*			*		*		
Joan	4	*				*		*		*
Lorde	3					*	*			*
Macy	4	*	*	*		*				
Mariah	2			*		*				
Marianne	4	*	*				*		*	
Meghan	4		*		*		*			*
Miranda	5	*	*		*	*			*	
Pat	2		*			*				
Suzi	2	*			*					
Tracy	3		*	*				*		

Table 4.2 Origins of maths anxiety

4.3.1 Teaching practice

The theme of teaching practice relates to the way both teachers and students worked with mathematics in the classroom. Four sub-themes were evident, being: pace of teaching, the presentation of mathematics, new ways, and position in class.

4.3.1.1 Pace of teaching

The pace in which mathematics was taught was recognised as a contributor to maths anxiety by half the participants. There was little time given to develop understanding of mathematics concepts; for solving mathematics problems and

equations; or to ask questions and gain clarification. For example, Suzi indicated that there was not time to develop understanding before a new concept was introduced, and that a previous formula that had not been fully grasped was needed “to get the next one.” She believed that her mathematics education stopped at primary school in Year 7 or 8: “... then the next formula we were taught I didn't get it at all, and he couldn't slow down for me, and then I stopped, and that’s where my maths education stopped.”

The pace of teaching at intermediate school was also raised by Miranda, where she found mathematics to be “cold, hard core, ‘What is the answer to this question?’ … it was fast and furious.” Miranda remembered that there was also pressure to answer quickly. Like Miranda, Marianne spoke of a teacher “throwing equations” around and expecting students to “blurt the answers out quickly.” While the pace of teaching was also quick for Bonnie, she found that due to this pace, she had little idea of what her mathematics teacher had just done.

The pace of teaching in high school was also raised by Joan, as things were done very, very quickly by a specific teacher. Along with the pace of teaching, Joan recalled that there was no time given for questions by one mathematics teacher. This overall lack of time for learning left Joan feeling lost for the two years that she was in his class. The pace of teaching was also recognised at the tertiary level. Macy had considered mathematics as her “happy place” until she started tertiary study, and that was where things turned to “crap” due to “an overload of information” with little time for the development of understanding. Macy described being given resources, and it was “flick, flick, flick through it and by the end of it you’re looking at it going, ‘none of this has any meaning, there’s nothing on it,’ and we’re on to the next thing now.” The pressure to get through “the maths course quickly,” with “so much material to cover that the actual teaching of the subject didn't actually happen,” unsettled her.

4.3.1.2 Presentation of mathematics

The specific manner that mathematics was presented by teachers was seen as a promoter of their maths anxiety by more than half of the participants. During interviews, the approaches of textbooks, formulas, and chalk and talk were regularly referred to. During primary school, Marianne experienced having a textbook put in

front of her and being told to complete a particular page of division problems and remembered "feeling really anxious about not being able to do these problems on this page." Similar to Marianne, Miranda identified that it was "just turn to page blah, read it, and answer those questions" at primary school. Teaching did not improve for Miranda at intermediate school, as again "it was always textbook stuff … it was never verbalised," and she reviewed her mathematics learning as "pure textbook". High school proved no better for Miranda, as she remembered mathematics being provided "on a piece of paper or a textbook, and I just wish that sometimes … I don't know, I just remember these teachers sitting in a chair and looking out the window." Miranda considered her learning throughout school and voiced that "the way that information is presented has always been the key for me."

Pure textbook learning was also raised by Meghan when she recalled that "all the way through primary school it was just basically you have a textbook." Not only was learning textbook based, but the answers at the back of the book were useful for Meghan, as she "just remember[ed] copying the answers from the back of the book." There were few other things to recall about learning mathematics at primary school for Meghan other than "just copying the answers." Similar to Meghan, textbooks were a feature of mathematics for Tracy at high school, though she also recalled mathematics being presented as formula, and learning to apply the correct formula to a given problem. During this time, mathematics "made absolutely no sense whatsoever."

The reliance on formula was also something that Meghan remembered from high school. She recalled that the teaching involved "formula after formula after formula and we had to just learn these formulas." Meghan described that her teacher:

> wrote the formulas up on the board. So, she wrote everything up, and she wrote the page numbers, and she said, "Right, go!" And then I remember she would just sit at her table. Every now and again she'd walk up and down, but apart from that there was no interaction with others. Yeah, there was nothing.

Meghan firmly believed that her maths anxiety "stemmed down to that one teacher. One teacher and how she taught it almost scarred me." Formula was also recalled

by Bic, “long complicated formulas,” which involved her teacher talking about mathematics “in a complex sort of way.” Although the word ‘formula’ was not specifically mentioned by Macy, she described that her mathematics learning “was very regimented, you know. You do it this way, you know. This is the way you do it, there’s no reason why you do it this way, but this is what you do.” Although regimented learning occurred at school, this did not bother Macy, “because once [she] knew what a rule was, [she] just did it and [she] turn[ed] out maths, no worries at all.” This regimented learning created no maths anxiety for Macy, in fact maths was her “happy place” then.

The use of a blackboard during teaching also featured for two participants. Bic remembered those “long complicated formulas” being written on blackboards and “other people” understanding them. Blackboards were also raised by Pat, as she remembered a high school teacher “doing all this stuff on the blackboard,” though she stated that she “just had no idea, [she] was really lost.” Similar to Bic and Pat, Bonnie said that at high school she learned mathematics in “the old days of chalk and talk … you got shown how to do it and then you did it.” This talk involved vocabulary that she “hadn't tuned into” and she had no idea of what the teacher had done on the board.

4.3.1.3 New ways

Learning with the Numeracy Development Projects (NDP) (MoE, 2001) was a new way of working, and thinking differently about, mathematics and was recognised as being an origin of maths anxiety for three participants. Tracy indicated that “the new way of doing maths” was a cause of her anxiousness. She went on to say that having to learn why something happened rather than relying on only a formula was complex. A new way of working with mathematics was also identified as a contributor to her maths anxiety by Mariah, who had previously had no difficulty in providing an answer to maths questions. However, when first asked to explain how she had got the answer for a Global Strategy Stage (GloSS) assessment question (MoE, n.d.-b), Mariah struggled with this request, had difficulty explaining the steps she had taken, and became quite frazzled. Explaining also unsettled Macy, who described her time at school as having “no grey area, so [maths] was right or wrong,” and she felt she

had a good knowledge of mathematics. Things changed for Macy during her tertiary study, as she was “introduced to this system that [was] about strategies and being able to explain your way out of it even if it’s wrong just did [her] head in.” So, her first experience of maths anxiety began. Realising that she would need to teach mathematics in a manner that was quite unfamiliar to her was also a source of anxiety for Macy.

4.3.1.4 Position in class

Four participants showed a strong awareness of the position they held in their mathematics class that were based on teacher decisions and considered this to be a generator of maths anxiety also. Bic spoke of being “bunged in the top class” in the first two years of high school due to her achievement with literacy. She recalled being “at the very bottom of the top class in terms of maths,” where she “just had no idea, couldn’t understand it.” Although there was little understanding for Bic through this time, she “didn’t want to ask questions cause [she] didn’t want to look like a twit.” Bic remembered scoring “17%, 1 - 7” in a mathematics test, and “felt like a complete and utter failure but [she] had no idea what to do to fix that problem.” When hearing her peers comparing their test scores that were in the 90s, and indicating that they had “so totally failed that maths test,” Bic said she “just wanted to smack both their heads in.”

In contrast to being a member of the ‘top class’, Meghan maintained that she was in the “you know, really thicko maths class” during high school where classes were streamed. Not unlike Meghan, Miranda revealed that she needed to repeat a year of high school mathematics and was placed in “alternative maths, that’s what they called it … it was another form of maths.” Members of the ‘alternative maths’ class were seen as “the donkeys of maths” … “I guess, failures of maths.” Unlike Bic, Meghan, and Miranda, Suzi was not placed at a particular class level, but a position she held in her tertiary mathematics class can be identified. Suzi was the person who others laughed at, because she “was counting on [her] fingers and stuff.” Memories of “the people laughing at [her]” were clear for Suzi, and she described these mathematics classes as “frightening.”

4.3.2 Teacher and parent behaviour

With regard to mathematics, the behaviour of teachers and parents stimulated maths anxiety for eleven of the research participants. Eight participants spoke only of teachers, and three mentioned both teachers and parents. When sharing of these behaviours, three sub-themes were evident: interactions and actions; personal characteristics, and connections.

4.3.2.1 Interactions and actions

Interactions with, and actions by, teachers and parents were raised by participants. Over half of the participants identified only teachers. Pat shared distinct memories from high school of having difficulty when instructed to go to the blackboard to write answers on the board. Her teacher, standing at the back of the room, responded to her difficulty with, “Come on! What’s wrong with you? Hurry up and get on with bla bla bla bla bla!” Pat described this experience as being “awful, it was really awful,” and in that moment, Pat “threw the blackboard duster at him,” which fortunately missed him, although she did get “into a power of trouble for it.”

Miranda too had teacher recollections to share. As a junior at primary school, her teacher “could teach the core group,” though “he was challenged” by “those kids that were not quite up with the play.” In his mathematics teaching, he had “one way and that was his way.” He became “so frustrated” and would “get really angry” with Miranda and yell, “Why don’t you understand it? And then he would go, ‘Just go outside!’ So yeah – I was sent out a lot.” Miranda knew that this teacher:

> liked [her] as a person – I remember him being nice to me but apart from when it came to maths. He would say, ‘I just don’t know how to teach you. You just don’t get it. So off you go, go and find something else to do.’

Miranda also vividly recalled being ridiculed in front of everyone at intermediate school by being told she had not been learning or practising, “which was totally far from the truth.” She said she was made to “feel like a dummy” or “made to feel like you were in the donkey group.” When asked to clarify the ‘donkey group’, she explained that “you were either a thoroughbred racehorse or a donkey,” referring to

the ability grouping that was utilised in the classroom. Although Miranda stressed that those terms were not utilised by teachers, she felt that teachers “just made you feel like crap basically.”

Similar feelings were evident from Lorde when she told of a high school teacher who “used to tell [her] off something chronic [for] asking questions.” The demeanour used by Lorde changed as she told of this teacher - she became the teacher through her use of voice, tone, actions, and facial expressions. In this role, Lorde told of this teacher who would growl and “stamp her foot and shake her head ‘no’ - “[Lorde], you do so know! Don’t you tell me lies!’” After “doing really, really well with maths,” mathematics learning for Lorde took a negative turn with this teacher, and she “never ever felt confident with it” and her “results just went down and stayed down, like never went back up after that, despite who the teacher was.”

Macy had a somewhat different experience with the interactions with her lecturers at university that promoted an awareness of maths anxiety. It was discussed, or “pushed,” onto the class, and it “was part of what [they] were taught and it was very much, ‘Oh, I know there’ll be those of you out there that are really anxious.’ But there was no solution given to that.” This lack of information itself created maths anxiety for Macy.

While what was said impacted maths anxiety, at times it was how statements were made that contributed to the development of maths anxiety also. Sarcasm from teachers, or being patronised by teachers, were identified by Bonnie as a contributor to her maths anxiety, where questions, such as, “Oh, do you not know the answer?” made the classroom setting feel uncomfortable for her. Mariah also raised an event that made the classroom setting feel uncomfortable for her and one that contributed to her maths anxiety. When fraction concepts were the focus for learning, the teacher became “really frustrated” with the students who were having difficulty in finding the answer. Rather than supporting learning, the teacher strongly shared, “Ah, you kids don’t know this!” Mariah did not feel encouraged to take risks after that. Joan also identified that how teachers at high school responded promoted maths anxiety. She “didn’t think the teachers worked hard to be mean on purpose,” it was “just their lack of patience in trying to explain things.” When she asked questions to clarify the mathematical concepts that were the focus of teaching and learning, she

was made to “feel like the questions you had were dumb because they were so basic.”

Parents were identified only three times as contributing to the development of maths anxiety, and all three of these related to interactions about expectations of progress. Meghan spoke of the influence of both her parents. Although “they would never help [Meghan] with maths homework,” they voiced perspectives on it. For example, “How are you going to use that in real life?” or “I can’t do that” or “Where’s the purpose in that?” At times, her parents would volunteer, “Oh, I’m not good at maths, so you’ll probably be no good at maths either.” She remembers:

> it would always be like that all the time. And I guess they didn’t see themselves as mathematicians and perhaps they didn’t have a very good maths education as well and they just kind of put that on to me as well. I mean [it’s] huge isn’t it? … You know, you’ve got your inner voice but you’ve also got your environment voice like your parents kind of. Yeah it’s hard, it’s what you hear is what you believe, isn’t it?

While these interactions held low expectations for Meghan, two participants experienced high expectations from parents. Lorde remembered her mother being supportive and encouraging of her mathematics learning, and that her “Dad was, in his own funny way, but he didn’t react very well if you weren’t doing very well.” Thinking back to stories that she had heard, Lorde shared that her father “was a real ratbag, … you know, he’d wag school as often as he could. You know, he wasn’t a great example.” Lorde recalled that her father had high expectations for her around mathematics, and that there were “lectures from Dad” about it. Her father “would go off the deep end if you didn't do well.” Lorde’s Mum was the one that “would help [her], but he’d be the one that would go off!” “He didn’t want [his children] to turn out like him.”

Similar high expectations were also held of Joan, who shared that her Dad was a mathematics professor and that he “really pushed [her] to take [maths] in Year 12.” Joan reflected on instances of going to her father for help with mathematics, though that “always ended up being a total mess ... it was not a positive experience” for either of them, as he became frustrated, and she became frustrated and more

frazzled. Joan recalled that her father was “so unimpressed” when she chose to withdraw from the Year 12 mathematics class, as she “could not handle it at all.”

4.3.2.2 Personal characteristics

The personal characteristics of teachers were seen as assisting with the development of maths anxiety. Marianne identified being shy and freezing up with a teacher that was quite stern during primary school. She suggested that she was “too scared to ask her how to do it, too scared to tell her [she] didn't understand.” Just as teacher characteristics were remembered by Marianne, Lorde remembered these also. A high school teacher was described by Lorde as being “a strop, she was really stroppy.” Lorde was labelled as a liar when asking questions of this teacher. This particular teacher had an impact on Lorde, as she volunteered that she did not “remember any other maths teacher at all, just her.”

While stern and stroppy have been identified, Meghan remembered mathematics with a “very, very strict” teacher. In this class, Meghan and other students “had [their] desks by themselves, [they] weren’t allowed to talk to anyone … and when she’d walk up past” them, Meghan would “be like, ‘Oh my God.’ You know, I’d just be scared.” The fear was real for Meghan, as she recalled “sitting in those maths class[es] feeling so scared of her that [she] just didn’t learn anything because [she] was so scared of her.”

4.3.2.3 Connections

A limited connection with teachers was alluded to by four participants. Tracy suggested that, due to frequently having different relievers, she was unable to develop a connection with those responsible for teaching her class. For Tracy, this limited connection severely reduced the opportunity to gain assistance in working

with the mathematics being taught. As Tracy spoke of a limited connection, so too did Joan, Bic, and Bonnie. Joan described a disconnect from “a really terrible maths teacher,” who “was unable to explain things in a way that [she] understood.” Similarly, Bic recalled her maths teacher as “an extremely talented mathematician, but the most useless teacher on the planet,” and that he “talked about maths sort of

in a complex sort of a way." Bic found that he "was very helpful to anyone who could actually do the maths," but "he didn't seem to cope with people who really didn't." Bonnie indicated that "if you were clever you were fine" with her teacher, though his mathematics often went "whoosh over [her] head."

4.3.2.4 Missed opportunity

Missed opportunity was recognised as generating maths anxiety for two participants. Miranda told of her experience in early primary school, with a "teacher who would send [her] out to play during maths time" after claiming that, "I can't teach you maths!" She reflected that she "spent nearly a whole year not having maths," and reiterated that point by emphasising, "that is a true story." Although Miranda missed mathematics learning due to a suggestion from a teacher, ill-health meant that Marianne was absent from primary school for considerable periods of time. After an absence, Marianne recalls being told to do something, though could not do it as she "hadn't ever seen it before." Her shyness and fear of her stern teacher prevented her from asking for assistance.

4.4 Maths anxiety fuelled responses to mathematics

All twelve participants revealed that their maths anxiety fuelled various responses to mathematics at fluctuating intensities. All four response types previously identified in the literature review were shared by participants: cognitive, affective, physiological, and neural. Of the twelve participants, three experienced responses across all four response types, eight experienced responses across three types, while one participant experienced responses relating to two types. These responses shared by participants are outlined in Table 4.3.

		Cognitive		Affective			Physio-logical	Neural
		Brain change	Negative self-talk	Distrust of ability	Fear of looking stupid	Nervousness and panic	7 types of change to physical functioning	Anticipation of mathematical activity
	61	7	7	8	5	8	15	11
Bic	4	*					**	*
Bonnie	3			*		*		*
Joan	4		*	*		*		*
Lorde	10	*			*	*	******	*
Macy	3		*			*		*
Mariah	6	*		*	*	*	**	
Marianne	6	*	*	*		*	*	*
Meghan	4	*	*				*	*
Miranda	6	*	*	*	*	*		*
Pat	5		*	*	*	*		*
Suzi	6	*	*	*	*		*	*
Tracy	4			*			**	*

Table 4.3 Maths anxiety fuelled responses to mathematics as students and teachers

4.4.1 Cognitive responses

This response type involves the intellectual activity responses to mathematics that more than three-quarters of participants have experienced. Two themes were evident, being: brain change and negative self-talk.

4.4.1.1 Brain change

Over half the participants in this research study reported a maths anxiety fuelled response to mathematics involving the idea that there were changes to brain function. Some described a mind blank, others a brain freeze, while another described it as a brain switch off. A mind blank may be described as an answer that was not forthcoming, even though the mathematical concept is understood and the answer is known. Lorde shared that she "just go[es] totally blank" when she's "put on the spot in front of everybody, and expected to come up with an answer, or participate in a game that the whole focus is on [her] and [her] answer." In another scenario, Lorde revealed how "something really, really basic like [basic facts] knowledge can disappear." She described being presented with a 'fly flip' showing seven flies and being asked how many more flies were needed to make 10. Lorde could not answer the question in that instance. In the telling, she scoffed at the idea of losing this basic fact and questioned, "who doesn't know at this age that 7 and how many more make 10?" Like Lorde, Miranda also revealed that when she is feeling tense about mathematics, someone "could ask [her] what 1 + 1 was and [she] wouldn't be able to tell them." She described that her head spins, she feels muddled in her head, and "a complete mind blank occurs."

Although not described as a mind blank, other participants also described changes in brain function, referred to as a brain freeze. Mariah described the brain freeze occurring when hitting "the point of … a sort of a brain fatigue." She shared that when doing complicated calculations, she reaches a point where all sense is lost, as "thinking about it over and over again isn't actually helping" and she "just can't make sense anymore … can't really process the information anymore, so hit a wall." This is the time of brain freeze for Mariah. While Mariah talked of brain freeze, Suzi and Marianne also talked of freezing. Suzi spoke about becoming frozen and everything going black, while Marianne disclosed that "just anything around maths can make [her] almost freeze;" she "balk[s] at the maths" and freezes up. While Marianne balks at the mathematics, Meghan shared that she feels "anxious even talking about [maths]," and that her "brain freezes" and that she just freezes – it is "like [her] brain like shuts down."

Other participants also described a shutting down of the brain. Bic described how she feels that her "brain switches off." When the mathematics becomes too complicated, it is like her brain thinks, "this is beyond me, I actually can't understand it, it's too complicated - and switching off now." The anxiety that Bic experiences leaves her feeling like she is "in the dark, feeling like you don't know, feeling like you'll never know … that becomes the focus of your thinking. And it makes it very hard to see what you're being asked to see." Bic felt strongly that she tries "so hard to understand it that [she] can't", and she sits during the switch off process "going, no, no stop, stop, my brain is no longer coping with this." While Bic talked of switching off, Suzi referred to a brain shutdown, and portrayed it as "a very slow dark curtain [being] dropped." She went on to say that when the dark curtain is dropped "everything in [her] brain is empty ... there is no, no cognition." When encouraged further, Suzi shared that in her brain, "there is nothing to compute ... there is nothing. It's empty. It's weird. It shuts you down."

4.4.1.2 Negative self-talk

A maths anxiety fuelled response to mathematics referred to by over half of the participants was negative self-talk; often referred to as a 'voice.' This voice shared negative ideas and doubting questions about ability and self-belief. As Meghan shares, "the voice is always in [her] head" and it tells her that she is "no good at maths" and that it prevents her "go[ing] any further with [maths]." The voice asks questions of Meghan that might damage belief in self: "... can I answer this? You know can I answer it kind of correctly, or -- ?" Meghan spoke of the voice she hears and the belief that "if you're not good with numbers then you're not that intelligent ... so normally people that are good at maths are the more intelligent ones."

While the voice of Meghan asked doubting questions, the voices of Marianne, Suzi, and Miranda only shared ideas of their ability with mathematics. Marianne shared that her voice "automatically tells [her] [she] can't do it", while the voice of Suzi tells her "there is nothing, nothing you know." The voice Miranda hears tells her that she "can't do this" and she "[doesn't] know what to do." Not unlike the previous voices, Joan noted that self-talk had her believing that she "was complete rubbish at maths", and that she was "out of her depth completely" in her year 12 mathematics course. In

discussion, Joan was in full agreement that her self-talk definitely knocked her back. Similar to Joan, Mariah identified that her self-talk had her thinking that she was “a bit stupid”, that she was unable to “work this out” – ‘this’ being a mathematics task, and that she was “not very good at maths”. While previous voices have developed doubt around ability with mathematics, Macy described “a voice going on in there” that applied pressure by telling her that her mathematics had “to be absolutely perfect.”

Contrasting with previous voices, the voice of Pat not only doubted her ability with mathematics, but also her ability to teach mathematics. Pat hears “just this little voice that says, ‘No, you might do that wrong. Might get that wrong or you might teach the kids wrong.’” As well as this, Pat shared that she has “this little thing in the back of [her] head that says, ‘Oh, you didn’t get School C [NCEA Level 1] maths and you weren’t very good at school and you always got in trouble and so you’re not good at maths.’”

4.4.2 Affective responses

This response type involves the mood, feeling, and attitude responses to mathematics that 10 of the participants have experienced. Three sub-themes were evident from their descriptions, being: distrust of ability; fear of looking stupid; along with nervousness and panic.

4.4.2.1 Distrust of ability

A maths anxiety fuelled response to mathematics referred to by over half of the participants was lack of trust in, or doubt about, their ability. Mariah has a lack of trust in her ability to work with mathematics problems and is hesitant to answer questions “cause there’s a chance it might be wrong.” This doubt in her ability to provide a correct answer is sometimes a source of “a lot of anxiety, because you’ve really got to make sure you get it right, and then, you know, you don’t always get it right.” Mariah shared that “even if [she] actually sort of ha[s] got the right answer [she]’ll sort of tend to be quite critical of [her] own response.” Her doubt and lack of trust in her ability with mathematics was clearly evident in her responses.

Prior to teaching, Miranda described starting in new employment, where she “had to deal with tenants and their rent and what they paid … It was like keeping books.” She ended up telling her new employer that she “was pretty useless” with mathematics, and this rekindled the idea that she was a failure in mathematics. Similar to Miranda, Suzi identified herself as being slow with mathematics around Years 7 and 8 and that she could not make sense of it. For a long time, Suzi believed she was “stupid around maths”; “a thicky,” and continues to see mathematics as her “flaw” and “just not [her] area”. This doubt around ability with mathematics was also shared by Pat when she revealed that, “I’ve always thought, ‘Oh my gosh, I’m so useless at maths’.” Not unlike Pat, Joan “felt [she] was complete rubbish at maths” and still does.

Two participants identified that they were not maths people. Bonnie saw herself as “not mathematical minded,” but “more creative and literacy minded.” While Bonnie spoke of not being maths minded, Marianne recalled working on a problem with another teacher and referred to ‘maths people’: “ … we’re both going what happens with our brains that doesn’t happen with someone who’s you know, maths inclined.” The distrust in her ability was evident again when she stated, “I’m just not a maths person.” Marianne understood the myth around this maths person idea, though even knowing “it’s a myth, will still feel like that.”

Identifying that she was not a mathematics person, Marianne shared her distrust of her ability with mathematics. She described an experience in Year 6 when she was given a page of division problems to work on, and she described that she began “feeling really anxious about not being able to do these problems on this page.” During Year 11, her busy teacher sat Marianne “beside the bright students who knew how to do maths” and expected them to teach her, leaving Marianne “just feeling so dumb at maths.” Marianne also talked about her teaching of, and further study in, mathematics and shared doubts about herself when she asked, “How can I be doing this maths stuff if I don’t even, if I can’t even solve a problem?” Marianne went on to share that she is “not only not good at maths but [she’s] a bad teacher at maths.”

Like Marianne, there were other participants who were also doubtful and distrustful about their work with mathematics in the classroom. Suzi spoke of “being a terrible teacher sometimes.” When she “didn't actually quite get it,” Suzi could remove

herself from the teaching role by suggesting her students “check out this clip on Khan Academy” and “follow up over there with that worksheet.” When those activities were complete, it was then that students went to Suzi. Suzi distrusted her ability in teaching mathematics at a higher primary level, as she indicated that she “can't be a Year 5-6 teacher, there's no way.” Students at higher stages “deserve better, a more competent teacher.” Like Suzi, Joan shared doubts about her ability for teaching mathematics with students in the upper primary level. She declared, “I won’t teach the Year 7 and 8s ... I would worry that I wouldn’t be able to cope with teaching the maths.”

The distrust in ability that limited teaching levels for Suzi and Joan was also shared by Miranda. She revealed that although she had wanted to teach in the middle school (Years 3-4) when starting as a teacher, she thought it was safer for her to teach juniors, as “middle school is different and you need to know a lot more” mathematics. Having recently made the move into the middle school, she finds her “Year 4s that are quite clever are basically teaching [her].” In her middle school position, Miranda has been told to “just back yourself. And it is like, it is all very well to say back yourself, but when you don’t know what you are doing, you know – .”

Although there was no distrust in her ability to teach mathematics across the full primary level, Tracy shared doubts around her ability to manage the classroom during mathematics: “I think that my classroom management during maths isn’t as good as it is during literacy.” Tracy shared that she starts to “freak out a bit inside … there’s lots of noise over there and I’m finding the management of that really challenging … Whereas that doesn’t happen in literacy, doesn’t happen in any other of the areas I feel really confident in.” A distrust in her ability “to lose some control … to give kids agency” during mathematics was evident.

4.4.2.2 Fear of looking stupid

Mathematics was seldom an issue for participants when working on their own, though five of the participants had a performance-based fear that they would look stupid in front of others due to their mathematical thinking. Most often, this fear of looking stupid appeared during professional development sessions. Lorde talked of looking “really stupid” during these times, often wondering if she’d know an answer

or the game to be played. Feeling pressured in the professional development space, Lorde would check in with “a couple of people here” on the teaching staff and sit with them during professional development. They assured her that they would sit beside her, wouldn’t let her “look silly” by herself, and that they had her “back no matter what”. Referring to her actions and responses in professional development sessions, Lorde said, “you make a dickhead out of yourself.” She described others as looking “so confident and so fast,” while she wanted to “just be a little grease spot and melt right now”, so she could “slip away and hopefully no one” would see her or notice her. Lorde was intent on not being seen and not being asked to share any mathematical thinking.

Like Lorde, Pat also described an aversion about being seen and heard. The idea of trying to “get under the table and hope she doesn’t pick [me] to answer a question” was how Pat felt. Miranda also had the idea of not wanting to be heard during professional development and having “that fear of being wrong and feeling ridiculed by that.” She would sit nervously thinking, “Please don’t ask me a question!” Looking stupid was also shared by Mariah when she spoke of being hesitant due to “getting the wrong answer” and being “sort of, you know, shamed in front of the other teachers.” Suzi was another participant who disclosed a fear of looking stupid, though not specifically during professional development sessions. Suzi identified maths learning at university as frightening, as she was concerned that she would be exposed as being stupid. In her earlier years she avoided “darts or anything that had maths in it. I would not, not play, not expose myself.” A fear of looking stupid was mostly in relation to other adults, and Suzi used somewhat colourful and repetitive language to share her ideas. She was “fearful because everyone’s going to get me – everyone will know because it’s like, f*** I’m stupid and everyone's going to know, everyone's going to know how dumb I am.” This colourful and repetitive language gave an intensity to Suzi’s feelings around others knowing about her perceived stupidity.

4.4.2.3 Nervousness and panic

Being nervous or panicky was a common maths anxiety fuelled response to things mathematical for almost three-quarters of the research participants. The idea of nervousness was shared by five participants, and feeling panic was shared by four. Mariah described a “sort of nervous, feel tense” idea, while Joan, in her sharing, outlined she experienced “that uncomfortable anxiety feeling in your stomach”, which she agreed was butterfly feelings and nervousness. Miranda described this response very strongly and said that she had a “feeling of nervousness and a little bit of that uncertainty, so it is a slight feeling of fear,” though went on to share that mathematics would “wind [her] up in knots, that she “was absolutely horrified and terrified of it,” and that mathematics “totally threw” her.

Like previous participants, Pat shared that she would “get really nervous about having to do it” – it being mathematics. Likewise, Lorde would get really nervous, though she also described “this overwhelming sense of panic”, where she “just need[s] to calm.” In the same way as Lorde, Macy and Bonnie also responded with panic to mathematics. Bonnie pointed out that “it’s just panic,” while Macy indicated some familiarity to it, as she spoke of “the old panic … panic definitely.” Panic was also shared by Marianne, though she shared that “secretly [she] still ha[s] these panics,” but outwardly portrays a can-do attitude.

4.4.3 Physiological responses

The physiological response type involves maths anxiety fuelled responses to mathematics in relation to bodily function that more than half the participants in this research study have experienced. A variety of changes were identified in relation to physical functioning of the body, and included an increased heart rate, a change in breathing, a difference with talk, and greater perspiration, feeling nauseous, a tightness in the chest, flushed face, and tears. While most of these participants identified one or two of the listed responses, Lorde identified six of these physiological responses in relation to her mathematical activity

Four participants indicated an increased heart rate. Tracy described how her “heart rate was always more up” when involved with mathematics and indicated, “it’s up now just talking about it.” Like Tracy, Marianne, Lorde, and Mariah indicated an increased heart rate also. Marianne shared that she feels her “heart racing”, as did Lorde. Not only does Mariah get “more and more frazzled, and then you get the, you know, heart beating faster,” but her breathing becomes faster also.

Unlike Mariah, whose breathing becomes faster, Suzi used actions to portray her experience of a lack of breath. Suzi demonstrated being put “on the spot” through sitting back, making a shocked facial expression, and holding her breath for a time. While Suzi experienced a lack of breath, Lorde said she can become “quite short of breath,” and “can come away feeling a little bit breathless sometimes” from an experience with mathematics. This shortness of breath “might be due to talking fast,” as Lorde feels the need “to talk to fill in the gaps,” and that she talks “fast ... really fast when I'm really nervous” around mathematics.

In addition to an increase in talk, shortness of breath, and an increased heart rate, Lorde also identified that she perspires as well. She realises that she is perspiring and finds herself thinking, “Oh my God! You're actually really sweaty! You don't normally sweat a lot, but you actually feel quite sweaty!” While there was not the strong response that Lorde experienced, Bic raised the idea of perspiring, when she shared, “I start to, I don’t actually physically sweat but I feel like I could.”

Feeling nauseous around mathematics was a physiological response for both Lorde and Meghan. Lorde revealed that she can “be on the toilet heaps, and sometimes [she] even feel[s] sick.” These responses related to mathematics professional development sessions. Feeling sick was also commented on by Meghan, though she assured me that she does not “vomit or anything like that.”

Although the following responses were each indicated by only one participant, it is important to share a complete picture of physiological responses. Lorde described a response of being “red and flustered looking.” She wished she “could control that stuff,” but instead, she became “red, so it's obvious.” Bic did not go red or feel flustered but described a “tight feeling in [her] chest” when she was “not 100% comfortable with understanding,” or when she could not do the mathematics fast.

Tracy described a physiological response that involved tears. The “whole way of teaching maths had changed” when Tracy returned to full time teaching and she had to upskill in a short space of time. This led Tracy to “cry most days” as she worked to get her “head around the stages, the levels, the difference between knowledge and strategies, how it all linked together with strand.” She “did cry, it brought a lot of tears.” Not only did grappling with a new way of teaching mathematics bring Tracy to tears but observing a “wonderful maths professional development person” did also. The tears were not from being put on the spot during professional development, but from “just watching” the professional development facilitator and a perceived realisation that there was “no way [she] could emulate that” teaching of mathematics.

4.4.4 Neural response

The neural response type involves possible or actual pain while anticipating mathematics due to a perceived threat detection. All participants bar one experienced this response. It was not the doing of anything mathematical that created an anxious response, but the anticipation of doing something mathematical that created the anxiety.

For Joan and Suzi, the anticipation of mathematics quizzes and examinations were activities that they felt overly threatened by. Anticipating the need to solve a mathematical question in front of others, including during teacher professional development or with students, left Miranda, Bonnie, Lorde, Marianne, and Bic feeling threatened. When Lorde feels threatened, she tells herself that she needs “to calm, slow and talk [her]self through, ‘Okay. Calm down. You're fine. You're going to be ok. This is not going to kill you. You are not going to die.’”

The anticipation of teaching mathematics was also something that Bonnie was threatened by. She was not alone in this, as anticipating mathematics teaching was also threatening for Tracy, Meghan, Miranda, Pat, and Macy.

4.5 Situations for maths anxiety

The twelve participants in this research study discussed situations that impact their maths anxiety. From the responses shared, two themes became evident, these

being performance and teaching-related mathematics. Ten of the twelve participants found that their experience of maths anxiety intensified when mathematics involved some form of performance, whereas all participants found that situations involving teaching-related mathematics increased the maths anxiety experienced. Table 4.4 provides summarised information about the types of situations that each individual identified as raising the maths anxiety experienced.

		Mathematics performance		Teaching-related mathematics		
		Within professional development	Outside of professional development	Mathematics planning	Mathematics teaching	Uncertainty with mathematics content and teaching
	30	7	6	3	4	10
Bic	2	*				*
Bonnie	3	*			*	*
Joan	2		*			*
Lorde	3	*	*			*
Macy	3			*	*	*
Mariah	3	*	*			*
Marianne	3	*	*			*
Meghan	2		*			*
Miranda	2	*				*
Pat	3	*		*	*	
Suzi	2		*			*
Tracy	2			*	*	

Table 4.4 Situations for maths anxiety

4.5.1 Performance

Ten of the 12 research participants shared ideas in relation to performance when they spoke of situations that impact their maths anxiety. Professional development situations were often referred to as a time when maths anxiety intensified. However, for the 10 that identified performance as a situation that impacted their anxiety, the performance included working with maths in front of others, which often connected with being put on the spot, and the idea that others expected a quick response.

Mathematics professional development fuelled maths anxiety for Bonnie, as she "hated being on the spot" when made to "play maths games with people [she] didn't know … and maths activities." Bonnie believed in-service professional development was usually "very good for you," and she would mostly come away thinking "I'll try this, I'll do that ... but I never got to feel like that about maths at all." The maths anxiety Bonnie experienced removed any interest in being involved in mathematics professional development, as she did not want to share her mathematics thinking, as she "didn't like maths," the professional development "was very uncomfortable," and she "didn't enjoy it at all." For Bonnie, anxiety appeared to be heightened in situations involving waiting to be "called on for answers, and "be[ing] in groups" solving a mathematics problem.

Bonnie believes "some people have more mathematical brains" and that "they can work out things quickly," which leads Bonnie to "just leave them to it usually and [she'd] just be into [her] own little space." When asked if she was happy that her school was not involved in mathematics professional development at present, Bonnie responded with a resounding, "Hell yeah!" and admitted that she "would never put [her]self forward for anything maths-y," but has "stuck [her] hand up for literacy" leader in her school. Throughout the interview, it became obvious that Bonnie did not like to be called on in relation to mathematics in any situation. When asked if this was the case, she agreed that she did not. This was interesting, as Bonnie described herself as "quite vocal", "quite confident" and an experienced toastmaster who could "speak in front of a crowd" – but not if it involved mathematics.

Akin to Bonnie, Miranda also becomes anxious during mathematics professional development, and shared an experience when she "hadn't been teaching very long." During this particular mathematics professional development session, the facilitator, who "was like, cut-throat", requested that Miranda work with a small group of students she was unfamiliar with while being observed by the facilitator and her junior team colleagues. Her "head was just spinning" and she was "thinking that this seems simple, but this could totally go pear-shaped and it kind of did." The activity was focused on "questioning and I just thought, I don't even know what to say to these kids. I don't even know you." Miranda had "this total like 'oh my gosh' feeling of anxiousness" and remembered thinking "this is a horrible situation to be in." For Miranda, "what made it worse" was the facilitator who, "in front of everybody, goes – 'Are you stupid?'" Miranda ended up "bawling", and then her "team leader jumped in and went, 'Oh my God! What are you doing?'" Not only was the facilitator and the team leader asking questions of Miranda, "an 'old school' teacher and strict and … yeah, she sort of jumped on the bandwagon as well, and she wasn't very nice either." Miranda stated that it "was the worst thing ever and I remember it was just horrible." This professional development experience left Miranda feeling "unsupported and made to feel like an absolute idiot, so that all got that fear again."

Now, when attending mathematics professional development sessions, Miranda finds it best to "just sit there and keep quiet and just don't say anything." When asked if she ever contributed anything during a professional development session for mathematics, Miranda quickly responded, "God no … No. No way. No way." She finds it is best to "just nod your head" as though to say, "'Yeah, that's cool, I get that.' I don't, but – ." Miranda considers herself "lucky" that amongst the people she sits with during mathematics professional development, "there is one other teacher who is just lovely" who can be heard "muttering, 'Don't worry, I don't get it either.' So, it's kind of nice to know that there is someone else who feels the same."

Just as Miranda becomes anxious during mathematics professional development, Bic also has similar experiences. She described how her sense of not knowing, with the awareness that "everyone's going to look at [her] strangely if [she] can't do this," increases her maths anxiety. It is not good in "a teachers' professional development thing" for Bic to not know something that "[she] felt [she] should", though, "it's not so

bad … if you don't know that you should know it." During mathematics professional development sessions, having thoughts that she really "need[ed] to perform" and "had to produce a result" heightened maths anxiety for Bic, especially when she had "to do something" and that there was "no way … to find another way of presenting the information" or when she was unable to "discuss it with somebody."

Similar to Bic, Marianne explained that having people watching and relying on her when she worked with mathematics was a likely situation for maths anxiety. Being observed in her mathematics classroom for the purposes of professional development left Marianne feeling "really exposed" and that "all eyes are on [her]." Marianne recognised that there is "an anxiety anyway" while being observed, but firmly stated that "if you're maths anxious, it's even worse." Professional development was not the only situation that heightened maths anxiety for Marianne. The idea of "talking in front of others" and their "wanting to know things from" her, along with the idea that someone expected her "to know it right there and then" and to be able to clearly explain, were contributors for maths anxiety. With the belief that she is "not a fast processor," but one who likes "to take time and think about things," Marianne feels an "expectation that you have to come up with that answer quickly if you get maths." This expectation serves to heighten the anxiety of working with maths in front of others. Being "worried someone's going to ask ... a curly maths question" that might leave her standing in front of people "feeling really embarrassed" also feeds into her maths anxiety when performing in front of others. When asked to clarify 'others', Marianne explained it was anyone: "teachers, learners, friends – maths in all situations."

Mariah reiterated similar thoughts to Marianne, as "any situation where someone puts you on the spot … about something mathematical" is when maths anxiety escalates for her. Mariah was clear that she "never get[s] maths anxiety" when working on a mathematics problem by herself, as "you have enough time to do it … you know you're doing it under your own conditions." When working with and in front of others, Mariah spoke of holding the belief that "you've got the maths sussed" and then it "might be a student [who] throw[s] something at you" and you suddenly realise, 'Oh okay! Actually, no I don't. I'm not quite as clear on this as I thought.'"

Mathematics professional development was “a classic example” of a situation for maths anxiety, as she might be “put on the spot”.

Just as Mariah spoke of her dislike of being put on the spot, both Meghan and Suzi also spoke of this ‘spot.’ Meghan suggested that she doubts herself and feels “not quite so confident” when asked a maths question, especially when a quick response is expected. She feels that if she is put on the spot, then her maths anxiety increases. Similar to Meghan, Suzi talked of being “put on the spot” and how maths anxiety intensifies for her when this occurs. When teaching Year 5 and 6 students, Suzi was put on the spot “lots of times, lots of times.” Being put on the spot is a time “when the blinds will be drawn again” for Suzi, though she was certain that she is fine “when not on show.”

Being put on the spot during mathematics professional development also impacted maths anxiety for Lorde and Pat. Lorde explained that when she is with adults, “like in a PD situation” and she thinks she is “going to be put on the spot”, then her maths anxiety is fuelled. Stating that she is “fine with [her] class and … fine with [her] friends, fine if you're out somewhere and you can work it all out,” but she identified that “maths PD is the biggest, [her] biggest issue is maths PD.” That is when she is likely to “go blank” and “make a dickhead out of [her]self.” When Lorde thinks she is going to be “put on the spot in front of everybody, and expected to come up with an answer, or participate in a game that the whole focus is on [her] and [her] answer,” then her thinking, “it’s gone.”

When discussing mathematics professional development, Lorde emphasised that she “just hate[s] it” and identified that a maths facilitator scared “the living crap out of [her].” It was interesting to find that Lorde “used to be the maths lead teacher”. However, in her words, “only lead teacher in the juniors,” and “that was safe, that was fine.” For Lorde, this role “wasn't so much about maths teaching,” “it was more data gathering,” “school organisation and structure ... assessment schedules and stuff like that.” Because the role did not involve mathematics content, and performance of mathematics content, “it wasn't threatening” for Lorde. Pat also described professional development situations as a time for increased anxiety, as she was nervous about performing in front of others if picked to answer a question.

Pat shared that she wondered if she should “get under the table” to avoid being picked.

Although not performing in front of others, performing in a test or examination encouraged maths anxiety for two participants. Joan remembered a “really good math teacher” at secondary school, though “she had quizzes every week to try to test what [they] learnt the week before,” and Joan remembered those as “pretty stressful.” Joan was also concerned about mathematics for her “teacher registration and education” – it was “the biggest struggle” for her. This struggle created anxiety for Joan, as she “got 90s in everything else … straight As in every other subject.” Her level of maths anxiety increased even more so after “having a talk with her math[s] professor and her saying, ‘I’m really worried what’s going to happen to you with math[s].’” In anticipation of failing an upcoming mathematics examination, and it being “the one thing standing in [her] way to become a teacher,” Joan remembers “cramming for it like nothing else just cause for [her] it was, it almost felt like that was the one thing I needed to get over to get my teaching qualification.”

Suzi also recalled a mathematics examination during her “teacher training.” Before the examination, she “didn’t think [she] was ever going to be able to” achieve, and she knew that she had “to calm down.” To calm down, and “to be able to get in and do it,” Suzi “took a swig of tequila before [she] went in.” When reflecting on this, Suzi shared that she did not “think [she’d] ever had a swig of tequila any other time in the middle of the day.” Suzi added that she “never looked at [those] results and [she] was always quite result driven with everything else, but [she] never sought out those results.”

4.5.2 Teaching-related mathematics

All 12 research participants shared ideas concerning teaching-related mathematics when they spoke of situations that impact their maths anxiety. These situations involved planning for mathematics, teaching mathematics, and uncertainty with mathematics content and its teaching.

After 17 years of teaching, Tracy still does not “enjoy teaching maths and it still causes [her] a great deal of anxiety.” This maths anxiety connected to teaching-

related mathematics continues to occur for Tracy, even though she has “discovered [she is] good” with mathematics teaching and “[her] children succeed.” Not only is teaching mathematics a driver of her maths anxiety, the planning for mathematics also impacts as “it doesn’t come naturally” to Tracy and “it just takes [her] so long.” In her personal life now, mathematics “doesn’t cause ... any anxiety at all,” but when asked to confirm if the anxiety related to teaching-related mathematics, Tracy answered with a resounding, “Yes!!”

While Tracy “starts to get really anxious” during mathematics “PD in [her] school,” her anxiety comes from expectations around her mathematics teaching practice, which she provided three expectation examples for. The first was modelling books, where problem solving is recorded. These are “just an anathema” to Tracy, as she “can't keep what's happening here with [her] kids and be recording their voice all at the same time.” Tracy just “can’t make it work.” Another example provided by Tracy was mixed ability grouping. She recognised that she had been “encouraged to have mixed ability groups,” though she is unable to “get [her] head around that so [she was] sticking with ability groups.” Working with students in ability groups “helps [her] to really organise [her] thinking.”

The last example shared by Tracy was the need “to create a rich task” for different areas of mathematics, which also heightens anxiety for her. When she is “encouraged to do lots of rich tasks,” she is “just absolutely [filled] with dread,” and she becomes “really worried and really anxious” as she doesn’t “even know where to start.” In stark contrast, Tracy does not feel anxiety in literacy related professional development and expectations for literacy teaching. She explained:

> if you were to ask me to create something like that, a rich task in literacy, my brain would be whirring with excitement and I would just go, ‘Whoa yes! We could do this and this and this and this.’ Come to maths - and then it just takes me so long and sleepless nights, actually literally sleepless nights where I just can’t sleep, and I can’t. I don’t know where the blockage is.

Tracy finished this discussion by sharing an idea about her anxiety around teaching-related mathematics: “it almost makes me not want to be a teacher, that’s how anxious I feel. If I could find a job where I could teach this age group and not have to teach maths, that would be my dream.”

As with Tracy, Bonnie compared her mathematics instructional practices with those of reading and writing. She noted that “reading groups are so nice and specific”; with reading, if students “can’t read at yellow, well you hear them read lots of yellow books till they can and then you read blue books.” In writing, if students “don’t know capital letters and full stops, [then] that’s what you teach them.” In contrast, maths teaching “is a bit airy fairy” for Bonnie, and she “wasn’t sure where to go next.” Bonnie stated that she has been “teaching all these years and all these different things have come in and lots of different ways of teaching [maths], whereas reading and writing stayed the same.” Mathematics teaching has left Bonnie questioning, “How am I going to do this?” and she shared that everything else in the curriculum “is clear as crystal,” though it was “like the elephant in the room whenever [she] taught maths – blah.” Bonnie was very clear that she is now fine with mathematics outside of teaching, and that her maths anxiety was “a teaching anxiety not a life anxiety.”

Just as teaching-related mathematics is a situation that promotes maths anxiety for Bonnie, Pat also experiences a similar response. Pat feels “really paranoid and worried about teaching maths,” her planning for maths is “excessive,” and she “kind of write[s] down step-by-step-by-step” what she needs to do. Being involved with teaching mathematics raises maths anxiety levels for Pat, as she has

> this thing that [she] can’t do it, [she] can’t do it and [she] will just do it all wrong and [she’ll] look silly and [she’ll] have parents coming to growl at [her] cause [she’s] teaching their kids the wrong way.

In elaborating when maths anxiety occurred in her teaching, Pat noted that working with “bright kids” was a situation that boosted maths anxiety, as she “knew damn well [she] didn’t know how they did it;” it being the mathematics.

Describing herself as “a bit of a math freak as a kid,” Macy also recognised that it is teaching-related mathematics that increases her maths anxiety. Working in an innovative learning environment (ILE) meant that Macy would be involved with teaching a variety of mathematics content and “end up with any workshop.” Macy described one experience when “divvy[ing] out who’s teaching what for the next week” in her Year 7-8 ILE involving three maths groups”, with one at “stage eight and beyond.” She found herself “thinking, looking at it going, ‘Shit no! Not having that one!’” Her mind went into “panic,” as she was unsure that she could “actually do” the maths with that group.” Not only was Macy anxious about teaching the advanced group, but also with her wonderings about “how do I tell him I’m not having that maths group?”; him being a co-teacher who was also the deputy principal, as she always ensures that her anxiety around mathematics “doesn’t show.”

In her teaching, Macy became familiar with the NDP (MoE, 2001) and the relevant resources, and used this knowledge and understanding in her teaching. However, when Macy started at a new school and asked if the Numeracy Development Projects were used, her maths anxiety increased when told, “Oh no, we don’t worry about that anymore.” Her anxiety was fired from concern about not being able to use “[her] resource,” wondering “what will [she] do” without the projects, and thinking, “Wow! What the hell are you using?” The unknown way of teaching mathematics was of grave concern for Macy, and this was confirmed when she stated “I do, I do know maths” when planning for stage four of Numeracy Development Projects (MoE, 2001), but was “so worried that [she is] not going to teach it as it should be.”

In reflecting on her teaching during the interview, Macy believed that as a teacher, she “just realised that [she has] probably lack of knowledge of how to teach it” and “that has created that anxiety.” Macy has the “perception” that she has to be “brilliant at everything”, and that “maths is such a critical part of that” and “you can only be failing” if “you don’t meet that criteria.” Macy acknowledged that she is “a perfectionist,” who spends a lot of time planning lessons so as “to give the students the very, very best teaching, and so that anxiety perpetuates on itself.”

In contrast to Macy who was secure in the use of the Numeracy Development Projects (MoE, 2001), Bonnie “sort of avoided the numeracy project stuff.” For her, teaching ‘strand’ mathematics, such as geometry, measurement, and statistics, in a

whole class situation created less anxiety. That maths anxiety increased when she knew she “had to come back to numeracy” because numeracy teaching involved groups, and “those groups throw” Bonnie. The thought that Bonnie was not “doing a particularly good job” of teaching mathematics was also a driver for her anxiety.

A number of participants shared that they became anxious due to their uncertainty with mathematics content and teaching. Marianne described herself as “a bad teacher at maths,” and described “demonstrating … incorrectly” and then she has “got the panic of, ‘Oh my gosh, … now I’m teaching them wrong!’” Marianne goes into a “panic cause here [she is] talking about the subject that [she] feels least confident in.” Outwardly, Marianne does not let this panic be seen by her students. However, “secretly [she] still ha[s] these panics.”

Like Marianne, both Joan and Suzi found anxiety increased in relation to mathematics content and teaching. Joan shared that she becomes more maths anxious when she is “having a difficulty explaining it, or if [her] students are struggling with it, or if [she’s] got those high achievers to try to challenge.” There is uncertainty for Suzi also. She sometimes “didn't actually quite get” the mathematics she was teaching in her Year 5-6 mathematics classroom and felt the “pressure” of not knowing. When discussing her gaining the Year 5-6 teaching position, she said that she “wouldn’t have hired [her]” for it, as she saw herself as “incompetent in such a key area.”

Teaching at the Year 5-6 level also created anxiety for Meghan, as the students “were higher level” and “high stages” and some “were very, very gifted at maths.” The uncertainty around mathematics content was obvious for Meghan when she shared that the students were “so much better than [her] at maths,” and she was uncertain that she would “be able to meet their needs and be able to extend them, knowing that [she] didn’t have that same maths ability.”

Uncertainty for teaching mathematics was evident in discussion with Lorde and Miranda. Lorde has “always hated teaching maths,” and has not taught it “willingly, [she] did it begrudgingly.” “It was not that [she] couldn’t do it,” though she is doubtful “if [she] ever thought [she] was good enough” or confident with mathematics teaching. Lorde laughed when she shared that, “ironically [she’d] ended up being the

maths lead teacher in the junior school," and this year she is "now responsible in teaching all the junior school maths. I'm not teaching my strengths, which is literacy."

Teaching-related maths anxiety was also evident for Miranda, as she indicated some uncertainty around mathematics teaching, as well as the planning of mathematics. When she was first appointed as a Year 3-4 teacher, Miranda was "feeling a little bit like, 'Oh my God.'" Miranda was uncertain about teaching mathematics at this level, as "the fact [was] that [she had] never done this before," and continues to be doubtful of teaching mathematics at a higher level. Not only was there uncertainty regarding her teaching practice, Miranda was also suspicious about her planning and this boosted her anxiety. She would attempt to plan mathematics, but was thinking, "I don't really know what I am planning because I haven't done this before." When Miranda did the planning, her co-teacher:

> would come to her and go, 'No, we need to be doing - this is good but we need to be doing this, this and this,' and then I just said to her, 'Hey, do you think it would be better if you plan it and then you have got the control of it?'

Unlike the previous participants who identified teaching-related mathematics as a situation for greater maths anxiety, this was not a concern for Mariah and Bic at the present time. Mariah is comfortable with mathematics content at the moment, as she is "not teaching high level maths." However, she has "reservations about maths in [her] teaching, and states, "it's not [her] favourite thing." She described how:

> Sometimes [you] think you've got the maths sussed and then you realise, might be a student throw something at you, and then you suddenly, 'Oh okay. Actually no, I don't, I'm not quite as clear on this as I thought.'

Uncertainty around mathematics teaching is evident for Mariah, as it is for Bic. In her mathematics classroom at present, maths anxiety levels for Bic "are much lower because [she is] unlikely to come across something that is going to put too much pressure on" her. In noting that this lower maths anxiety was because she has taught at the same year "level for three years," she took pains to recall that she could become anxious due to uncertainty with mathematics content when previously

“teaching year 7 and 8s.” When teaching more advanced levels, she described that she was “trying so hard to understand it that [she couldn’t].” When asking for “a bit of a hand” to develop mathematics content understanding and information was being shared, Bic “c[ould]n’t keep up” at times, and she found herself, “going no, no stop, stop, my brain is no longer coping with this.’ Related to maths anxiety increasing with uncertainty about mathematics content and her attempts to gain assistance with her mathematics understanding for teaching, Bic generalised this situation to any conversation where she is uncertain of the mathematics – she will “try and follow it”, but will “become very anxious.”

As can be seen, all participants found that teaching-related mathematics was a situation for maths anxiety. In consideration of the literature discussed in Chapter 3, it is believed that this teaching-related mathematics situation should be referred to more specifically as maths teaching anxiety going forward.

4.6 Maths anxiety management strategies

All 12 participants in this research study discussed strategies that they have used, or continue to use, to manage their maths anxiety. A number of themes have been identified and include distract and avoid, trusted support, be prepared, limit the level, and learning for mathematics teaching. Table 4.5 provides summarised information about the types of management strategies that each individual utilised, either during their time as a student or as a teacher, or both.

Although the participants identified these themes as management strategies, there was also concern shared in regards the mathematics learning for their students. This concern was most often shared while discussing being prepared, limiting the level, and learning for mathematics teaching. While these activities assisted in the management of maths anxiety, participants also felt that these activities enabled them to better support the mathematical learning of students.

		Distract and avoid			Trusted support	Be prepared		Limit the level	Learning for maths teaching
		Clown and chat	Step away	Drop it		Understanding	Planning		
	52	3	6	10	5	8	7	5	8
Bic	3		*	*					*
Bonnie	2			*		*			
Joan	4			*		*	*	*	
Lorde	7	*	*	*	*	*	*	*	
Macy	3					*	*		*
Mariah	4		*	*	*				*
Marianne	3	*		*					*
Meghan	5			*	*	*		*	*
Miranda	5				*	*	*	*	*
Pat	5		*	*		*	*		*
Suzi	7	*	*	*		*	*	*	*
Tracy	4		*	*	*		*		

Table 4.5 Management strategies

4.6.1 Distract and avoid

Ten research participants used avoidance to manage their anxiety. Avoiding mathematics was essential for these participants, as it reduced the likelihood of them becoming more anxious. Avoiding mathematics involved practices classified as clown and chat, step away, and drop it.

4.6.1.1 Clown and chat

Three participants utilised humour, as well as introducing a change of topic, to distract from a mathematics focus, and so avoid mathematics. As a student, Suzi became skilled in “clowning around in the back” of a space to distract attention away from mathematics. While clowning was useful, Suzi also found that she was able to draw attention away from a mathematics focus by encouraging teachers “to talk about what she wanted to, so we didn't have to do the work.” One maths teacher remembered by Suzi “was easy” to influence and “get him to talk’ and “he would easily indulge” in the new topic introduced, with the focus moving away from mathematics.

Like Suzi, Marianne also became skilled with utilising clowning and chatting, and continues to use these strategies. In Year 12 at high school, Marianne “couldn’t see the relevance” of mathematics, “didn’t really care about” it, had “given up” on mathematics, and “clowned around.” Although Marianne may not clown around as an adult, she uses “a humorous remark” to change the focus from mathematics and identified herself as being “pretty good at side tracking people” in both professional and social situations. In saying that she can side-track, Marianne also “think[s] maths is probably a little bit easier to avoid than reading, as in it’s not quite as noticeable - you can get around it a lot easier than if you struggle to read.”

Lorde currently uses clowning and chatting strategies also. When things are “getting a bit heavy” and she is “feeling a bit stressed out” in a professional development session, Lorde will “do something really stupid on purpose just to be the class clown” and make “an even bigger dick” of herself. Lorde finds that this takes “the heat off” her and she does not “feel so stupid.” For instance, when professional development is “super, super, super threatening [she] will make [her]self look stupid.” Lorde identified her ‘something stupid’ in a variety of ways, such as sharing “a smart wise crack,” asking for a question to be repeated, seeking clarification of information, saying “I’m not quite finished yet, I need more time,” or ‘forgetting’ information. Lorde most often finds that when she appears to be ready to work with the mathematics, “by then they've all done it” and the activity is complete. It is interesting that Lorde does something stupid that makes herself look stupid so as not to feel stupid.

Through discussion it was discovered that although she does something stupid to look stupid, that was okay as she “knew what [she] was doing,” and “was intentionally doing it.”

4.6.1.2 Step away

Six participants found that stepping away from mathematics was a useful strategy to manage anxiety around mathematics. Mariah was one of these participants and said that “probably the best way” to manage maths anxiety was to avoid mathematics. In saying this, Mariah explained stepping away can be useful. When she is maths anxious “everything sort of freezes” for Mariah and she is “totally useless at that point.” When this occurs, it is useful for her “to actually step away” from mathematics as “thinking about it over and over again isn’t actually helping.” Stepping away from mathematics enables her to “calm yourself down.” Mariah spoke of breathing techniques to create calm when stepping away, and once calm her “brain engages again” and she is able to “com[e] back to it later.”

In contrast to Mariah who stepped away to regain a sense of calm to then return to working with mathematics, Tracy completely avoided mathematics through stepping away. In year 12, mathematics “made absolutely no sense” for her and she “really didn’t understand what [she] was doing. Tracy “failed maths for the first time” in her life, and “failed it really badly.” From that point on, she “just avoided maths in any way” even though she was able to do all the maths “that you would need in your life.” The use of this management strategy continued during her tertiary study, when Tracy avoided the “formal kind of maths stuff” and “did just the basic maths course,” choosing instead to take electives involving “art and music and literacy - the things that [she] was loving and succeeding in.”

Resembling Tracy, Pat also stepped away to manage maths anxiety. At university, Pat did “everything [she] could really to avoid having to do maths.” This was a continuance from her avoidance at a younger age, when maths made her “really nervous”, so she stepped away from mathematics in a variety of ways. For example, “losing [her] piece of paper that [she]’d been up all night kind of working out how to do a particular equation” enabled her to step away from mathematical discussion in class. In her leaderships roles as a teacher, Pat has been in an out of the classroom

situations, though she has stepped away from mathematics by making sure that “the teaching [she] was doing wasn’t maths” and that “someone else would be in the room for that part of maths.” Bic was another participant who stepped way. She strongly stated that avoidance was the best thing to manage her anxiety around mathematics. Through stepping away, Bic “avoided the bits that [she] couldn’t cope with.”

Suzi was another participant who stepped away from mathematics and mathematical situations. At university, it was easy to “hide” from mathematics, as Suzi found “there were people in groups to swish it along.” Once teaching, when she “didn't actually quite get it,” Suzi would step away from the teacher role by suggesting her students “check out this clip on Khan Academy” and “follow up over there with that worksheet.” When those activities were completed, it was only then that students went to Suzi. Another approach Suzi utilised to step away from teaching mathematics was to “blag it you know, literally blag it.” When asked to clarify what blagging was, Suzi stated that it was to “put it onto the kid who [she] know[s] knows.”

Moreover, Suzi stepped away from mathematics teaching by removing herself from the classroom space. As an illustration, Suzi described a time mid-lesson when she “just froze and it went black again.” In this instance, Suzi “picked up an iPad” and stated that she just had “to go to the toilet, one moment.” She was intending to “go into the loo and watch the video, come back and carry on with it.” However, when she entered the bathroom “the principal was in there, with a maintenance person, because some pipe had burst.” Suzi “ended up having to go to the sickbay,” though, in remembering, she did not believe she watched the video, as she was “worried they'd hear it.”

Several times throughout the interview, Suzi identified that she removes herself from a social or professional situation involving mathematics by letting people know that she “just need[s] to go to the toilet, sorry.” After stepping away from the mathematics situation, Suzi returns with the hope that the mathematics is “all sorted.” In these situations, Suzi does not instantly “just jump up and go, ‘I've got to go to the loo,’” but has a voice that prompts thinking of how to step away: “... what do I do? I've got to get out, got to get out of this. And then, how do I get out of this?” While Suzi finds

she needs to step away at times, she stated that really it is best to “avoid it, you avoid putting yourself in a situation [where] you're going to need your maths.”

In addition to going to the bathroom, as Suzi did, Lorde also reported stepping away to “go and get a cup of tea.” Lorde also steps away, though in reverse, by delaying her arrival at mathematics professional development. Mathematics professional development is “the only time in [her] life [she is] ever late,” as Lorde is “never late for anything” and is “always the early person.’ Her colleagues have commented that it is “a bit weird” that she arrives late for mathematics professional development sessions. In recognising these strategies, Lorde exclaimed, “Oh my God! This is terrible!” In remembering that she does not “usually take a sick day”, Lorde disclosed that “if it's really, really super, super threatening - once I did take a sick day on purpose.” In each of the stepping away situations identified by Lorde, all were specific to mathematics professional development. Lorde displayed some embarrassment when sharing this information, and stated it is “[a]ctually one thing to know it and another thing to admit it.”

While many participants gave detailed information about the actions taken to step away from mathematics, and so avoid it, Bic gave little detail about this management strategy other than to strongly state that avoidance was the best thing to manage her anxiety around mathematics. Through this strategy, Bic “avoided the bits that [she] couldn’t cope with.”

4.6.1.3 Drop it

From the twelve participants, ten found that dropping mathematics was a management strategy for anxiety around mathematics. Two participants had used the management strategy of dropping mathematics while students at high school, and the remaining eight participants shared that they had dropped mathematics as teachers.

As a student, Joan said her father “really pushed her” to enrol in a Year 12 mathematics class. However, she described that she withdrew from it after “a month or two max.” Joan withdrew, as she “felt completely and utterly lost in it” and “just could not handle it at all.” Withdrawing from the mathematics class was made more

difficult for Joan, as she needed her father's signature to come out of the course. Joan described it as the "walk of shame going to her father."

Like Joan, Bic enrolled for Year 12 maths, even though she had "not really been all that keen on doing it." Her thoughts were that she "should probably just knuckle down" and that she was "sure [she] could figure the problems out if only [she] worked harder." She realised after the first week that it "was really a bad idea." She decided to take up the opportunity to attend a Year 10 camp that linked with a different school subject. After enjoying camp, Bic:

> went back to school in the third week, and one maths session and went nah this is no point in carrying on with this, this has just become a complete and utter waste of my time, and the teachers time. I went to the guidance counsellor and said, 'What can I do in place of maths?', because I mean I had to do something.

As a teacher, one of these participants discussed a planned approach to dropping mathematics teaching, whereas others looked to take advantage of in-the-moment opportunities to avoid mathematics teaching. Bonnie planned to limit mathematics teaching time, as she "always put maths first so that if [they] had assembly or something, then maths was the smallest amount of time ... that [she] had to teach it." In addition to this timetabling of mathematics, Bonnie also "didn't give it that much time." Bonnie assured that she "always did it" and "found bits" to incorporate in her mathematics teaching. These 'bits' included "the 10 short questions every day … solv[ing] a problem in the morning", and "calendar maths" when working with junior students. Even though Bonnie was clear that she was "exposing them to numbers all the time," she did concede that "sometimes [she]'d just say, 'Oh, work on the stuff in your boxes'" to her students.

Contrary to the planned approach of Bonnie, Suzi was an opportunist, with mathematics the "first thing to go" in her classroom. If there was an opportunity, or if there was "pressure in the class," mathematics would drop from the timetable for the day. Meghan also took advantage of opportunities to drop mathematics from her teaching as it was "one subject that [she] would definitely want to skip." Often "just do[ing] maybe 45 minutes instead of an hour" of mathematics in the day. Along with

Suzi and Meghan, Pat also utilised opportunities to reduce mathematics teaching. “If it was just too much”, Pat put mathematics aside and “carried on doing art,” or “would have got really involved” in other curriculum learning areas, such as “social studies or whatever.”

In the same way that Pat might forgo mathematics to focus on other curriculum learning areas, Mariah has “tended to emphasise maths a bit less, [and] tended to emphasise literacy a bit more in [her] teaching.” Mariah ensures that “every single day [they]’re always doing literacy,” whereas “some days maths will drop out” of the timetable. Although identifying that mathematics might be dropped from her timetable, Mariah emsured that it was “not that [she’s] not teaching maths, it’s just that it might get a little less - less emphasis.” After further consideration, Mariah quietly voiced again that “perhaps [she is] emphasising it less in [her] teaching.

Unlike Mariah, Lorde was more direct in regards the dropping of mathematics from her teaching and strongly stated: “I just don’t like doing maths.” If “there's gotta be something to miss out, or something's on,” then, although “embarrassed to say,” she would shuffle her timetable around so that mathematics will drop, and other curriculum areas stay. “That’s the truth of it.” With a smile, Lorde shared that “if [she] can miss maths out in [her] day”, then “it’s like, ‘Yes! I don't have to do maths.’” Although dropping mathematics has obviously occurred in her teaching for a considerable time, Lorde was proud to announce that at the time of the interview, it was her “best year ever for teaching maths, and not avoiding it.”

While not dropping mathematics teaching entirely, Tracy took a different approach. Tracy identified that she is “the most anxious about probability and algebra” and believes that she has never understood them. Because of this, Tracy planned to “sort of avoid teaching” them in her mathematics programme. So, while mathematics was not entirely dropped, specific content was. Like Tracy, Marianne was unsure of her mathematical knowledge at times and, as the interview progressed, information shared by Marianne indicated that she too had dropped specific mathematics content from her teaching. In the first place, Marianne stated that she “didn’t skip it because [she] didn’t know” and was definite that she did not drop mathematics from teaching as that was “one thing [she] kn[e]w that [she hadn’t] done.” However, dropping specific content from mathematics teaching was later indicated by

Marianne. She “steered clear of things [she] really didn’t understand; decimals being one of them.” In sharing this, Marianne stated, “So there, that’s pretty big for me to admit that.”

Unlike Tracy and Marianne, who were specific about the content that they would drop, Pat was not specific when sharing that she “would have avoided teaching some stuff” relating to mathematics earlier in her career if she “could get away with it.” Pat recognised that “that’s sad for the kids that [she’d] avoided it for.”

Pat also dropped mathematics through her leadership roles, as she had:

> kind of been in and out of the classroom situation, so [she] could make sure that the teaching [she] was doing wasn’t maths … [she] would do the English and social studies or something, and someone else would be in the room for that part, the maths.

As part of her recent leadership role, Pat had held responsibility for “the Otago Problem Solving,” though she had recently dropped this mathematics teaching also. She was pleased to have “managed to palm it off on [the principal].” Pat sold it to him with, “Oh look, you’re so much better at maths than I am, you know, and these kids really need extending.” In dropping this mathematics teaching, Pat said it was “really good to have got rid of that.”

In contrast to the eight participants who identified that they had dropped mathematics teaching, or content specific mathematics teaching, to manage maths anxiety, Macy was clear that she “would never drop it” and that she does not avoid it. She said it was more about “how [she] deal[s] with it rather than not doing it,” even though “it still freaks [her] out.”

4.6.2 Trusted support

Five of the 12 research participants found that having a trusted support person, or people, was a useful strategy to manage their anxiety around mathematics. This trusted support often provided help with understanding mathematics, support with mathematics teaching, and a listening ear about mathematics concerns.

A trusted support person was something that Tracy felt had “helped [her] the most;” having “one person that [she] can talk to who absolutely loves [her] and trusts [her] and believes in [her].” This trusted support person was considered “a very, very, very excellent maths teacher” by Tracy, who:

> would go to her a lot. And she became the maths lead in the school and then I would go to her a lot and she was very, very wonderful at just sitting and listening and giving me ideas. And I used her as a sounding board a lot and I cried a lot and she will attest to that.

Although now in a leadership role, this trusted person remains a source of support for Tracy, even though “she doesn’t have as much time.” Tracy is comfortable with this, as she needs “to see her less because [she is] better at [mathematics teaching] now than [she] was at the beginning” of her teaching career. Tracy would “run [her] thinking by her,” asking her to look for “pitfalls in it” and for thoughts about if it “would work.” For Tracy, this support has “been absolutely marvellous because she’s very encouraging.”

Similarly, Lorde also had trusted support for her mathematics teaching. However, rather than one trusted support person like Tracy, Lorde had two people that she connected with to provide support. One is a teacher, who “is like [her] family here” at school, and the other is her “teacher aide.” Lorde knows that she is “totally safe” with them. Although her teacher aide “can't always help [her] with that [mathematics] stuff,” her teacher friend teaches at a higher level, and she can help “no matter what”. For example, this support person will show Lorde “how to use the equipment.” Lorde looked to have total trust in this support person, as she stated, “It doesn't matter what I ask her, it's fine and she won't ever dob me in, I just know.”

Prior to going into a professional development session, Lorde will check in with these two trusted support people and say:

> Hey, you know how I feel about maths, you know what happens to me aye. You know I can't do it, but you know I can do it when I'm not in here aye, and they go, ‘It's ok, you'll be alright, we'll look out for you.’

Her support people promise Lorde that they have “got [her] back” during professional development sessions. They assure Lorde that they will sit beside her, “won't let [her] look silly by [her]self,” and “if it's a task, [they]’re all in it together.”

Miranda also spoke about gaining support from people. However, “it took [her] a long time to realise that it is actually okay to say to someone ‘I don’t actually know how to do this.’” Miranda considered a teacher aide within her school as a trusted support person, as “she is quite onto it with her maths.” Describing a time when she was told by a teacher that she would need to take a fraction workshop while relieving in a Year 6 class in her school, Miranda was unsure and “had no clue about what he was even talking about.” Rather than allowing her anxiety to build, Miranda went to her trusted support person and said, “Right, give me a crash course right now on how to actually solve this problem because I have no clue.” Not only did this support person explain how to solve the problem, but it was “just fortunate that she was teacher aiding in that classroom at the time, so she came and helped the group” that Miranda was teaching.

Miranda worked in a job-share position at her school and taught three of the five days in her classroom each week. The teacher that Miranda job-shared with was “very strong at maths” and “she explains things” to Miranda. Although her syndicate leader considered Miranda to be the lead teacher in the classroom, Miranda was secure in following the lead of her co-teacher, as she was “learning from [her].” As well as a teacher aide and a co-worker, Miranda gained support from a Mathematics Support Teacher in her school. Secure that she “can go to her at any stage,” Miranda shared that she is “kind of okay people knowing about not [being] confident and that,” referring to her confidence with, and anxiety around, mathematics. Although Miranda has shared about her anxiety around mathematics with these people within her school, “[she doesn’t] think that people actually get it”, and they do not “have an understanding of what it feels like.” In the same way that Miranda asked for assistance from various people, Mariah also identified that “asking someone for help is another way” to manage her maths anxiety.

Meghan found trusted support through her deputy principal. Meghan was able to “ask lots of questions” of her, and she was never judged by her. Her deputy principal understood that Meghan had had “different experiences,” with maths and that those

experiences had “shaped [her] mindset.” Meghan trusted her deputy principal who was “helping [her] to um, to change that mindset.”

4.6.3 Be prepared

Eleven of the 12 participants considered being well prepared for teaching as a management strategy for their anxiety. Being prepared for teaching was seen as essential for these participants, as it reduced the likelihood of them becoming more anxious. Being prepared for teaching involved developing knowledge and an understanding of the mathematics content to be taught and checking that their understanding of that mathematics content was correct, as well as planning for teaching.

Being prepared was a strategy that involved participants in not only discussing the management of anxiety, but also sharing their concern for student mathematical learning. They felt that preparedness placed them in a better position to support learning.

4.6.3.1 Understanding

Eight participants discussed developing or checking their own understanding in preparation for teaching as a means of managing their mathematics related anxiety. To develop this understanding, both the internet and hard copy resources were identified as useful. To illustrate, for Macy “to be a step ahead” of her students, her “anxiety means a lot of prep” and considerable background work. This is to “make sure that [she] know[s].” Although she tends to do this with all of her teaching, Macy does it “more so with maths” to ensure that she will “know absolutely everything and all the possibilities.” To “check that [her] thinking is correct,” Macy will “find resources,” and has “piles of stuff” and “maths books everywhere.” “Over the summer holidays [she] will work as well,” as she always “need[s] to just make sure that [maths] is second nature.” In addition to books and “stuff,” Macy utilises the internet as “a check thing” to make sure she is “on the right track.”

Similar to Macy, Pat also found internet resources useful to check her understanding of mathematics. Watching a YouTube video, or something from the Khan Academy,

assisted Pat “a little bit just to make, make her think, ‘Yeah, I know that,’ and just kind of get that focus in” on the mathematics content. Besides checking for understanding, Pat developed her mathematics understanding through “a lot of extra work … practising at home trying to work out how to do things. But not, never, never feeling confident or competent that [she] was doing the right thing.” Working at a senior level in the school, Pat was asked “to take this gifted maths class. That was quite a challenge.” Although “really intent on making sure that [she] had tasks that were fun and interesting” for the students, Pat managed her maths anxiety. She did this by staying within the confines of her understanding and not delving into “the real deep kind of maths that you can do with that level of kids.”

For Suzi, developing understanding was a focus. She needed “to learn the lesson,” as she “had to learn before” she taught it - “so [she] learnt, [she] learnt maths.” Even though she learned “[t]hrough NZ maths textbooks,” a variety of websites were identified by Suzi for use in developing understanding also, including “Teacher Tools videos, Khan Academy … YouTube. Suzi was critical of the websites that she utilised, as Khan Academy was “okay, but it's not so good because it's kind of a little bit different than the way we do it,” but Teacher Tools was identified as being “the best, really.”

During the two years that Suzi worked at the Year 5-6 level, she had “to be very prepared, and prepared in the sense if [she] didn’t actually quite get it” then she would be able to direct students to videos that she had utilised during her preparation. Suzi would “watch videos beforehand for a lesson and I'm like, ‘Ok I've got this, I've got this.’” Suzi felt prepared for teaching as she “had it all, [she]'d watched the video, the teacher tools video beforehand, [she]'d read. You know, [she] was up with it, [she]'d done [her] work prior to the lesson.”

Joan also prepared for teaching by developing her mathematics understanding. Belonging to “a lot of teacher websites,” Joan has found online resources to be “the most helpful.” This was because she gets “to choose them,” - if she “didn’t understand that one, [she]’d look for another one that - that made sense to [her].” When teaching mathematics that she is “not familiar with, [Joan] will research the crap out of it”, with research being described as her “best friend in a lot of ways.” From this research, Joan manages her maths anxiety “by being a resource hoarder,”

She will “gather as many physical and online resources as [she] can,” as this gives her “something to hold onto.” While Joan “probably only use[s] a fraction of what [she’s] gathered,” she feels prepared for teaching due to her awareness that she has “things there to help if [she’s] having a difficulty explaining” or if she is working with “high achievers to try to challenge them in ways that [she] probably wouldn’t be comfortable with.”

Lorde also found the internet useful to develop understanding, more specifically the nzmaths website (MoE, n.d.-c). Lorde described this website as her “go to person first” that she uses “all the time.” When discussing her understanding, Lorde felt like she “know[s] the content,” but is not “confident with it, no.” This non-confidence has Lorde feeling unsure that she knows “the proper way” at times. Also utilising the internet when things are not so clear, Miranda will “sit there and just chuck on a YouTube clip and just watch another teacher teaching a strategy that [she] want[s] to possibly have a look at.” Not only does “watching a quick clip” develop understanding, at times it “just reinforces that she did know that” and provides a “reminder that [she] will be all right.”

Meghan also found the internet useful, including doing “a lot of online tutorials and a lot of just practicing [her]self.” When watching the tutorials, Meghan would “pause them and then ... try and work out the answer and then ... do [her] own questions” with similar numbers. Additionally, a colleague “has done a whole lot of tutorials as well to share with the teachers,” so she can “go on there and access them any time and learn from that.” Although Meghan does not “feel as anxious teaching” due to this preparation, she also believes that she does not have to know everything, as “the kids are there to teach [her] as well,” and she finds that she can “do lots of learning off the kids.” Meghan is “really open about that” and lets her students know this.

Just as other participants developed their understanding for mathematics teaching as a way of coping with maths anxiety, Bonnie also ensured she had a clear understanding of mathematics content. Rather than utilising the internet, Bonnie would “set up big folders” of information and resources and would “take things home to read.” For Bonnie, mathematics “was like the elephant in the room, [w]hereas everything else is clear as crystal.”

4.6.3.2 Planning for teaching

Seven participants consider planning for mathematics teaching as a useful management strategy for their anxiety around mathematics. While Pat might “fake it” and “bluff it” around mathematics, she is a planner when it comes to mathematics teaching. In fact, she will “overcompensate by over planning.” For Pat, planning involves “researching and researching and researching and researching,” as well as “doing all these copious amounts of notes.” Pat concedes that she is “probably overdoing it, doing far more than [she has] to do to manage.” Like Pat, Macy is also a planner as she likes to be “really well prepared, over prepared, yeah over prepared! A lot of research.” Macy “put[s] so much homework into it.” This planning is done to ensure she is “the best [she] can be” and because she “[does]n’t want to have any gaps for the kids.” Similar to Pat and Macy, Joan was also well-planned for mathematics teaching. She shared that she would “rather be overprepared for maths than other areas of teaching just so [she] kn[e]w [she] have a decent handle on it.” Although Pat, Macy, and Joan give considerable time to be well-planned and prepared for mathematics, on the contrary, Bonnie does not. She is “forever trying to find shortcuts to plan it.”

Unlike Bonnie, mathematics is “the thing [Tracy will] leave till last in [her] planning,” all the while admitting that “it’s the thing [she] need[s] to spend the greatest amount of time on ‘cos it doesn’t come naturally to [her].” For mathematics, the planning Tracy organises enables her to “keep the control” during mathematics teaching. Her planning ensures that her mathematics teaching is “much more teacher controlled rather than student agency,” unlike with literacy where Tracy is “very confident” in having less control. Within her planning, Tracy is “in charge; that’s making it work” to manage her anxiety within her mathematics classroom.

In contrast to Tracey, Lorde “need[s] to plan [her] maths first” each week and sees this as a strategy to manage the anxiety she experienced around mathematics. Lorde must “always do [her] maths first, otherwise [she]’ll task avoid it.” If this occurs, Lorde knows she “won't do a good job of it.” This was a concern for Lorde, as teaching must be “powerful” to support learning. Lorde indicated that planning

mathematics first was essential, as she reiterated, she “always plans [her] maths first, and prepare and organise for maths first.”

Although not indicating when mathematics planning occurred, a mathematics textbook was a part of planning for Suzi. She read the book, then “taught it pretty much, not verbatim from the NZ maths books, but very similar ... the lessons are called the lessons in the book - so yeah.” Suzi believed mathematics was “the area that [she had] to tidy up these holidays.” She needed to plan and “get it really tight, ready to hit them [with] two terms of good solid teaching in maths, because the first two [had] been sloppy.”

Different from many other participants who manage their anxiety around mathematics through attention to planning, Miranda does not. In the job-share teaching position that she has, Miranda does not plan for any mathematics teaching and “definitely” considers that a management strategy. She moved from a Year 1-2 to a Year 3-4 class and “was trying to plan maths” at this higher level, although she thought she “[did]n’t really know what [she was] planning.” Miranda was concerned about her planning; she felt that she “let the kids down,” and was “letting her [co-worker] down too.” Her co-worker “is very experienced with maths… she is very clever with maths.” Although it “wasn’t a cop out,” Miranda suggested her co-worker plan for all mathematics teaching, and this suggestion was considered and accepted.

From then, the co-worker “took the lead” and planned for mathematics. Planning is laid out “step by step and that is for [Miranda’s] benefit … she will do easier and harder and extension.” Miranda finds that the planning by her co-worker “is really good … to follow,” as it saves her from becoming “stuck” in her mathematics teaching. Miranda’s co-worker “starts a new round on a Thursday and Friday, so the kids have been introduced correctly.” Miranda also “gets her to take photos,” then they “get together and talk about how it went,” discuss the photos, and “she can prep [Miranda]” to “finish her round.” Using this arrangement has enabled Miranda to “become more confident because [she] has a better understanding” and “feel[s] at ease as well.” Her co-worker “loves it because” she has “got the control of it” and no longer needs to clarify planning and make suggestions, such as “this is good, but we need to be doing this, this and this.”

In comparison to many other participants, Mariah is “actually quite comfortable with the content of what [she’s] teaching,” since, “at the level [she’s] been teaching,” she is “not teaching high level maths.” Content “hasn’t been a problem with planning,” which is “more about just understanding what [she’s] meant to teach.”

4.6.4 Limit the level

A management strategy for maths anxiety that five participants have found useful is to limit the class level of their teaching that they have been involved with. Not only was limiting the level a management strategy for anxiety, but participants believed that they were not hindering student mathematical learning. That is, when participants taught to the level that they believed they were capable, they would be positively supporting student learning in mathematics; any higher level and they would not be providing a good service or a good deal for students and may not meet their needs.

For Joan, teaching students at Years 7 and 8 “would create so much anxiety that it would just be too difficult.” Although she was “sure the kids would be great” and she could “handle the kids, [she] can handle all the other subject matter, [she] would worry that [she] wouldn’t be able to cope with teaching the maths.” It is due to the mathematics, “it’s for that reason, it’s for no other reason,” that she “won’t teach the Year 7 and 8s.” Joan found this “sad”, because “it’s primary maths – how difficult can it really be?”

Likewise, “it was definitely maths that kept [Meghan] down in the junior end of the school.” She recently applied for, and was offered, a new teaching position. However, when “they said what level of the school it was, [she] straight away said no.” The position was with Year 5 and 6 students. When asked why not, she told them she “can’t do the maths.” They were encouraging of Meghan to accept the position, as they were prepared to “put the support in ... model lessons ... provide whatever support [they could] to help [her].” Meghan has taken this opportunity and is currently supported with mathematics tutorials made by a senior colleague.

In contrast to Meghan’s experience, Suzi moved away from this higher level to manage her maths anxiety. During her time at the Year 5 and 6 level, Suzi:

> wondered if they worked out that she was avoiding [maths], because the principal said, ‘So - your maths?’ … and then [Suzi] became the Year 1 teacher. I'm like, I wonder if they've worked out and they just had a quiet chat. I don't know, but she indicated that she knew.

Suzi has since been employed at a different school where she continues to be a teacher of Year 1 students. Suzi forcefully stated that she “can’t be a Year 5-6 teacher, there’s no way!”

The Year 5 and 6 level is also an area that Lorde has not considered teaching. Lorde works alongside Year 2-4 students and believes that she will “go to [Year] 4.” When considering teaching at the Year 4 level, she believed she would “be freaking out”, as some of her “upper Year 3s who are actually at national standards freak [her] out.” Lorde has an Early Childhood Education degree, and when explaining the level limit of her teaching, she will “use the excuse that [she’s] only trained to do 0-8” aged children.

Miranda also limits the level of teaching to manage her maths anxiety. In fact, Miranda wanted to complete a teaching qualification when leaving school, “but maths always put [Miranda] off … that held [her] back.” Miranda “[did]n’t think [she] would cope because of the maths.” After a number of years, Miranda was determined that she was “not going to keep continuing [her] life and feeling that fear” of mathematics. She “thought, ‘Stuff it!’ and … gave it a go” and “just quit [her] job.” Miranda “always wanted to teach sort of middle school, but [she] thought [she] was safe if [she] taught juniors.” However, Miranda “actually trained in early childhood.” While she “wanted to teach older kids,” early childhood “was just ... a safeguard” against mathematics. Early childhood “didn’t really float [her] boat,” so Miranda then completed her degree in primary teaching.

Miranda started in the junior school, and she “always taught juniors, [she] never taught above Year 2. Recently, an opportunity arose that prompted Miranda to reflect that she had “wanted to try middle school”, so she thought, “Feel the fear and do it anyway!” “Now [she is] teaching in the middle school,” and it is “different and you need to know a lot more.” Miranda teaches Year 3 and 4 students, and she finds her “Year 4s that are quite clever are basically teaching her … some really clever

mathematicians." In spite of transitioning from early childhood, to juniors, and then to middle school, Miranda does not think she will go beyond middle school; "not past Year 4." She is unsure that she "could extend [her]self further than the stage that they are at now."

4.6.5 Self-directed professional learning

Eight of the 12 research participants have continued learning for mathematics teaching as a means of managing their maths anxiety. Each of these participants initiated self-directed professional learning. This is somewhat surprising, as mathematics professional development situations aggravated maths anxiety for many participants.

Self-directed professional learning was a strategy that involved participants in not only managing maths anxiety, but that it demonstrated their concern for student mathematical learning. Participants wanted to ensure that they were in a position to support student mathematics learning and felt that their own learning better enabled them to support learners.

Five participants initiated self-directed professional learning through interacting with an approach to mathematics shared internationally (Boaler, n.d.). Bic "signed up really, really quickly" when "offered the opportunity to do Jo Boaler's 'How to learn math [for teachers]' course through Stanford University." However, Bic was somewhat hesitant to make a start on this course that was to take "12 weeks or something." Once she did make a start, Bic "thought, man – should have done this ages ago." Surprisingly, Bic "actually did the entire course in under 3 weeks, just because it resonated that much," and she became aware of "the thing about, you know, anybody can learn maths to a high standard - you know growth mindset ra de ra de ra." Even with this 'ra de ra de ra,' Bic believes "the Jo Boaler thing was a bit of a turning point" for her approach to mathematics and its teaching, and "found it really quite freeing."

In like manner, Suzi had completed "the Jo Boaler course," through her own choosing and without support from her school, and "follow[s] the Jo Boaler blog." Suzi stated that she "know[s] [her] positive mindset malarkey," "building

relationships," and "making connections." In contrast to Bic and Suzi who completed an online course, Meghan has "read Elephant in the classroom [(Boaler, 2010)] and [was] now reading Mathematical mindsets [(Boaler, 2016)]." Mariah was also reading Mathematical mindsets (Boaler, 2016) and watched videos from Carol Dweck on mindsets also.

As with the previous participants, Miranda has also spent time developing ideas relating to the approach to mathematics teaching and learning of Jo Boaler, as the teaching staff had "been doing a little bit at school." From there, Miranda initiated self-directed professional learning and had "watched some of her clips" and "looked into a bit of mindset stuff." She found that she "could totally relate to a lot of that."

Two participants, Marianne and Pat, found that initiating self-directed professional learning has reduced the level of their maths anxiety. They are both involved with the ALiM project (MoE, 2017a) and have also completed their Mathematics Support Teachers (MST) (MoE, 2017c) post-graduate qualification. Although maths anxious, Marianne has continued into Master's level study, and "by the time [she has] finished … four masters level papers" in mathematics education will have been completed.

Mathematics professional development is something that Macy "will draw on" and "suck it in" as much as she can, "because that's filling [her] gaps." Macy has found that not only does she look at "what's being taught," but in her head she is thinking, "Oh, so that's how you teach that!" In relation to initiating self-directed professional learning, Macy will "seek them out" and although "really hard," she will "take the opportunity to see other people teach." She identified that "these are the things" she does "to keep that anxiety, in some respects, under control."

Incidentally, Lorde enrolled in a maths PACE (Professional and Continuing Education) course as she had not completed any mathematics courses during her early childhood degree. However, there was not so much a focus on learning for mathematics teaching for Lorde. Instead, she "just did it so people couldn't say, 'Well you never trained as a primary teacher. You never did maths.' So, I did that to justify my position being at a primary school opposed to early childhood."

4.7 Hidden lives

In this research study, seven participants volunteered that they tended or worked to ensure that those around them were not aware of their experience of maths anxiety or their perceived mathematical skills. Some talked of being exposed. Lorde "would avoid admitting it, 'it' being maths anxiety, and she would take actions to "make sure [it] doesn't show." She also explained that "people have come for jobs" and her new principal, "he's given them a maths test." Lorde was adamant that she would not expose herself in this situation, and swore that she "wouldn't do a maths test for a principal. I'd be like, 'This is not the place for me.'" Lorde strongly maintained that she would "walk out", as she did not want to demonstrate her perceived lack of mathematical skills. Although not directly expressed, Lorde may be perceived as being isolated by the maths anxiety she experiences, as she shared that "people don't tend to admit to it."

As with Lorde, Marianne did not intend to be exposed. She maintained an outward can-do attitude, even while she "secretly" experiences "these 'panics'". When involved with mathematics, she sometimes began to be concerned that, "Oh my gosh! Now I'm really exposed."

Suzi is another participant who had concerns about exposure. In fact, she was "fearful because … everyone will know" about the anxiety she experiences and her perceived lack of mathematical skills. This fear of exposure has followed Suzi into tertiary level study, and continues in her role as a professional. Tertiary learning was "frightful" for Suzi, as "again it was the exposure … they'll know." However, because there was "always someone … to lead it along, it was quite easy to hide." In social activities, she would "avoid[ed] [participating in] darts that had maths in it," as she "would not, not play, not expose [her]self." Suzi's concern regarding exposure was larger than darts, as she explained that "you avoid putting yourself in a situation … that you're going to need your maths, you need to show, to expose yourself." In regard to being exposed, neither Macy nor Pat provided the detail that Suzi did, though both pointed out that they would not allow their experience of maths anxiety to be exposed. Pat emphasised that she "faked it" and would "bluff it" when she was

involved with mathematics so that the maths anxiety would not show. Like Pat, Macy hid her maths anxiety and “would make sure that [it] doesn’t show.”

Unlike other participants who worked to ensure their maths anxiety was not exposed, Tracy was not so focussed on keeping it hidden from others. As noted previously, Tracy had found “one trusted person” that she “talks of it with.” However, apart from this one trusted person, Tracy also kept her experience of maths anxiety hidden. Another participant, Miranda, used a different strategy. Rather than hiding her perceived lack of mathematics skills and experience of maths anxiety from others, she simply avoided situations in which she had to confront it head-on. She did this by choosing not to “teach higher than what I am doing and that is my way of - I will hide from that.”

4.8 Mathematics self-efficacy and mathematics teacher efficacy

Although no formal assessment of efficacy was completed by the participants in this research study, all participants shared beliefs in regards mathematics or mathematics teaching during the interviews. These beliefs relate to two different forms of efficacy. Self-efficacy is described as “people’s judgements of their capabilities to organise and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgements of what one can do with whatever skills one possesses” (Bandura, 1986, p. 391). Teacher efficacy has been described as “teachers’ judgment of their capability to impact student outcomes” (Tschannen-Moran & Hoy, 2007, p. 954), which leads to mathematics teacher efficacy being described as mathematics teachers’ judgement of their capability to impact student mathematical outcomes. As can be seen in Table 4.6, responses from almost all participants suggested both low mathematics self-efficacy and low mathematics teacher efficacy.

	Low mathematics self-efficacy	Low mathematics teacher efficacy
	11	12
Bic	*	*
Bonnie	*	*
Joan	*	*
Lorde	*	*
Macy		*
Mariah	*	*
Marianne	*	*
Meghan	*	*
Miranda	*	*
Pat	*	*
Suzi	*	*
Tracy	*	*

Table 4.6 Efficacy for mathematics and teaching mathematics

4.8.1 Mathematics self-efficacy

The discussion during the semi-structured interviews highlighted the point that low mathematics self-efficacy was held by eleven of the twelve participants. Macy was the one participant whose responses did not suggest that she had low self-efficacy for mathematics. She emphasised: "I do know maths," and that she "knew what the rules were" and "could work with that." In contrast, there was strong suggestion of low mathematics self-efficacy for others. These indicators of low self-efficacy for mathematics for individual participants are briefly outlined below.

- Having difficulty with mathematics, Bonnie said that she is "not mathematical minded."
- Miranda was firm in her statement when she repeated, "I am no good at maths. I am no good at maths!"

- “Stupid around maths - I mean that's my flaw … I know it is,” was declared by Suzi.
- There was repetition from Pat about her beliefs, “Oh my God, I’m useless at maths”, and “I’ve always thought, ‘Oh my gosh, I’m so useless at maths.’”
- Meghan does not “consider [her]self a very able mathematician at all,” and “always ha[s] got that inner voice in her” thinking, “I can’t do it and I’m no good at it.”
- Without hesitation, Joan shared, “I felt I was complete rubbish at math[s], I still do!” She just “do[es]n’t want to do [maths]!”
- Tracy had difficulty with mathematics “from Year 12 onwards”, as mathematics made “absolutely no sense whatsoever” and areas of mathematics continue to create confusion for her.
- Marianne revealed that she is “just not a maths person”, as she is “not good at maths.” If assessed by National Standards, Marianne believed that “she would be assessed as below or well-below.”
- Although Lorde achieved “School Cert [NCEA Level 1] maths”, she had never felt confident with mathematics. She believes she is “shocking with percentages and decimals,” and since her “principal rattled [he]r cage” recently, she has “gone home and been doing things on [her] computer at night time too. I've been practising my timetables for God's sake!”
- Bic had “struggled and hated maths all the way through school.” She perceived herself as “no good at algebra” and she “struggle[d] to remember formulas and rules.”

Although these participants left little doubt about their low self-efficacy, Mariah was a little uncertain as to her confidence with mathematics. She shared: “I don’t know whether I’m good at maths or bad at maths. I don’t. I’m not sure.” In saying that, Mariah did point out that when she experienced difficulty working with mathematics, she found herself reflecting, “You’re a bit stupid, you can’t work this out, you’re not very good at maths.” This uncertainty and reflection leads to questioning how “good at maths” she really is.

4.8.2 Mathematics teacher efficacy

From the discussion during the semi-structured interviews again, it is contended here that low mathematics teacher efficacy is in place for all twelve participants. Indications for these beliefs of low mathematics teacher efficacy for all participants are outlined.

- During her interview, Macy frequently shared her doubtful wonderings experienced about her teaching. For example, “Am I teaching it the right way?” and “Am I teaching it correctly?” She often does not “even know where to start” with her mathematics teaching, and, although she does “know maths,” she is “so worried that [she] is not going to teach it as it should be.” Macy “still [has] no idea which is the best way to teach it” and does not “trust [her] own ability.” Macy “lack[s] knowledge of how to teach maths.”
- Bonnie questions herself about her mathematics teaching, asking “How am I doing this?” and “Where do I go next?” Working with mathematics in the classroom “is a bit airy fairy” for Bonnie and she feels “guilt that [she] wasn’t giving [her students] a good enough deal,” because she “would not be doing a particularly good job of it.” In discussion, Bonnie described mathematics as “the elephant in the room … oh maths. Blah!”
- Teaching in a new position with Year 3-4 students, Miranda explained that, for this higher-level mathematics teaching, her head “definitely spins, I feel muddled in my head.” She noted that she has “that feeling of not being able to explain … what [she is] thinking and what [she is] trying to present or get across.” She felt pressured with the “feeling of making sure that what [she is] giving them is enough for them to be able to learn.”
- Suzi believes that Year 5-6 students “deserve better, a more competent teacher” than her. Describing herself as “a terrible teacher sometimes,” Suzi believes that she “need[s] to feel more empowered,” and that she “need[s] to do a better job” with her mathematics teaching.
- Feeling “really paranoid and worried about teaching maths,” Pat practises the mathematics at home that she would be teaching. However, she believed that she was “not doing a really good service to [her] class,” and found it “quite a challenge” when involved with teaching high achieving mathematics students,

as she “will just do it all wrong.” She admitted that she “never really got into the, like the, real deep kind of maths that you can do with that level of kids.”

- Meghan raised doubts about her capacity to teach mathematics, and asked herself questions in relation to her students, such as: “Am I going to be able to meet their needs?” and will I “be able to extend them?”
- At times, Joan experienced “difficulty explaining” mathematics to her students, and was also unsure how best to help when “students are struggling” with mathematics.
- Tracy clarified that she found “teaching maths fairly challenging” and that it “doesn’t come naturally to her.” Tracy would much rather teach literacy than mathematics, as she claimed to be a better literacy teacher. Although Tracy was “encouraged to have mixed ability groups,” she could not “get [her] head around that, so [she was] sticking with ability groups because that just helps [her] to really organise her thinking.” Staying with the known helps Tracy’s teaching, even though it may not be the better option for her students. Tracy summed up her aversion to mathematics teaching when she explained: “If I could find a job where I could teach this age group and not have to teach maths - that would be my dream.”
- For Marianne, “maths seems to have, you know, this negativity attached to it.” This negativity was evident when she described herself as “a bad teacher at maths.” She believed that she was “teaching them wrong,” and has doubts about how “well” she taught mathematics. She said: “Maybe I shouldn’t have become a teacher because of how I feel about maths.”
- Lorde had “always hated teaching maths,” whereas literacy was her strength. She admitted that she was her “own worst enemy” around mathematics teaching, and she “will beat [her]self up” telling herself that “you’ve got to be better, you can do this better, you can do this better.” Lorde was unsure if she “ever felt [she had] measured up” and feels that she would “never be good enough,” although she admitted that she is “probably a little bit self-destructive.”
- With a move to a senior class at her school, Bic was uncertain of her ability to teach at that level. She immediately thought that she would have to “up [her] game in the maths department!” She found herself “in a situation where there

were some things that [she] had to go and upskill. At times, she was unsure and needed a “hand to deal with this,” to enable her to “better explain it to [her] kids, the model for it or something like that.” The responsibilities of ‘upping’ her game, upskilling, and providing better explanations, these moments “put too much pressure on” Bic to the extent that her efforts to understand maths resulted in failure.

- Mariah “always tend[ed] to think maths isn’t really [her] best subject for teaching.” Despite her reservations about mathematics in her teaching, she “ma[de] sure that it’s a big part of the curriculum, even if it’s not her ‘favourite’” subject to teach.

4.9 Summary

This chapter has enabled the voices of the participants who have self-reported as experiencing anxiety with mathematics to be heard. The personal histories of each individual have been shared, and findings in relation to the impact of maths anxiety on the professional role and the influence on mathematics teaching have been communicated.

Participants easily recollected both the onset and origins of maths anxiety. It emerged during a time when each participant was a primary, secondary, or tertiary student. While a limited number of participants recalled the influence of parents, all identified that teachers played a significant part in the emergence of their maths anxiety. A wide range of responses to maths anxiety were experienced by participants, including, though in no way limited to, mind freezes, fear of looking stupid, shortness of breath, and avoidance.

Two specific situations for an escalation in anxiety levels for mathematics were identified. The first involved performance and that involved working with mathematics in front of others, which often required being put on the spot, and the perceived expectation of a quick response. The second situation involved teaching-related mathematics and included planning for mathematics, teaching mathematics, and uncertainty with mathematics content and its teaching.

As students, the participants in this study used distract and avoid strategies to manage the anxiety experiences. However, the variety of strategies utilised by the participants as teachers, grew to include not only distract and avoid, but also being prepared, limiting their teaching level, initiating self-directed professional learning, and utilising trusted support. Although participants utilised trusted support to assist with the management of maths anxiety, it was often hidden from others. A number of participants were determined that others should not know about their maths anxiety.

With the evidence shared by participants, although no formal assessment was completed, it is apparent that the great majority of participants in this study hold low self-efficacy in relation to mathematics, and that low mathematics teacher efficacy is discerned in *all* participants. This is a concern for both the participants and the students that they interact with.

Chapter 5 DISCUSSION

5.1 Introduction

An engagement with mathematics is essential for the activities of everyday living. However, research has revealed that such engagement may be compromised by maths anxiety. In consideration of what research has shown, the aims of this study were (i) to explore the histories of teachers who self-reported as experiencing maths anxiety, and (ii) to consider how that maths anxiety impacts and influences their professional role and teaching practice. The research questions guiding this study were:

1. What are the personal histories that influence primary teachers' who experience maths anxiety?
2. How does maths anxiety impact the professional role of the primary teacher?
3. How does maths anxiety influence the mathematics teaching in the primary classroom?

In this study, the histories of 12 teachers who self-reported as experiencing maths anxiety have been explored, and the impacts and influences of maths anxiety have been investigated. The voices of these teachers were heard through semi-structured interviews that allowed them to "tell their own stories of their lived world" (Brinkmann & Kvale, 2015, p. 58).

It was earlier hypothesised in this study that teachers who experience maths anxiety would not leave that anxiety behind when they entered the school gate; it would travel with them throughout each day, accompanying them to their classroom, the staffroom, the professional development setting, and beyond. It was believed that their personal histories are an enduring legacy from their time as students and would follow them into their professional lives. While this was expected, it was a surprise to uncover that, although participants were located for this study in relation to their self-reported maths anxiety, all participants talked of anxiety around activity relating to

their mathematics teaching. Their anxiety over mathematics itself had carried with them into teaching and maths teaching anxiety also developed.

With reference to the literature, this chapter discusses and seeks to explain the data. It also reflects on key aspects of the findings in relation to the aims of the study. This interpretation, explanation, and reflection is framed around the three research questions, and is expanded to include discussion of maths teaching anxiety.

5.2 The personal histories of maths anxiety

While the participants in this study had little memory of mathematics from their earliest days at school, their recall suggested that they appeared to start school with a positive mathematics mindset and were confident mathematicians. This finding is consistent with that of Clarke et al. (2006), Lee and Lomas (2015), Perlmutter et al. (1997), and Perry et al. (2015) who found that, on the whole internationally, students begin school with an informal competence in, and confidence with, mathematics.

5.2.1 Onset

Participants identified the beginnings of their experience with maths anxiety subsequent to starting school, be it primary, secondary, or tertiary levels of education within New Zealand. Five participants were at primary school, with the earliest experience of maths anxiety at about six or seven years of age being recalled by one participant; six were at secondary school; and one was a student at the tertiary level when she first experienced maths anxiety.

The earlier onset of maths anxiety for many participants is contrary to previous research that showed that maths anxiety is likely to begin during the adolescent period and beyond (Hembree, 1990; Martinez & Martinez, 2003; Scarpello, 2007). However, the finding is in accord with more recent research that reports the earlier beginnings of maths anxiety (Maloney & Beilock, 2012; Petronzi et al., 2019). More specifically, it is consistent with the findings of Aarnos and Perkkilä (2012) that suggest that the onset of maths anxiety may occur between the age of six and eight. The conclusions offered by Aarnos and Perkkilä provide further support for the claim that teacher behaviour and teaching practice may influence the onset of maths

anxiety due to the interaction between students and teachers in the formal school setting. The notion that behaviour and practice influences maths anxiety aligns with Vygotsky's sociocultural theory, which holds that mental activity develops through participation and social interaction with others (Rogoff, 1998).

5.2.2 Origins

In the current study, all of the participants indicated that teaching practice and teacher behaviour were the trigger for their maths anxiety. In this study, it was notable that from the total of 40 responses relating to what triggered maths anxiety only three also involved parents, and each of these had a focus on interactions; interactions that focussed on progress expectations. While there is a strong indication, in some contexts, that parents may contribute to maths anxiety, in this study over 90% of responses provided by participants regarding the origin of their anxiety with mathematics related to teacher practice and behaviour. Because of these high response levels, the focus of this section will be teacher contribution.

For the 12 participants, mathematics teaching practice resulted in participants feeling *pressured, left behind, confused*, and *lost*. In particular, maths anxiety escalated in situations where teaching practice involved *little interaction* or *explanation*, and involved *speed, teacher chalk and talk, memorising formulas*, and *solving equations the teacher's way*, along with *textbooks*, which were *useful due to having the answers at the back*.

Not only was teaching practice found to impact maths anxiety in this study, but teacher behaviours also played a part. As a direct result of teacher behaviour, participants reported *feeling humiliated, awful, like crap*, and *a dummy*. As such, maths anxiety was raised when teachers *embarrassed, ridiculed, yelled, showed frustration*, and used *insensitive comments*; or were *stroppy, stern, sarcastic, angry*, or *patronising* towards participants in this study. These are important yet troubling findings. More concerningly, wider research suggests that they are not confined to this study. In particular, they are consistent with international studies that reported teacher behaviour contributed to maths anxiety (Adeyemi, 2015; Bekdemir, 2010; Geist, 2010; McAnallen, 2010; Uusimaki & Nason, 2004), and left individuals feeling humiliated, embarrassed, ridiculed, and hurt (McAnallen, 2010).

Although the findings that relate to the impact of teacher behaviour on maths anxiety were, to some extent, expected, the intensity of the behaviour detailed by the participants was concerning given the widespread availability of professional development for teaching, and the current initiatives that call for the building of mathematical communities of practice (Anthony & Walshaw, 2007, 2009; Averill, 2012; Boaler, 1999; Hunter, Miller, Choy, & Hunter, 2020; Hunter, Hunter, Anthony, & McChesney, 2018; Hunter, Hunter, Jorgensen, & Choy, 2016; Strayton & Lawton, 2019; Walshaw & Anthony, 2007).

Reforms involving mathematical communities of practice require teachers to demonstrate an ethic of care (Anthony & Walshaw, 2007, 2009; Walshaw & Anthony, 2007) for students. These communities require teachers to be focussed on ensuring that their students develop a sense of belonging, and on understanding what hinders and helps student learning. It also requires the development of interrelationships that enable students to engage in productive mathematical thinking and discourse practices. As a member of a mathematical community of practice, it is expected that the teacher will be non-threatening and respectful, and value and work with student contributions. In doing so, the teacher enables student contributions to help shape the lesson. She or he builds on student thinking and assists students to develop a positive perception of, and relationship with, mathematics (Anthony & Walshaw, 2007; Bills & Hunter, 2015; Hunter et al, 2018).

Relationship building and social nurturing are also essential for mathematical communities of practice (Anthony & Walshaw, 2007; Bills & Hunter, 2015; Hunter & Anthony, 2011; Hunter et al., 2018). Since mutual respect is encouraged, full participation from everyone in the classroom space is fostered and responsibility from students is supported. Through these practices, mathematical learning and identity are developed. Teachers in these mathematical communities of practice work to promote mathematical advancement and proficiency for all students with challenging, rather than simplified, tasks and support (Boaler, 2016).

Despite current reform efforts within New Zealand mathematics classrooms, it is evident from participant responses that the environments in which their experience of maths anxiety surfaced bore little resemblance to mathematical communities of

practice. Indeed, it is not difficult to comprehend how negative experiences of mathematical learning reported by participants would contribute to high levels of uncertainty and consequent anxiety – in this case maths anxiety. These findings support a direct association between the beginnings of maths anxiety, and teaching practice and teacher behaviour.

Drawing on the Vygotskian perspective that views the individual and society as inseparable entities, it can be argued that even though maths anxiety is experienced by the individual, the social action in the mathematics classroom, and, in particular, the interactions between the teacher and the student, is key to the emergence of maths anxiety. Through Vygotsky's sociocultural theory, we see how the teacher's social activity has impacted student perceptions, how they view mathematics, and ultimately how they view themselves as mathematicians. For these participants it may be considered that the interactions and actions experienced were not useful for the development of mathematical learning, self-belief, or self-efficacy; nor were they useful for their developing mathematical identity. As a consequence, their learning experiences appeared to contribute significantly to their negative experience of mathematics in, mostly, the formative years of their mathematical identity development.

5.2.3 Management strategies

A range of strategies to manage maths anxiety was reported in the previous chapter. However, only half the participants in this study took it upon themselves to confront the anxiety as students. For these participants, the management strategy utilised was that of 'distract and avoid.' More specifically, two participants utilised clowning and chatting to avoid mathematics, and therefore maths anxiety; three stepped away from mathematics to manage their maths anxiety; and two participants dropped mathematics. One participant combined two of these 'distract and avoid' strategies prior to becoming a teacher.

As teachers, all participants developed strategies to manage their anxiety. However, the range of management strategies was broader. While still including distract and avoid, the range of management strategies now also included trusted support, being

prepared, limiting the level, and learning for mathematics teaching. It is thought that in the role as teacher, the participants may have required a greater variety of management strategies, as the situations in which mathematics was discussed were more varied, and they now also held responsibility for teaching mathematics.

Although avoidance has previously been described as a cognitive response to maths anxiety by Freiberg (2005), the participants in this study not only thought about avoidance, but articulated it as a management strategy. This may be explained by participants feeling that they had some control over the use of their avoidance strategies, unlike other responses that were shared by participants, and identified as merely cognitive, by Freiberg.

As teachers, the wider range of management strategies supports a similar pattern of management strategies found in the limited research that has been located. Research participants in another study (Adeyemi, 2015) have utilised the management strategies of asking for assistance from colleagues and becoming fully prepared for teaching by being well-planned and researching the topic of focus. The finding of avoidance as a management strategy for maths anxiety supports that of Jaggernauth (2010), Sloan (2010), and Trice and Ogden (1986). The finding that teachers limit their year level of classroom teaching is consistent with that of previous research studies (Adeyemi, 2015; Ganley et al., 2019; Leung & Cohen, 2004). Lastly, the management strategy of self-directed professional learning finding is in accordance with findings reported by Adeyemi (2015) and Gresham (2018).

The distract and avoid management strategy was useful for these participants when they were students. Their personal experiences as students with mathematical learning and their interaction with teachers may be explained through sociocultural theory that proposes learning to be as much about identity as about cognition (Wenger, 1998). The experiences that heightened their maths anxiety are likely to have prompted questions about themselves as students, such as ‘who am I?’ and ‘what do I know?’ These questions are likely to have been confronting for participants as students, therefore the avoidance of mathematics assisted in reducing that confrontation.

All management strategies were useful for the participants as teachers. Although the 'distract and avoid' management strategy removed themselves from mathematics, other management strategies utilised involved some form of self-directed professional learning for themselves as teachers. As such, participants became intent on not only managing, perhaps even reducing, their maths anxiety, but also indicated that they needed to put aside their personal mathematical experiences and histories to develop their mathematical knowledge and understanding for teaching. In these instances, care for their students was the motivator, as stronger mathematical knowledge and understanding would enable them to more appropriately support, and reduce the possible negative impact on, the mathematical learning of their students. In alignment with Vygotsky's sociocultural theory (Eun, 2019), these participants were aware that the cognitive and behavioural social interactions that may occur between themselves and students have the potential to impact negatively on student mathematical learning. By managing their own maths anxiety in various ways, often involving self-directed professional learning, it is likely that they were enabled to develop as more knowledgeable others in the social facilitation of and participation in (Vygotsky, 1978) their classrooms.

5.2.4 Responses

The findings suggest that maths anxiety prompts various responses from the participants. More specifically, the current study found that the participants together provided a wide range of responses to maths anxiety and these, some or all, related to cognitive, affective, physiological, or neural responses. Eleven participants demonstrated at least three of these types of responses, with three of these participants demonstrating all four types. The uniqueness of each participant's responses to maths anxiety broadly supports the work of others in this area, including the work of Freiberg (2005), Shields (2005), and Wigfield and Meece (1988). Similarly, Ma (1999) has argued that maths anxiety may take multidimensional forms.

Although anxiety over mathematics may take multidimensional forms, it was surprising that participants in this study identified so many different manifestations of the anxiety. When considering that maths anxiety takes multidimensional forms, it is

useful to remember that from the perspective of interpretivism, within which this thesis is situated, the experiences of individuals will differ; there may be many interpretations and perspectives of reality (Cohen et al., 2018; Wahyuni, 2012). Deieso (2016) has argued that perspectives differ within mathematics classrooms due to the differing experiences and histories of the individuals within them. These different perspectives are likely to influence an individual's interaction with mathematics. For the purposes of this research, it may be argued that these differential experiences, and the social interactions in which individuals engage, are able to explain the different responses to mathematics that emerge amongst individuals.

The personal histories of participants offer a specific vantage point for this analysis. However, past experiences are not the only lens through which to analyse the findings. Teaching also offers a rich medium for the investigation at hand. In the next section, teaching, and the anxiety that accompanies it, will be discussed. The impact of that particular anxiety on the professional role of the teacher and teaching in the classroom will be examined.

5.3 Maths teaching anxiety

Participants of the study were recruited based on self-reported maths anxiety and were involved in questions relating to the emergence of maths anxiety. However, from probes that related to the professional role of the teacher and mathematics teaching in the classroom, the study also sought to investigate *maths* teaching anxiety. This was an appropriate course of action, as maths teaching anxiety revealed itself during the semi-structured interviews as an important object of study. Before proceeding with this discussion, it is important to review how maths teaching anxiety has been defined in this study: Maths teaching anxiety is deemed to be a negative response specific to anticipation of or involvement with activity relating to mathematics teaching, or to the beliefs held in relation to perceived competence with teaching mathematics.

Notably, *all* participants experienced maths teaching anxiety, though it was clear during the interviews that they experienced this anxiety to varying degrees. Realised

in a number of different ways, participants experienced anxiety around their anticipation of and involvement with planning for mathematics teaching, professional development for mathematics teaching and mathematics teaching itself. Participants also held low efficacy about their perceived competence with mathematics teaching. The finding that all participants experienced maths teaching anxiety is contrary to the findings of previous studies that have challenged the notion that these two anxieties go hand-in-hand (Adeyemi, 2015; Brown et al., 2011). For example, Brown et al. (2011) reported that 60% supported that notion. Similarly, Adeyemi (2015) reported in her study that only 57% of participants supported the notion that maths anxiety and maths teaching anxiety go together.

There are possible explanations for the divergence between the findings of this study and those of others. Adeyemi's (2015) study utilised Peker's (2009a) definition that focussed only on the activity of teaching mathematics. This definition for maths teaching anxiety is narrower than the definition used in this study that included the belief in competence to teach mathematics, as well as the anticipation of teaching mathematics and activities related to mathematics teaching. These activities may include the planning and professional development for mathematics teaching, along with the teaching of mathematics itself. Some may argue that the definition of maths teaching anxiety in this study may be too broad. However, previous definitions were considered, along with the notion that maths teaching anxiety has an external focus and reflects how a teacher may view her or his propensity to engage students with mathematics and its learning (Brown et al., 2011). Since the anticipation of mathematics in the professional teacher role also impacted on the participants in this study, the broader definition was selected.

Another explanation for the differences in findings between this study and others centres on the participants themselves. In this study, teachers qualified for participation if they were in-service teachers. Contrary to this criterion for participation, the participants in the study of Brown et al. (2011) were pre-service teachers. These pre-service teachers were very likely to have had the support of an associate teacher with whom they were working alongside during their field-based teaching experience. That specific support may have reduced the experience of maths teaching anxiety for the participant pre-service teachers.

However, there is agreement between the findings of this study and those of previous studies (Adeyemi, 2015; Brown et al., 2011; Hadley & Dorward, 2011; Olson & Stoehr, 2019), to the effect that a correlation (and an overlap) does exist between maths anxiety and maths teaching anxiety, and that the relationship between maths anxiety and maths teaching anxiety is unpredictable.

5.4 The professional role

When the professional role of the teacher is considered, it is important to recall the professional requirements for certification for teachers in New Zealand. Alongside expectations of sufficiency in teaching practices, teachers must also follow the Code of Professional Responsibility that involves commitment to students, families and whānau, the teaching profession, and society (Teaching Council of Aotearoa New Zealand, 2017). In addition, they must also meet, or be likely to meet, the Standards for the Teaching Profession that, for example, include teaching, professional learning and relationships, learning-focused culture, and design for learning (Teaching Council of Aotearoa New Zealand, 2017). From these requirements, we know that teachers should engage in professional learning and collaborative learning-focused relationships with teaching colleagues and other professionals, design learning that is based on curriculum and effective pedagogical practice, and show a commitment to high-quality and effective teaching (Teaching Council of Aotearoa New Zealand, 2017).

5.4.1 Professional development

Hattie (2012) has emphasised that teachers have the greatest impact on student learning, and it is widely recognised that teacher professional development improves students learning (Eun, 2019). In consideration of this, it is revealing that of the 12 participants in this study, seven identified mathematical professional development as a context in which their experience of anxiety was heightened. As part of professional development activities, they feared being called on, felt very uncomfortable, were hesitant to contribute, and felt the dread of the expectation that mathematical ideas discussed and learned in the professional development sessions would need to be incorporated into classroom teaching. Although New Zealand teachers, in general, claim engagement in professional development (EARU &

NZCER, 2019), which can lead to teacher learning and improved student outcomes in the classroom (Eun, 2019), it was of concern that many of the participants did not expect to gain from their professional development attendance. The experience of anxiety cannot be ruled out as a contributing factor since many were strongly focused on their anxious responses to the professional development rather than on their engagement in learning. Without engagement, there is likely to be little learning occurring for them and, as a consequence, little improvement in student outcomes. To date, no other study has explored the relationship between anxiety with mathematics and teachers' experiences of mathematics professional development within the New Zealand context, or indeed internationally.

From the interpretivist perspective, the participants who identified mathematics professional development as a situation for intensified anxiety are likely to have brought their previous experiences of mathematics with them to this professional development (Deieso, 2016). Their earlier experiences had distracted them from possible learning. In light of the sociocultural framework and, in particular, the Vygotskian theorising (Rogoff, 1998) that has guided this study, it is important to remember that these participants distanced themselves from the learning opportunity that occurred and did not involve themselves in the participation and social interaction in the shared learning activities made available at the professional development opportunities. Rather, by withdrawing from others and the available activities, these participants attempted to reduce their anxious responses.

When considering the professional development with which teachers in New Zealand are likely to engage, ERO (2018a) has reported that it is usually "focused on both developing content knowledge and teaching practice" (p. 7). Research has shown that mathematics-based professional development is useful to assist in developing content knowledge and teaching practice (Hunter et al., 2018). Furthermore, research has also proposed that professional development may be more useful when it also involves learning that specifically targets anxiety around mathematics (Adeyemi, 2015; Gresham, 2018). However, given that previous research (Askew & Venkat, 2017; McCoach et al., 2013; Roth & Walshaw, 2015) has argued that intellectual endeavours and emotional aspects cannot be separated when working mathematically, some teachers in New Zealand may be unintentionally marginalised

when the focus of professional development is on cognitive development. In order for anxious teachers to engage positively within professional development opportunities, it is argued here that the emotional aspects of learning must also be addressed. Johnston-Wilder and Lee (2019) go so far as saying that a focus on mathematics content and teaching practice without intervention around affect is “mathematical abuse” (para. 6).

5.4.2 Mathematical care for students

Overwhelmingly, participants were aware of their own anxiety and many shared that they did not want their own students to have a similar experience of mathematics learning, nor did they want their students to develop an anxiety around mathematics, as they themselves had. Relating to low mathematics teacher efficacy, participants were also concerned that their teaching may negatively impact student outcomes. This concern was voiced in various ways. For example, that they *might teach the kids wrong;* that their students *deserve better, a more competent teacher*; that they had not *yet provided a programme that is fully engaging*; that they are not able *to teach it as it should be* taught; and guilt was felt as they were not *giving [students] a good enough deal.* This point aligns somewhat with the principle of an ethic of care (Anthony & Walshaw, 2007, 2009; Walshaw & Anthony, 2007) in that teachers should work to build a non-threatening, respectful environment that ensures each student is supported to develop their mathematical competency and identity. Maintaining their professional role, the participants in this study demonstrated mathematical care for students, though perhaps with a somewhat different approach.

Recognising that their teaching of mathematics may have a detrimental impact on student mathematical development, participants showed care for students as they were concerned that they did not teach mathematics the *right way*, that they *might let students dow*n because of their mathematics teaching, that they were not providing *a good mathematical service* for their students, or they were *not meeting students' needs*. In recognising the potential impact, five participants eliminated responsibility for higher level mathematics teaching by either limiting their level of mathematics teaching or by shifting the responsibility for planning of mathematics teaching to another teacher. This strategic approach is consistent with that of previous research

studies that have shown that teachers who experience anxiety around mathematics may choose to teach at a lower level either to avoid teaching content that promotes anxiety (Ganley et al., 2019; Leung & Cohen, 2004), or because they believe that they do not have the capability for higher level mathematics teaching (Adeyemi, 2015) and, therefore, would be detrimental for student mathematical learning.

In alignment with Vygotsky's sociocultural theory (Eun, 2019), these participants were aware that the cognitive and behavioural social interactions that may have occurred between themselves and students may negatively impact student mathematical learning and identity development. Demonstrating mathematical care, whilst also managing their anxiety, they made choices to remove the potential negative impact for students.

A second approach in which almost three-quarters of the participants showed mathematical care for their students was through self-directed professional learning for mathematics teaching, even though more than half the participants in this study found professional development an activity that heightened the anxiety they experienced. These eight participants who sought their own professional learning for mathematics teaching were concerned about their mathematics teaching and were interested in developing a greater awareness of mathematics and its teaching so that their understanding and skills were improved. Much of this professional learning was of their own choosing and separate from the facilitated professional development that occurred for staff within their school setting. The professional learning included developing a familiarity and understanding of mindsets[5], though more specifically, mathematical mindsets (Boaler, 2010, 2016); learning through the Accelerated Learning in Mathematics (MoE, 2017a) and Mathematics Support Teacher (MoE, 2017c) programmes; a master's degree involving mathematics education; as well as observing others teach mathematics.

Other studies have also found that teachers who experience anxiety for mathematics and its teaching may be more motivated to improve their mathematics teaching (Hadley & Dorward, 2011; Smith, 2010), and may work to reduce the likelihood of

[5] Several participants shared that they had watched videos from Carol Dweck or Jo Boaler on mindsets. However, no specific video was able to be identified by the participants, so no reference is provided here.

their students developing a dislike for mathematics as they had (Adeyemi, 2015; Gresham, 2009; Ng et al., 2003). Participants showed an awareness that their actions in the mathematics classroom may influence the relationships that students had with mathematics. This point aligns with Vygotsky's sociocultural theory which holds that mental activity develops through participation and social interaction with others (Rogoff, 1998). To maintain their professional role, and enhance participation and interactions, participants limited the level of, or involvement with planning for, mathematics teaching, and focussed their efforts in developing greater effective pedagogical mathematics teaching practice in their care for students.

Lastly, although 11 of the participants described being prepared as a management strategy for anxiousness around mathematics, their actions may also be considered as demonstrating mathematical care for their students as they wanted the best for their students while managing their own anxiety. Participants talked of wanting to engage students with mathematical learning and to that end spent considerable time prior to teaching to develop their understanding of mathematics and to be well planned. They did this so that they were in a position to *understand student thinking*; to *be a step ahead and to know all the possibilities*; *to be the best they could be*; to ensure *teaching was powerful*; and to provide *good solid teaching in maths*, rather than *sloppy* teaching. If participants were unsure of, or believed they might experience difficulty explaining, mathematical concepts, they were then prepared with resources that they were able to direct students to.

Minimal literature was located regarding the time spent in preparation for mathematics teaching by teachers who experience anxiety around mathematics. However, Adeyemi (2015) reported from her interviews with four teachers that being fully prepared for teaching was essential, including researching and actively studying the mathematics topic prior to mathematics teaching.

In alignment with Vygotsky's ideas, the preparation participants had undertaken to understand the mathematical concepts that were the focus in their classroom setting and/or the resources that they made available to students, contributed to a new self-understanding (Abtahi, 2017), as the more knowledgeable other in the classroom. That is to say, these participants prepared for teaching so that they, or the resources made available to students, were in a position to be a more knowledgeable other, or

at least equal to their students' thinking. Participants saw this preparation as a necessity, as without it they would not be in a position to support students to grapple with mathematical concepts that they may be unlikely to grapple with on their own. Moreover, the environments that these participants created were "not the site but rather the source of development" (Vygotsky, Kellogg, & Veresov, 2019, p. 67) for students, as they themselves had grappled with the mathematical concepts and were in a more positive position to work alongside students to develop mathematical understanding.

5.4.3 Hidden lives and support

Within the responses shared, a number of participants attempted to maintain their professional role by hiding their experience of maths anxiety or their perceived weakness with mathematics. They ensured that *it doesn't show*; they were concerned that their anxiety would be *exposed* or *bandied about*; and they would *fake* or *bluff* a positive relationship with mathematics. Although all participants experienced anxiety around mathematics, and some kept it hidden, five had discovered trusted support within their school environment to maintain their professional role. However, most of these five participants ensured that only a limited number of people were aware of the maths anxiety experienced and the perceived mathematical weakness. These trusted support people were considered a *sounding board*, checked planning ideas for *pitfalls*, were *encouraging* and *supportive*, were *totally safe* with holding knowledge of maths anxiety and mathematics experiences, gave time to *explain things*, and *never judged*. Interestingly, three of the five who benefitted from trusted support people, were also participants who kept maths anxiety hidden.

Minimal, if any, literature was located regarding the hidden lives of teachers who experience maths anxiety and the support they gain from colleagues. No literature was located to support the finding that teachers who experience maths anxiety may keep that anxiety hidden. However, the findings of this study corroborate with those of Adeyemi's (2015) semi-structured interviews with four teachers who reached out for help and asked colleagues for assistance.

In the general population, individuals may be heard to volunteer that they are ‘no good’ at mathematics; others may give the impression that they are ‘cool’ as they dislike mathematics and so remove the risk of being considered a ‘nerd’; and still others happily agree that they are similar to individuals who do not enjoy mathematics, as though they have joined the ‘in’ group and deserve a badge of honour as a member. This is in stark contrast to the hidden lives experienced by a number of teacher participants in this study. One is left to wonder if teachers are expected to know and be ‘good’ with everything. Although Morge (2005) identified that mathematics was “unique because failure often does not lead to embarrassment”, this was not the case for a number of participants in this study. They saved themselves from embarrassment by mostly hiding their experiences of maths anxiety and their perceived weakness with mathematics.

Drawing on the Vygotskian perspective that mental activity develops through participation and social interaction with others (Rogoff, 1998), it can be argued that previous experiences have impacted how participants live with their experiences of maths anxiety and their perceived weakness with mathematics. The participation and social interaction that participants experienced as mathematical students, and sometimes teachers also, often left them embarrassed, confused, humiliated, ridiculed, and pressured at times. It is little wonder, then, that the mathematical lives of participants were often hidden.

5.5 Teaching mathematics

It is evident from research that anxiety may influence the mathematics teaching that occurs in classrooms. Although the participants in this study have stated that they doubt the strength of their mathematics understanding and teaching; have avoided teaching mathematics, especially at higher levels; and are uncertain about orchestrating mathematical communication; it was notable that all have demonstrated an inclination to change their mathematics teaching.

5.5.1 Carriers of doubt

More than half of the participants in this study reported that they lacked confidence in, and held doubt about, themselves to work mathematically and to teach effectively.

Eleven participants presented as having low self-efficacy regarding mathematics, and all participants demonstrated low mathematics teacher efficacy. Participants saw mathematics as their *flaw*, believed they were *useless* or *rubbish* or *no good at maths*, judged themselves as *not mathematically minded*, or did not consider themselves to be *maths people*. Participants were wary of working with high achieving students, were concerned they were incorrectly teaching students, held the belief that students were better with mathematics than they themselves were, and there was little, if any, enjoyment for teaching mathematics for many of the participants. There were fears *of not being able to explain* and *being a terrible teacher*, concern about *teaching math*s or *teaching it the right way*, doubt about their ability to *better explain it*, or that they plainly *hated teaching maths*. The results of these beliefs left participants feeling threatened by mathematics itself and its teaching.

These findings of this study corroborate previous studies that have identified the doubts that teachers carry about themselves and their work with mathematics. Studies have reported that teachers who are anxious with mathematics have low confidence, or low self-efficacy, in their own mathematics content knowledge (Adeyemi, 2015; Brown et al., 2011; Leung & Cohen, 2004; McAnallen, 2010), along with low confidence to teach mathematics, or low mathematics teacher efficacy (Adeyemi, 2015; Bursal & Paznokas, 2006; Gresham, 2009; Jaggernauth & Jameson-Charles, 2015; Liu, 2016). As suggested by Beilock and Maloney (2015), mathematics should be considered a challenge, rather than a threat. However, participants in this study continued to see mathematics as a threat rather than a challenge.

When the participants' previous experiences of learning mathematics are considered, it is important to remember that the identity these participants developed as students of mathematics involved humiliation, embarrassment, ridicule, pressure, confusion, sarcasm, and stroppiness. It is understandable that their relationship with mathematics and its teachers influenced the identity they developed as mathematics students, and that a similar relationship with mathematics and a similar identity developed in their role as teachers.

With the support of Vygotsky's (1978) ideas, we know that the interactions and participation experienced in the classroom may influence learning and development. The interactions and participation for these participants that were experienced during mathematics learning, contributed significantly to their negative experience of mathematics and their anxiety around mathematics. Furthermore, the interactions and participation for these participants that have been, and continue to be, experienced as teachers of mathematics contribute significantly to their negative experience of mathematics and their anxiety around mathematics. This anxiety is considered to be learned (Hembree, 1990; Morris, 1981), and should therefore be able to be unlearned (Mutodi & Ngirande, 2014). However, these participants are unlikely to have had the opportunity to unlearn, or address, the anxiety that they experience. This is because their remembered experiences with mathematics as both students and teachers are mostly negative and these mostly negative remembered experiences have not often been replaced with positive, or successful, mathematical participation and social interactions.

5.5.2 Avoiders

To manage the doubt around mathematics and experiences, seven participants identified that they avoided, as much as possible, teaching mathematics. For example, one of these participants deliberately planned their avoidance by timetabling mathematics for the time most likely to be interrupted by other things, as well as limiting the scheduled time for mathematics teaching and learning in the classroom. Others were opportunists who dropped mathematics when something was added to a day's timetable, shortened the scheduled mathematics teaching time to extend learning areas that preceded or followed mathematics, removed mathematics from the timetable completely at times, or limited the areas of mathematics taught.

Although there is a paucity of research in regards the avoidance of teaching mathematics due to anxiety, the findings of this study are consistent with research studies that have been located. Engelhard Jr (1990), Jaggernauth (2010), Sloan (2010), and Trice and Ogden (1986) have all reported that anxiety prompts teachers to avoid teaching mathematics, and the mathematical learning opportunities

available for students are therefore reduced (Allen, 2001; Dowker, 2019; Maloney, 2016).

Avoiding mathematics teaching presents as a major concern, as students need sufficient opportunities to learn mathematics (MoE, 2007). In 2018, the ERO study, involving the teaching and learning of mathematics in the upper primary levels (Years 5-8) of 40 schools in New Zealand, emphasised the importance of ensuring that mathematics teaching and learning occurred every school day. In terms of opportunity to learn, the review noted also that it was essential to teach the full mathematics and statistics curriculum including geometry, measurement, and statistics, and not to focus heavily on only number and algebra. However, this current study has revealed these opportunities to engage with the full mathematics and statistics curriculum, and to teach mathematics every day, are less likely for those teachers who experience anxiety around mathematics.

As we know from Vygotsky's important proposal (1978), learning and development are socially facilitated. It would seem that the mathematical learning of the participants in this study was not enhanced by social facilitation and they withdrew from mathematical learning by developing skills to avoid mathematics, and then utilised these avoidance skills in their teaching. This is a concern, as it is likely that teachers who experience anxiety around mathematics and also avoid teaching mathematics may limit the mathematical interactions of students, which then become "disrupted" (Vygotsky et al., 2019, p. 82), and so their mathematical learning and development will be "disturbed" (Vygotsky et al., 2019, p. 82). Not only might their learning be disturbed, but students may "*grow into the intellectual life of those around them*" (Vygotsky, 1978, p. 88, emphasis in original), and so may develop maths anxiety themselves.

5.5.3 Uncertain orchestrators of communication

Developing discussion with and between students requires mathematical risk-taking, though eight participants in this study indicated an uncertainty for developing discussion, and all that it entails, in mathematics teaching and learning. They were aware that they sometimes had difficulty explaining things when working with students and believed that they were not as *maths smart* as some of their students.

They also identified that they were uneasy with the possible thinking that students might share and, when a student shared their thinking, were sometimes confronted with the realisation that their understanding of a mathematical concept was not as clear as they had originally thought.

The participants' difficulty with the expected management of their classroom also meant they were hesitant to reduce teacher control. They were aware that holding onto control limited opportunities for development of student agency during mathematics teaching and learning.

Although no literature that reports an uncertainty about utilising discussion in mathematics teaching and learning related directly to teachers who experience anxiety around mathematics was located, some research offered perspectives around opportunities to support problem solving in particular. Working with teachers who experienced anxiety with mathematics, Bush (1989) reported that problem solving and small group teaching, which may involve considerable discussion and risk taking, was less likely to occur than transmission orientated mathematics teaching. Similar results that involved limiting opportunities for active involvement, discussion, clarification, and questions by students has also been reported (Finlayson, 2014; Ganley et al., 2019; Karp, 1991; Martinez, 1987). It may well be that the uncertainty and hesitancy shared by participants was a barrier to implementing student-centred teaching and learning. Therefore, by default, the teachers shut down opportunities for sharing, questioning, explaining, and justifying, and more general mathematical communication (Anthony & Walshaw, 2007, 2009), with and between students.

These results may be due to the curriculum reforms concerning expectations that teachers will develop learning communities that advocate collaborative group inquiry processes, which also require the sharing of one's mathematical thinking (Whyte & Anthony, 2012). Developing inquiry communities requires teachers to take both mathematical and management risks, as they encourage students to be working with each other and their teachers to develop mathematics conceptual understanding. For this to occur, teachers must be able to understand and act on the mathematical thinking shared by students (Anthony & Walshaw, 2009). The participants in this study expressed considerable uncertainty in their capacity to do this. They also

reported a hesitancy to manage their mathematics classroom through holding a reduced level of control of mathematics teaching while encouraging student agency.

Discussion, and all that it entails, promotes social interaction and participation, and this is seen as essential for learning and development from a Vygotskian perspective (Eun, 2019). When participants were uncertain about their capacity to support sound mathematical discussion, their fallback was to maintain control and so dampen student agency, thus reducing the likelihood for interaction and active student participation. This is a concern, as, although teachers may manage their anxiety around mathematics, student opportunity to consider the mathematical thinking of more knowledgeable others is reduced, therefore disrupting and disturbing (Vygotsky et al., 2019) their mathematical learning.

5.6 Summary

Teachers' anxieties around mathematics and their related experiences of teaching mathematics have been the focus of discussion in this chapter. The experiences and actions of participants in this study have been considered on their own and in relation to previous literature where that has been available. Through a close attention to the interpretivist and sociocultural foundations of this thesis, explanations for the findings of this study have been obtained. To this end, a summary of this research will be provided in the chapter that follows.

Focussing on a group of teachers within New Zealand who teach mathematics while also experiencing anxiety for the subject has enabled us to see how the mathematical learning experiences of individuals and the teachers involved in that learning may play a significant part in the emergence of this anxiety (Ashcraft et al., 2007; Beilock & Maloney, 2015; Buckley et al., 2016; Dole, 2013; Martinez, 1987; Sloan, 2010; Stoehr, 2017b; Uusimaki & Nason, 2004; Vinson, 2001; Whyte & Anthony, 2012; Williams, 1988). We know that individuals respond to this anxiety in a variety of ways (Ashcraft et al., 2007; Ma, 1999) that may involve a combination of cognitive, affective, physiological, or neural responses. We also know that the degree to which these responses occur also varies. Individuals who experience anxiety around mathematics develop a variety of strategies for managing their

anxiety, and to that end, the participants in this study reported a wide range of strategies that were utilised in a variety of combinations with varied effect.

The professional role and teaching practice of the participants in this study have most certainly been impacted and influenced, sometimes negatively, but also encouragingly in a positive way. While these participants may not be overly enthusiastic for professional development, they demonstrated mathematical care for their students as many were willing to undertake their own professional learning around mathematics and its teaching. Although teachers in the primary education sector in New Zealand are expected to be able and willing to teach at any level of a primary school, some participants in this study chose to limit the year level for teaching and planning. While not meeting expectations, they demonstrated mathematical care for their students through placing this limit on themselves as the lower levels did not exacerbate their anxiety around mathematics as much as higher year levels. In short, they felt better equipped to teach junior levels in a more professional and positive way.

Although hidden lives may be a feature for teachers experiencing anxiety around mathematics, some may be open to gaining support from trusted individuals to enhance their mathematics understanding and teaching. Despite participants being carriers of doubt for mathematics and their teaching of it, and despite being avoiders of, and uncertain facilitators of communication during, mathematics teaching, all participants undertook self-directed professional learning.

Chapter 6 CONCLUSION

6.1 Introduction

This research study has explored the histories of primary school teachers who self-reported as being maths anxious. From these teachers' reports, it was possible to highlight who and what might have contributed to their anxiety. It was also possible to reveal the impact and influence their anxiety had on themselves and others. Three research questions were used to investigate this purpose:

1. What are the personal histories that influence teachers who experience maths anxiety?
2. How does maths anxiety impact the professional role of the teacher?
3. How does maths anxiety influence mathematics teaching in the classroom?

To answer these questions, an interpretivist epistemology was embraced, while a sociocultural perspective was utilised to explore the histories, impact, and influence of anxiety around mathematics. This was a qualitative study, employing semi-structured interviews that enabled the voices of participants to be heard. Those voices provided insights and understandings from personal perspectives.

The previous five chapters have introduced the thesis (Chapter 1); discussed literature pertaining to this thesis, introducing maths anxiety and then focussing on maths anxiety, connecting this to teachers, teaching, and maths teaching anxiety (Chapter 2); described the research approach used in this thesis, including the research design, ethical considerations, and limitations (Chapter 3); outlined the findings of this research study (Chapter 4); and discussed the main points emerging from the data (Chapter 5).

This chapter presents the conclusion of the study focussing on primary teachers and their history, along with the impact and influence of anxiety around mathematics on their professional roles and mathematics teaching. A summary of the findings is presented, followed by recommendations from this study for practice and policy. The

contributions that this study makes to research on teaching and teacher education are noted. Finally, suggestions for future research are provided, and concluding thoughts are shared.

6.2 Research summary

Focussing on a group of teachers within New Zealand who teach mathematics while also experiencing anxiety for the subject has enabled us to see how the mathematical learning experiences of individuals and the teachers involved in that learning may play a significant part in the emergence of this anxiety (Ashcraft et al., 2007; Beilock & Maloney, 2015; Buckley et al., 2016; Dole, 2013; Martinez, 1987; Sloan, 2010; Stoehr, 2017b; Uusimaki & Nason, 2004; Vinson, 2001; Whyte & Anthony, 2012; Williams, 1988). Participants welcomed the opportunity to share personal learning experiences that they considered to be somewhat fraught. Typically, their own school learning was fast and furious. It demanded memorising formulas and placed restrictions on interactions between the teacher and students, as well as those between students. It required listening to teachers and answering their questions and involved mimicking the procedures demonstrated by teachers. When the participants were students, teaching practice undeniably played a key part, though so, too, did personal characteristics of teachers, minimal connections with teachers, and absence from mathematics learning opportunities.

The responses to anxiety around mathematics shared in this research study were wide ranging. This finding is consistent with that of Ashcraft et al. (2007), Jackson (2008) and Ma (1999), as it was evident that the participants responded to this anxiety for mathematics in a variety of ways. These ways involved a mix of cognitive, affective, physiological, and/or neural responses. The precise mix and the degree to which these responses occurred also varied significantly between participants, although no participant had experience of only one of these response types. Specific responses included, but are not limited to, negative self-talk and a momentary brain change; nervousness, panic, a distrust in their ability, and a fear of looking stupid to others; changes to heart rate, breathing, and talk; as well as feeling nauseous, a tightness in the chest, a flushed face, increased perspiration, and tears; along with the anticipation of doing something mathematical, including teaching mathematics.

The research found that the participants who experienced anxiety around mathematics developed a range of strategies for managing their anxiety. These same management strategies have been reported by others (Adeyemi, 2015; Allen, 2001; Dunkle, 2010; Engelhard Jr, 1990; Ganley et al., 2019; Gresham, 2007, 2008, 2018; Itter & Meyers, 2017; Jaggernauth, 2010; Leung & Cohen, 2004; Olson & Stoehr, 2019; Stoehr, 2017a). The strategies that were shared by participants in this study produced varied effects. These strategies included: distract and avoid, seeking support from trusted individuals, being well prepared in both understanding of and planning for mathematics, limiting the level of their own teaching, and undertaking self-directed professional learning to develop understanding of mathematical concepts and for mathematics teaching. However, three of these strategies were not only utilised to manage anxiety, but also brought about support for their teaching and student learning. These three strategies were: being well prepared in both understanding of and planning for mathematics; limiting the level of their own teaching; and undertaking self-directed professional learning to develop a better understanding of mathematics.

The professional role of the participants in this study was most certainly impacted by the anxiety around mathematics that participants experienced. This research has shown that the anxiety of participants was heightened when they were involved with mathematical professional development courses and workshops. Rather than focusing on new learnings and understanding, the participants' central focus was invariably on their anxiety. As a result, they often did not improve their understanding of mathematics or its teaching from their attendance at the course or workshop, although it is known that professional development can lead to teacher learning (Eun, 2019)

This research has also shown that these professional participants frequently kept their lives as individuals with anxiety around mathematics hidden in their professional roles. They were concerned that principals, colleagues, and professional development facilitators would become aware of the anxiety they carried with them, and therefore attempted to remove themselves from mathematics when in the company of others within their school environment when possible. However, it was found that some of these participants were willing to seek support from trusted individuals to enhance their mathematics understanding and teaching. This finding is

consistent with previous research (Adeyemi, 2015). When help seeking occurred, most participants limited this support to one or two specific individuals, while a few others were prepared to share their anxiety to a slightly wider audience in the hope that support would be more readily available.

While, for the most part, the professional participants in this study did not eagerly participate in professional development opportunities, nor openly share their anxiety, their own mathematics related anxiety prompted them to demonstrate mathematical care for their students. They demonstrated this in a number of ways. Unlike their minimal engagement with professional development courses and workshops, the participants were willing to initiate self-directed professional learning around mathematics and its teaching in the belief that this would enhance their professionalism. This finding supports that of previously reported research (Hadley & Dorward, 2011; Smith, 2010).

Participants also demonstrated mathematical care for their students through limiting the year level for teaching. Serving to decrease the level of anxiety, they felt better equipped to teach junior rather than senior levels in a more professional and positive way. Lastly, mathematical care for students was demonstrated by participants when they developed their understanding of the mathematics to be taught and gave considerable time to meticulous planning. Detailed plans frequently ensured that they were well prepared in their professional role as mathematics teachers. This finding is consistent with previous research reported by Hadley and Dorward (2011) and Smith (2010).

The mathematics teaching of participants in this study has most certainly been impacted. Participants in this study were carriers of doubt in relation to mathematics and their teaching of it. They saw mathematics as their flaw, that they were useless with it, and they were not mathematics people. In regard to mathematics teaching, there was little confidence in teaching mathematics, as participants saw themselves as terrible teachers and hated teaching mathematics. Doubts surrounding capability often led to feeling threatened by mathematics and its teaching. Creating a tension with actions of care, these teachers often tended to avoid mathematics teaching. This finding is in alignment with findings reported by Jaggernauth (2010); Jaggernauth and Jameson-Charles (2015), and Trice and Ogden (1986). Avoidance

appeared in a variety of ways, including scheduling mathematics so that it could be frequently avoided, limiting the time given to mathematics in day-to-day classes, allowing other curriculum learning to take precedence over mathematics, and limiting the areas of mathematics taught.

This research also found that anxiety around mathematics impacted the discussions that participants facilitated with and between students. Lack of discussion and discussions with low cognitive demands have been shown to hinder mathematical development (Finlayson, 2014; Ganley et al., 2019; Karp, 1991; Martinez, 1987). Some participants were uncertain orchestrators of mathematical communication during the teaching of mathematics, as they lacked confidence in responding to their students' ideas and questions. They had difficulty explaining mathematical concepts, and sometimes felt less mathematically-smart as their students.

Although there are similarities amongst the participants and the anxiety experienced around mathematics, each participant offered a unique, individual, personal history of their often-hidden lives. As such, there are also many differences across the research cohort – difference with respect to personal histories, the impact on their professional role of a teacher, and the influence on their mathematics teaching in the classroom. To that end, the findings of this study support Martinez and Martinez's (1996) claim that anxiety around mathematics is an "interacting … tangle" of "multiple causes and multiple effects" (p. 2).

6.3 Research contribution

There is a paucity of New Zealand literature that relates to maths anxiety, and none located that relates to teachers. However, this research involving teachers who self-reported as being maths anxious has provided a significant contribution to the research field. As this research study is focussed on the voices of teachers who experience anxiety with mathematics and its teaching, considerable detail was offered by the 12 teachers, detail which was sometimes harrowing. This detail not only revealed findings that contribute to discussion and debates within the available international literature, but it also represents the foundation of New Zealand literature on this topic.

In the New Zealand context, it is crucial that we, the members of the education sector, begin to understand the experiences of teachers who have anxiety around mathematics, and the impact and influence that this anxiety has on their professional role and their teaching of mathematics. Without an understanding of and for these teachers, it is unlikely that we will be in a position to assist in reducing the levels of anxiety that they experience, nor in reducing the chances of learners experiencing maths anxiety. Just as there is no research relating to teachers who experience maths anxiety in New Zealand, there is also none that canvasses maths teaching anxiety. Of significance is the point that this research provides an initial understanding of maths teaching anxiety in the New Zealand context. Mathematics teaching anxiety is an emergent construct within the international literature. That research base is largely from the United States and Turkey, therefore this research involving New Zealand primary teachers broadens the field.

Internationally, considerable research has been undertaken with pre-service teacher participants. A much lesser body of research has focussed on in-service teacher participants. Therefore, this research contributes to the growing international knowledge and understanding of in-service teachers who experience anxiety around mathematics and its teaching.

Of further significance are the findings in relation to the teachers' professional role and mathematics teaching in maths anxious teachers. The findings from this study provide new insights over and above those that they support. In particular, they offer an alternative conceptualisation of professional development experience; preparation for, and avoidance of, mathematics teaching; and uncertainty for facilitating discussion in mathematics teaching and learning.

Equally important is the significance of findings that provide awareness and further insights regarding the uniqueness of maths anxiety for individuals. Participants shared varying ideas regarding maths anxiety. These included variance across the onset and origins, the responses experienced, the situations that heightened anxiety, the management strategies utilised, the hidden lives experienced, along with the mathematics self-efficacy and mathematics teacher efficacy held by individuals. This study builds an appreciation of the nuanced nature of anxiety around mathematics and its teaching. This anxiety is not so much a concept that may be captured,

assessed or measured through a questionnaire or survey, but rather it is a phenomenon that is fluid, in that individuals experience maths anxiety differently in relation to contextual stimuli and situations and that the individual's levels of maths anxiety vary across these stimuli and situations.

6.4 Recommendations

From this research, a number of recommendations are provided. These recommendations stretch across a range of individuals and entities: teachers, school personnel, professional development providers, Initial Teacher Education (ITE) providers, and the Ministry of Education (MoE).

1. Teachers who experience maths related anxiety must first acknowledge their anxiety. When individuals acknowledge their anxiety, they are more likely to be willing to seek assistance from others. It would be useful for team or staff meetings in schools to include constructive and non-threatening discussion around positive and negative experiences of teaching mathematics, as well as successful and unsuccessful strategies that have been utilised in teaching practice. These discussions may lead to the provision of assistance in ways to address teacher anxiety around mathematics.
2. As maths anxiety is a learned condition, it can be unlearned. However, a greater awareness of maths anxiety must be developed for teachers, including those working in ITE, before this unlearning will occur. A greater awareness of maths anxiety will not only provide teachers with an understanding of maths anxiety, but also the teaching practices that are likely to promote it. With this understanding and knowledge, teachers will be in a more positive position to recognise this anxiety in themselves and that experienced by colleagues, pre-service teachers, and students; assist in reducing anxiety for mathematics; and remove, or at least reduce, those instructional practices that enable maths anxiety to flourish in their classroom.
3. It is crucial that mathematical professional development opportunities provided for teachers not only involve the development of mathematical knowledge and teaching practice, but attend to the emotional aspects of teaching and learning also. When professional development involves learning around emotional

aspects, it is likely that anxious teachers will engage more positively with professional development opportunities, since, as this research has shown, intellectual endeavours and emotional aspects cannot be separated. When emotional aspects are acknowledged, teachers with anxiety around mathematics will become less marginalised; they will experience less 'mathematical abuse'; and the mathematical ideas and concepts that are a part of the professional development are likely to become more meaningful.

4. Initial Teacher Education should continue to focus on effective pedagogy and fundamental content in mathematics in their mathematics courses, though they should bring a focus on maths anxiety also. In particular, ITE mathematics courses should provide opportunities for pre-service teachers to reflect on prior experiences of mathematics learning and to acknowledge the potential origins of any anxiety; allow strategies for reducing maths anxiety to be shared, and, where appropriate, trial some strategies; and develop skills and knowledge in pre-service teachers so that they might recognise maths anxiety in their future students.
5. Although there is tension in New Zealand at present in relation to the teaching of mathematics in primary schools, it is recommended that the MoE reinforces teaching that continues to involve an initial and ongoing emphasis for students to develop conceptual, rather than rote, understanding of mathematics. When deep conceptual understanding is promoted, it is less likely for maths anxiety to develop within students.
6. It is important to recognise that anxiety around mathematics is not an individual issue or responsibility. It must also be owned by school personnel, professional development providers, ITEs, and the MoE. We know that a consequence of the anxiety teachers experience around mathematics may then impact the development of student interest in or disaffection towards mathematics. It is important to consider that the teacher-student relationship with mathematics may go some way to explaining the relatively poor international scores that New Zealand students are achieving. As maths anxiety is reduced, then there is the potential that more members of our society will develop better mathematical skills and knowledge. This is imperative, as, the most recent Programme for the International Assessment of Adult Competencies (PIAAC) (Organisation for Co-

operation and Development, 2016), results have shown that poor numeracy skills and knowledge were evident in New Zealand adults to a relatively large degree.

6.5 Suggestions for future research

This research has provided an insight into the personal histories that influence teachers who experience maths anxiety, and the impact and influence that anxiety has on their professional role and mathematics teaching. Further research studies that might build on the findings of this study are outlined below.

1. Large-scale, quantitative studies involving in-service teachers from across New Zealand would enhance and extend this research. The participants in this study self-reported as being maths-anxious, although a large-scale, quantitative study may assess for maths anxiety, and provide information in relation to the extent of maths anxiety in our primary teacher population. A quantitative study might also provide information about the levels of anxiety that teachers experience. Such evidence would indicate the support required across New Zealand for teachers to reduce their anxiety.
2. As above, it would be useful to undertake research involving pre-service teachers from within New Zealand. If it is known that pre-service teachers are entering tertiary education programmes with anxiety around mathematics, such evidence serves as a basis for the inclusion of maths anxiety as a focus for ITE classes.
3. Further research involving the areas identified previously in this chapter that have little, if any, reported literature would be both informative and useful. These areas include: experience and perception of mathematical professional development; preparation for, and avoidance of, mathematics teaching; uncertainty for facilitating discussion in mathematics teaching and learning; as well as further support to the limited literature in relation to effective pedagogical practice by teachers who experience anxiety with mathematics. Understanding more about these four areas may allow a clearer picture of anxiety around mathematics to emerge. This clearer picture might be utilised to inform decisions on areas for professional development.

4. The above suggestions for future research have a focus on the experiences and consequences of anxiety around mathematics for pre-service and in-service primary teachers. While it is interesting to gather and report this information to observe where New Zealand sits beside international research, it would be timely to carry out research that involves working with individuals, or small groups, to reduce the level of anxiety around mathematics that is experienced by pre-service and in-service teachers. Action research is likely to contribute to the ideas for how this anxiety may be reduced.
5. While it is important to know the status of anxiety around mathematics with pre-service and in-service primary teacher populations, it would also be worthwhile to investigate the status of maths anxiety amongst students in primary schools within New Zealand. At this point in time, no New Zealand literature has been located that involves research in relation to maths anxiety and primary school students. It would be interesting to compare data across Year 5 to 8 students, as findings previously discussed indicate that attitudes towards and achievement with mathematics reduces between Year 5 and Year 8. It may be suggested that maths anxiety contributes to this decline. Research with primary students would provide evidence of what contributes to this anxiety amongst our primary students.

6.6 Concluding thoughts

Hunter and Anthony (2011) have argued that it is critical for teachers to monitor the dispositions that students hold towards mathematics and mathematics learning. However, it may be just as important, if not more so, for teachers to monitor their own dispositions towards mathematics, and work to overcome, or at least reduce, the anxiety they experience around mathematics and its teaching.

Schools within New Zealand, at this point in time, are the workplace destination for many teachers with mathematics related anxiety. By implication, they are also the learning location of the students who work alongside these maths anxious teachers. To begin to remove, or at least reduce, mathematics anxiety, it is critical that teachers are provided with the support they need to recognise and voice their anxiety. Importantly, they need the opportunity to unlearn their anxiety around

mathematics. When this occurs, there will be a much greater potential for the well-known intergenerational negative perceptions of mathematics to dissipate. For in the words of Williams (1988):

> Tell me mathematics, and I will forget; show me mathematics and I may remember; involve me in a tension-free atmosphere in small group work and with manipulative aids in mathematics and I will understand. If I understand mathematics, I will be less likely to have math[s] anxiety, and if I become a teacher of mathematics I can thus begin a cycle that will produce less math[s] anxious students for generations to come (p. 101).

This cycle must begin somewhere in New Zealand, so let us begin with our teachers – both pre-service and in-service.

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Appendices

Appendix I Eight "Big-tent" criteria for excellent qualitative research (Tracy, 2010, p. 840)

Criteria for quality (end goal)	Various means, practices, and methods through which to achieve
Worthy topic	The topic of the research is • Relevant • Timely • Significant • Interesting
Rich rigor	The study uses sufficient, abundant, appropriate, and complex • Theoretical constructs • Data and time in the field • Sample(s) • Context(s) • Data collection and analysis processes
Sincerity	The study is characterized by • Self-reflexivity about subjective values, biases, and inclinations of the researcher(s) • Transparency about the methods and challenges
Credibility	The research is marked by • Thick description, concrete detail, explication of tacit (nontextual) knowledge, and showing rather than telling • Triangulation or crystallization • Multivocality • Member reflections
Resonance	The research influences, affects, or moves particular readers or a variety of audiences through • Aesthetic, evocative representation • Naturalistic generalizations • Transferable findings
Significant contribution	The research provides a significant contribution • Conceptually/theoretically • Practically • Morally • Methodologically • Heuristically
Ethical	The research considers • Procedural ethics (such as human subjects) • Situational and culturally specific ethics • Relational ethics • Exiting ethics (leaving the scene and sharing the research)
Meaningful coherence	The study • Achieves what it purports to be about • Uses methods and procedures that fit its stated goals • Meaningfully interconnects literature, research questions/foci, findings, and interpretations with each other

Appendix II Closed questions

Personal Information Sheet

1. What is your ethnicity?

☐ NZ Maori ☐ NZ European/Pakeha ☐ Pasifika

☐ Other _____

2. What is your gender: ☐Female ☐ Male

3. What is your age (in years)?

☐ 20-24 ☐ 30-34 ☐ 40-44 ☐ 50-54 ☐ 60-64

☐ 25-29 ☐ 35-39 ☐ 45-49 ☐ 55-59 ☐ 65+

4. What is your highest qualification in teaching?

☐ No teaching qualification
☐ Certificate
☐ Diploma/Graduate Diploma
☐ Bachelor's Degree
☐ Bachelor's Degree with Honours
☐ Post-graduate Certificate
☐ Post-graduate Diploma
☐ Master's Degree
☐ Doctorate
☐ Other _____

5. What is your highest TERTIARY qualification that is not a teaching qualification?

☐ No other TERTIARY qualification
☐ Certificate
☐ Diploma/Graduate Diploma
☐ Bachelor's Degree
☐ Bachelor's Degree with Honours
☐ Post-graduate Certificate
☐ Post-graduate Diploma
☐ Master's Degree
☐ Doctorate
☐ Other _____

6. What level of teacher certification do you hold?
- ☐ Provisional
- ☐ Subject to Confirmation
- ☐ Full
- ☐ None of these

7. How many years have you been teaching? _____ years

8. At what year levels have you had the most teaching experience?
- ☐ NE-Year 2
- ☐ Years 3-4
- ☐ Years 5-6
- ☐ Years 7-8
- ☐ Other _____

9. In what type of school have you had the most teaching experience?
- ☐ Contributing (0-6)
- ☐ Intermediate (7-8)
- ☐ Full Primary (0-8)
- ☐ Kura Kaupapa Māori
- ☐ Area School (0-13)
- ☐ Other _____

Appendix III Open-ended questions

Questions and prompts

1. Why did you make contact about being a part of this research project?

2. Tell me about what maths anxiety means for you. How does maths anxiety impact your reaction to mathematics?

3. On a scale from 1 to 10, how maths anxious are you? (With one being not anxious and ten being very anxious).

4. Take some time to describe your memories of your mathematics experiences throughout your life – these might:

   - be both positive and negative experiences, and

   - relate to your time at school, completing your tertiary education, in your workplace, or in your personal life.

5. Let's talk about the settings or situations that you feel have influenced the maths anxiety you experience (may be able to dig a little deeper into responses given previously)

6. Talk me through your thoughts about the impact, if any, that maths anxiety has had on your on-going relationship with maths and your teaching.

7. I often wonder how individuals manage or cope with maths anxiety. Tell me about how you've managed or coped with your maths anxiety, if you think that you have.

8. Considering your experience of maths anxiety, what ideas do you have that might assist others that experience maths anxiety?

9. And now I'd like you to think about advice that you might give to those that do not experience maths anxiety?

10. To finish, I'd like you to consider the following, as I'm interested to know how you think and feel about maths:

    If maths were a food (colour/animal), it would be ……. because …….

Appendix IV Transcription confidentiality

Primary Classroom Teachers and Maths Anxiety

TRANSCRIBER'S CONFIDENTIALITY AGREEMENT

I Pamela Sian (Full Name - printed) agree to transcribe the recordings provided to me by Julie Whyte.

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.

Name: Pamela Sian

Signature: Pamela Sian **Date:** 25/09/17

Company: Full stop Ltd.

Appendix V Management strategy – Step away

	Management strategy – Step away
Bic	- I avoided, yeah I avoided the bits that I didn't, that I couldn't cope with p. 17
Lorde	- I avoid getting there (*PD*), it's the only time in my life I'm ever late, I avoid getting there on time because then they might have done those horrible threatening activities first, like in PD sessions, like when you have to play games and stuff, then you're kind of put on the spot p. 1 - I do this whole like I'm never late for anything but I do this whole avoidance stuff, that's the only time I ever do it, like I'm always the early person, or you know on time but (*But not for maths PD*) No p. 2 - I do lots of avoidance like try and be late for PD, I'm never late for anything, everyone says to me that's a bit weird, or I need to go to the toilet, I need a cup of tea I'll just go and get a cup of tea, oh my God this is terrible. How do I cope with it. I don't usually take a sick day if it's a really, really super, super threatening, once I did take a sick day on purpose. Oh my God - Actually one thing to know it and another thing to admit it. p. 21
Mariah	- I just looking at all those numbers and just can't make sense anymore, I've got to actually step away from it and come back to it cause it's just not, thinking about it over and over again isn't actually helping. p. 4 - getting away from it for a bit so if I'm struggling with something just stepping away from it coming back to it later or yeah just trying to calm myself down using techniques to calm down. Aside from that I can't really think of anything. Yeah usually well stepping back from it p. 9 - everything sort of freezes if I'm maths anxious and I actually you know I'm totally useless at that point. p. 10 - I suppose for me what's helped is just trying to, yeah just trying to sort of step away from it and calm yourself down and then that's when, well for me that's when your brain engages again p. 10 - So whatever helps to calm things down I don't know breathing techniques p.10
Pat	- I used to get really nervous about having to do it but kind of like avoidance and losing things and you know losing my piece of paper that I'd been up all night kind of working out how to do a particular equation. p. 2-3 - when I went to university as well I did everything I could really to avoid having to do maths p. 6 - I picked up leadership roles so I've kind of been in and out of the classroom situation so I could make sure that the teaching I was doing wasn't maths you know I would be, I would do the English and social studies or something and somebody else

	would be in the room for that part of maths p. 13
Suzi	- it was easy to hide at University p. 6 - there were people in groups to swish it along p. 7 - but sometimes I can't control it, with the seniors anyway I'll just blag it you know, literally blag it p. 2 - How it affected my teaching, with the seniors I had to be very prepared, and prepared in the sense if I didn't actually quite get it, then I'd have to be able to hey you check out this clip on Khan Academy, and then follow up over there with that worksheet, come to me after p.10 - and then kind of mid lesson I just went, I just froze and it went black again, it was just, I was just frozen, and then I picked up an iPad I was like I've just got to go to the toilet one moment, so I was going to go into the loo and watch the video, come back and carry on with it, but when I went to the loo the principal was in there, with a maintenance person, because some pipe had burst so I'm like oh hey hi, I don't think they clicked that I had an iPad in my hand, but I ended up having to go to the sickbay though, I don't think I watched it, I think I was worried they'd hear it (*Ok so you went back into the class without*) Went back into the class and I would have blagged my way through it (*And blagging your way through it, is that you just*) Put it onto the kid who I know knows p. 11 - I say with my colleagues or the principal or anything like that, that's would be you know, no I would avoid that, I'll go to the toilet which is what I do with them, oh so tell me about dinner, how much shall we pay here, I'm like oh sorry got to go to the loo p. 13
Tracy	- I failed maths for the first time in my life in year 12 and failed it really badly. And I guess from that point on I just avoided maths in any way even though I could still do the all kinds of ordinary types of maths that you would need in your life p. 4 - I avoided any formal kind of maths stuff, so at teachers' college I did just the basic maths course and you know all my electives were things like art and music and literacy the things that I was loving and succeeding in. p.4

Appendix VI Ethics committee letter

Date: 29 January 2016

Dear Julie Whyte

Re: Ethics Notification - **4000015425** - **Primary classroom teachers and their mathematical relationships: A mixed methods research approach**

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:
"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director - Ethics, telephone 06 3569099 ext 86015, email humanethics@massey.ac.nz. "

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973
E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Human Ethics Low Risk notification

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

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MĀTAURANGA

Classroom Primary Teachers and Maths Anxiety

INFORMATION SHEET

Researcher Introduction

My name is Julie Whyte, and I am undertaking this research as part of a Doctorate of Education (EdD) at the Institute of Education, Massey University, Palmerston North. I am a registered and certified primary teacher, and a Teacher Educator within the Bachelor of Teaching (Primary) programme at the Eastern Institute of Technology (EIT), Taradale.

Project Description and Invitation

I am conducting research into maths anxiety with classroom primary teachers who identify as being maths anxious. I'm interested in the experiences of maths anxiety, factors that have contributed to that anxiety, and its impact on classroom practice. You have shown an interest in being a participant in this research study, and this document provides information so that you are able to make an informed decision regarding your participation in the research study.

Participant Identification and Recruitment

All participants must identify as being maths anxious. Participants may be recruited via a message posted on the NZ Teachers (Primary) Facebook page; the Maths Co-teaching|Co-learning Facebook page; or an A4 poster seen in their school. Participants may also be recruited by recommendations from others. I wish to recruit up to 15 classroom primary teachers to participate in this research study. If more than 15 individuals indicate they would like to participate, a selection will be made from a range of regions.

Project Procedures

The study involves an individual interview. The interview will take approximately 45-60 minutes. This will be held at a negotiated place and time that is suitable to you. Your interview will be recorded and then transcribed. A transcript of your interview will be sent to you to ensure the transcript is accurate, to identify if any additions or adaptations are required, and to confirm you are satisfied with its content.

Te Kunenga ki Pūrehuroa
Institute of Education
Dir Albany Drive & Collinson Road, Private Bag 11222, Palmerston North 4442, New Zealand T 06 356 9099 www.massey.ac.nz

Data Management

All interview data will be stored in a secure location, with no public access. Data will be used only for the purpose of my research and any presentations and publications arising from this research. Data will be kept for seven (7) years after the completion of the EdD, after which time all data pertaining to this study will be destroyed in a secure manner. All efforts will be taken to maximise confidentiality and anonymity for participants, and names of all participants will be assigned pseudonyms to maintain anonymity. On completion of this research study, a summary of the findings will be made available to participants on request.

Participant's Rights

You are under no obligation to participate in this research study. If you decide to participate, you have the right to:

- decline to answer any particular question;
- withdraw from the study up to the time that data collection is completed;
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- ask for the recorder to be turned off at any time during the interview; and
- be given access to a summary of the project findings when it is concluded.

Project Contacts

Please do not hesitate to contact me if you are interested in, or would like anything clarified about, being a participant. If you have any questions about the project, do not hesitate to contact myself and/or one of my supervisors.

Researcher

Julie Whyte

[redacted]

Supervisors

Professor Margaret Walshaw

[redacted]

Professor Glenda Anthony

[redacted]

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact:

Dr Brian Finch

Director, Research Ethics

[redacted]

Appendix VIII Consent form

MASSEY UNIVERSITY
INSTITUTE OF EDUCATION
TE KURA O TE MĀTAURANGA

Classroom Primary Teachers and Maths Anxiety

PARTICIPANT CONSENT FORM - INDIVIDUAL

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/do not agree to the interview being sound recorded.

I wish/do not wish to have my recordings returned to me.

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

Signature: _____ **Date:** _____

Full Name (Printed) _____

Te Kunenga ki Pūrehuroa
Institute of Education
Cnr Albany Drive & Collinson Road, Private Bag 11222, Palmerston North 4442, New Zealand T 06 356 9099 www.massey.ac.nz

Appendix IX Phase member checking – Face-to-face interview

Maths anxiety interview transcript

Inbox

Julie Whyte <[redacted]> Thu, Feb 1, 2018, 2:24 PM
to [redacted]

Good afternoon [redacted],

I'm hoping this email finds you happy and healthy. I'm also hoping you had a fabulous festive season, and that you were able to take a break during the school holidays.

I'm making contact with you regarding the interview discussion we completed last year in relation to my doctoral research. Progress is being made with that research and I have your interview transcribed, which is attached. If you would like to read it through and let me know if you are all okay with it, or it you think changes should be made, that would be great.

While I've given you this opportunity, I know that there were several participants who did not want to access the interview transcript. My ethics says that I must email them out to all participants, but if you prefer not to access your transcript that is okay too.

If I hear nothing back from you, I will take that as meaning you are okay with the interview transcript.
Warm regards.
Julie

Appendix X Phase member checking – Skype interview

Maths anxiety interview transcript

Inbox

Julie Whyte <[redacted]> Thu, Feb 1, 2018, 2:20 PM
[redacted]

Good afternoon [redacted],

I'm hoping that this email finds you happy. I'm also hoping you had a fabulous festive season, and that you were able to take a break during the school holidays.

I'm making contact with you regarding the interview-discussion we completed last year in relation to my doctoral research. I realise that it's some time ago since we had our Skype session to discuss your experiences of maths anxiety and teaching maths. Progress is being made with my research and your interview has been transcribed, which is attached to this email. If you would like to read it through and let me know if you are all okay with it, or it you think changes should be made, that would be good.

While I've given you this opportunity, I know that there were several participants who did not want to access the interview transcript. My ethics says that I must email them out to all participants, but if you prefer not to read through your transcript that is totally okay too.

If I hear nothing back from you, I will take that as meaning you are okay with your interview transcript.

Warm regards,
Julie