

**BIBLIOTHERAPY TO ADDRESS MATHEMATICS ANXIETY
IN PRIMARY PRE-SERVICE TEACHERS**

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Statement of Authorship and Sources

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution.

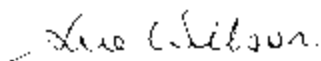
No other person's work has been used without due acknowledgement in the main text of the thesis.

All research procedures reported in the thesis received the approval of the relevant Ethics/Safety Committees (where required).

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For those teachers, who like me, have never believed maths to be their “thing,” there is the distinct possibility that our desire not to let students suffer our fate and to improve on our own childhood experiences in classrooms could well be the factor that makes us the more effective teachers. We are more open to the need for reflective teaching and professional development, and more willing to look for alternate explanations and examples. (Pre-service teacher reflection, 2002)

This reflection from a participant in a previous small study was the provocation for this thesis. Her insights resonated with me as I reflected on the essential qualities of effective teachers of mathematics and provoked me to investigate further.

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Abstract

This thesis contributes to the understanding of an important ongoing issue in mathematics education and adds to the literature on ways to address this issue. The study is located against a social and historical background of issues of exclusion from participation in opportunities that are afforded by competence in mathematics.

Mathematics anxiety (maths anxiety) in primary pre-service teachers has been reported in the research literature as an ongoing issue. This anxiety can lead to high levels of stress and poor performance and can impact on confidence and emotional and academic wellbeing. Often, proposed solutions have focussed on how pre-service teachers might better learn mathematics. However, research addressing affect has indicated the need for greater emphasis on understanding their emotional responses and anxieties.

This thesis reports a descriptive and interpretive sequential mixed method study within the affective domain which investigated the effectiveness of bibliotherapy to better understand and address maths anxiety. The purpose was to understand the impacts of maths anxiety on the mathematical identity of primary pre-service teachers, and how these impacts might be ameliorated. The study investigated questions concerning the range and extent of maths anxiety in pre-service teachers at the start of their teacher education course, their perceptions of the influences that had stimulated this anxiety, and the effectiveness of bibliotherapy in better understanding and/or addressing maths anxiety in pre-service teachers.

Data were collected through quantitative and qualitative methods, using the Revised Mathematics Anxiety Rating Scale (Alexander & Martray, 1989) to identify the range and extent of participants' maths anxiety, and the narrative device of Critical Incident Technique (CIT) to investigate the experiences to which they attributed this anxiety. Participants' views provided their perceptions of their mathematical identity. The study investigated the effectiveness of bibliotherapy in two different contexts, Cognitive bibliotherapy in existing classes and Interactive bibliotherapy in a small-group workshop developed in collaboration with the student counsellor. The study employed a multi-scope analysis which used a range of methods – descriptive and inferential statistics (t-tests, confirmatory and exploratory factor analyses), and analysis of themes identified by the CIT and bibliotherapy in the two different contexts.

The study found that pre-service teachers begin their teacher education course with existing levels of maths anxiety, which are largely associated with the negative effects of testing and evaluation. The findings also confirmed the major contribution of former teachers to the development of pre-service teachers' maths anxiety, drawing attention to the consequences of blame and humiliation reported by participants and to the importance of the concept of pedagogical tact. The study emphasised the benefits of including in this research pre-service teachers who did not identify with maths anxiety in this research.

The workshop provided a transformative experience, as participants showed increased understanding and revision of their maths anxiety and identified alternative conceptions of their previous mathematical experiences. Insight was identified as a major factor in the development of participants' future mathematical identity. This led to evaluations of their future effectiveness as teachers of mathematics, thus illustrating the development of a more positive projective identity.

Contributions of the study included the modification of the bibliotherapy stages, development of a key of ideal types for responses and development of a new concept of "biblioperception." It provided a model for professional collaboration with the student counsellor in the form of the workshop protocol.

This thesis argues for a paradigm shift in the way researchers, teacher educators and policy makers view maths anxiety in pre-service teachers. There is a need to identify and celebrate the positive influences that past experiences of maths anxiety can have on evolving more effective teachers in our classrooms, potentially enabling a wider range of students to develop more positive relationships with mathematics.

In recognising the potential for pre-service primary teachers' experiences and understanding of maths anxiety to increase their effectiveness teachers of mathematics, this thesis not only posits a new way of thinking about maths anxiety in pre-service teachers, but also provides insights into how it might be addressed, which would be of interest to both researchers and teacher educators. It also discusses implications and recommendations for future research, education practice and policy.

Glossary of Abbreviations and Key Terms

AAMT – Australian Association of Mathematics Teachers, an organisation of mathematics educators from each state and territory of Australia.

ACARA – Australian Curriculum and Reporting Authority, an independent statutory authority responsible for the development of the Australian National Curriculum.

AITSL – Australian Institute for Teaching and School Leadership, the institute which developed the Australian Professional Standards for Teachers.

CBT – Cognitive Behaviour Therapy

CIT – Critical Incident Technique

Course – the 4-year initial teacher education program taken by the participants of the study.

MARS – Mathematics Anxiety Rating Scale

Maths anxiety – anxiety towards mathematics, identified by survey or participants' responses, not involving a clinical diagnosis.

MTA – mathematics test anxiety

PANAS – Positive and Negative Affect Schedule

Practicum – placement in a school for practice teaching under the supervision of a teacher.

Pre-service teacher – a student studying an initial teacher education course. Primary pre-service teachers are preparing to teach students from Foundation to Grade 6.

RMARS – Revised Mathematics Anxiety Rating Scale

Secondary school (high school) – school for students from Grade 7 to 12.

STEM – science, technology, engineering, and mathematics.

Unit – a semester-length program of study in the teacher education course

VOM – Views of Mathematics construct

Publications during the thesis

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CHAPTER 1: DEFINING THE RESEARCH

Mathematics is one of humanity's great achievements. By enhancing the capabilities of the human mind, mathematics has facilitated the development of science, technology, engineering, business, and government. Mathematics is also an intellectual achievement of great sophistication and beauty that epitomizes the power of deductive reasoning. For people to participate fully in society, they must know basic mathematics. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not only of opportunity but also of competence in everyday tasks. (National Research Council, 2001a, p. 1)

Overview

This thesis reports on a study that investigated mathematics anxiety (henceforth, maths anxiety) in Australian primary pre-service teachers and aimed to identify ways by which this anxiety might be addressed. Because the participants were preparing to be primary teachers, the ultimate aim of the research went beyond solely identifying methods to overcome maths anxiety. The thesis also explored the need for all pre-service teachers to develop an awareness and understanding of the potential implications and impacts – positive and negative – of maths anxiety in their learning and future teaching.

This thesis is based on the reflections of pre-service teachers who shared their stories. These displayed and illustrated different levels of maths anxiety, including those of pre-service teachers who experienced profound maths anxiety; and the thesis outlines ways to support them to revise their reflections and deal with their anxiety.

This chapter begins with a brief introduction, followed by the context for the research (Section 1.2). It delineates the research problem (Section 1.3), the purpose and rationale for the focus on this research study (Section 1.4), the research questions (Section 1.5), and the research design (Section 1.6). Finally, it outlines the structure of the thesis (Section 1.7).

1.1 Introduction

Almost everyone has a story to share about the mathematics experiences in their lives. When talking about her passion for this research, the author finds that it is almost as if she is giving people permission to speak; and the floodgates open, and their reminiscences pour out. Over time, she has become increasingly concerned by people's stories of how the decisions that they make in their lives are being curtailed by their fear of mathematics.

The author was drawn to this specific topic by her role as a pre-service teacher educator, and her aim for a better mathematics educational experience for pre-service teachers and, ultimately, for their future students. Her concern was that the fears of her pre-service teachers who are anxious about mathematics will translate into their teaching. In order to counteract this, it is vital to acknowledge and address their maths anxiety. Moreover, as will be seen, this is not a local problem; it is an issue with international ramifications.

The context of this research is important. Op 't Eynde, De Corte, and Verschaffel (2001) stress the situatedness of emotions and the impact of the context on people and their learning: "People are always situated in and constituted by the social and historical context(s) in which they find themselves. They give meaning to themselves and the surrounding world by interacting with it" (Op 't Eynde, De Corte, & Verschaffel, 2001, p. 151). Hence, this thesis begins with an examination of the context within which the research is located, and the historical position of mathematics in education.

1.2 The research context

This section provides contextual understanding of the environment within which this research occurred and demonstrates its national and international relevance. High levels of maths anxiety form a dominant theme throughout discussions of the societal and educational context of mathematics.

1.2.1 The societal context of mathematics

The 21st Century has been marked by rapid social and technological changes on a global scale. This has led to a rapid social and cultural transition.

Every few hundred years throughout Western history, a sharp transformation has occurred. In a matter of decades, society altogether rearranges itself—its world view, its basic values, its social and political structures, its arts, its key institutions. Fifty years later a new world exists. (Drucker, 1992, p. 95)

The author of this thesis argues that the last 50 years have seen a transformation of the type referred to by Drucker, exemplified by the exponential changes brought about by information and communication technologies, and it seems likely that such radical shifts may become more frequent. This transformation places demands on mathematics education, because mathematics is an indispensable part of modern society. In order to accommodate such shifts, productive relationships with mathematics are important because “as our knowledge expands and the economy evolves, more people are working with technologies or in settings where mathematics is foundational. Processing of information, problem solving, and using numbers and symbols to communicate are becoming routine job requirements” (Minton, 2007, p. 4). However, mathematics is still widely regarded as a discipline that focuses on instrumental knowledge and whose educators “usually emphasize teacher-directed methods such as lectures” (Cranton, 2011, p. 80). Although the fundamental importance of mathematics is almost universally acknowledged, it is often perceived as not being personally relevant. Numeracy is so embedded in our daily lives that people often do not recognise that an activity is placing demands on their mathematical skills. People are not always conscious of the importance of, and contribution of, mathematics skills to their everyday activities (Latterell, 2005).

Nevertheless, it is widely accepted that people need to have mathematical skills if they are going to engage successfully in modern society. The globalisation of Western education means that students compete globally and functioning as a critically aware citizen depends on being able to use mathematics confidently (Furner & Duffy, 2002; Newton, 2007). Competence in mathematics is often used as “a vocational filter” (Sheila Tobias, 1978, p. 29). Students who exhibit persistent problems learning mathematical skills and concepts during their education years usually carry these difficulties into their adulthood and professional lives (Robinson, Menchetti, & Torgesen, 2002). Poor mathematical literacy skills have far-reaching implications for adults, because mathematical skills and understanding are needed to function with our high level of technology and have been linked to better employment outcomes and

higher salaries (Shapka, Domene, & Keating, 2006). Addressing this problem has benefits for social justice, because mathematical literacy is an important aspect of equity in our society, enabling people to make informed decisions about their lives, their health and the environment.

Parallel to the changes in the last 50 years has been an increase in awareness of maths anxiety as a pervasive affective state. Sheila Tobias noted, over 40 years ago, that “math avoidance is extremely limiting for people at all levels of work” (1978, p. 29); now, anxiety towards mathematics has been identified as an issue nationally and internationally (OECD, 2015). Mathematical know-how is widely regarded as essential, not only to the life chances of individuals, but also to the health of communities and the economic wellbeing of nations (Walls, 2009, p. vii). Therefore, the problem of maths anxiety has social, economic, and political implications, resulting from the loss of the contribution of people who would otherwise grow and develop as mathematically literate citizens.

In the traditional deficit view of school mathematics, only a few students were expected to succeed. Mathematics was seen as knowledge that operated to select the smart and intelligent. There was a bias in assumptions about who would be capable of studying mathematics. Extensively, mathematical success has been defined in ways that dominate achievement and create barriers. Mathematics has been perceived as a “critical filter” (Benn, 1997; Sells, 1978) for sorting, preparing and directing students to different social stations. Consequently, researchers associated this perspective with elitism and social stratification (Tate, 1995). These views were supported by Atweh, Bleicher, and Cooper (1998, p. 63): “the function of school mathematics in Western culture as a badge for the privileges of society has often been noted.” This has been reiterated at the beginning of the 21st Century as “mathematics has traditionally been a gateway to technological literacy and to higher education” (Schoenfeld, 2002, p. 13), and as a civil rights issue by Moses, who stated: “In today's world, economic access and full citizenship depend critically on math and science literacy” (2001, p. 5).

Thus, in the early years of the 21st Century, mathematics has continued to be regarded as a gatekeeper (Martin, Gholson, & Leonard, 2010), a barrier or an impediment, functioning as a system for inclusion/exclusion (Thomas, 2009). Valero (2014) claimed that educational failure in mathematics is concerned historically with the ordering of

power, and that it is impossible to detach school mathematics practices from elitism, because “failure of many in maths is the precondition for the success of the very few. It is failure of the many that grants value to the few who succeed” (p. 175). This notion is reinforced by Bourdieu’s (1986) description of the concept of the transmission of the dominant culture, oppressing other cultures, and creating the cultural capital of the dominant class. As the cultural knowledge of the dominant class becomes the culture within state institutions including schools, this cultural hegemony continues to result in the dominance of certain beliefs about mathematics. As Gates and Jorgensen (2009) state:

this is often seen through the acceptance that mathematics represents objectivity and impartiality that is not apparent in other fields of education. This assumption enables participants to buy into the belief that those who are successful do so as an apolitical act of their inherent worth. (p. 164)

As a consequence, success in mathematics remains a source of validation and feelings of self-worth. Failure is perceived to be a result of the student’s shortcomings and is not addressed because it is seen as the student’s fault (Wilson, Lake & McGinty, 2010). Continued labelling of individuals as failures, and the accompanying alienation that many continue to experience, function both as determining factors and social filters. This results in unrealised potential (Frankenstein & Powell, 1989). Studies in self-efficacy (Bandura, 1997) further support the effect of internalisation of an individual’s perceived ability to successfully perform tasks.

There is a long history of people who do not form productive relationships with learning mathematics. Negative attitudes towards mathematics are common. Minton (2007) indicated the potential personal impacts:

negative beliefs and assumptions have permeated our culture and, in effect, have limited people in their daily lives and had long-term consequences on their livelihood. Because innumeracy in today’s world deprives students of opportunity as well as competence in everyday tasks, it is vital that students understand the mathematics they’re learning. (p. 3)

Many people can identify an interaction where they experienced a loss of confidence and started to think of themselves as persons who could not learn mathematics. This is not only a cognitive experience, but also an emotional one. Negative beliefs drive

thinking and behaviour. Limiting beliefs are counterproductive and self-defeating and prevent people from having a positive relationship with mathematics, resulting in disconnection and withdrawal. People cope with the pain of anxiety by avoidance.

Negative attitudes to mathematics, and maths anxiety are also widespread and pervasive in the media and in social media. It is ironic that, in spite of its widely acknowledged importance, it can be socially acceptable to admit to not liking or having ability in mathematics (Isiksal, Curran, Koc, & Askun, 2009). It can be less embarrassing to show a lack of mathematical skills than language skills (Latterell, 2005). However, Buxton (1981) and Cockcroft (1982) reported feelings of shame experienced in association with difficulties in mathematics, and more researchers (Bibby, 2002; Brown, 2008; Ingleton & O'Regan, 2002) have related similar findings.

1.2.2 The educational context of mathematics anxiety

This research is located within an educational context of falling levels of participation in physical science and mathematics courses in Australian schools (Kennedy, Lyons, & Quinn, 2014). Such trends are also occurring in schools overseas, for example in Great Britain (Smith, 2004) and South Africa (Hlalele, 2012). Hence, this research pertains to the national debate about falling numbers of students in mathematics. Fewer students are studying mathematics in general throughout high school, and they are not enrolling in the more difficult mathematics subjects in senior years (Harris & Jenz, 2006). This trend has been noted in the Australian Chief Scientist's "Mathematics, Engineering and Science in the National Interest" report; Chubb (2012) identified a declining trend in senior school students' mathematics participation from 76.6 percent in 2002 to 72 percent in 2010, and declining participation in mathematics and science at university level. International studies such as the Programme of International Student Assessment (PISA), have reported falling levels of mathematical and scientific literacy in Australian students (Thomson, De Bortoli, Nicholas, Hilman, & Buckley, 2011). These reports received significant critical public comment and negative media attention.

In reviewing access to higher education internationally, Baldwin and James (2010) stated: "the rates and patterns of access to and participation in higher education are significant policy issues in most countries" (p. 334). They reported that relevant factors include "lower school-completion rates, lower levels of educational attainment in

schools – thus limiting opportunities in the circumstances of competitive entry based on academic achievement” (p. 337), and they suggested rural or remote locations as one example of where these factors might apply. They concluded that “the imbalances in higher education participation often reflect endemic educational disadvantage that begins in the earliest years of schooling” (p. 337). The contribution of student progress in mathematics cannot be underestimated, because “achievement in mathematics is considered a substantial element in decisions concerning placement, selection, and admission in most educational systems at all levels” (Nasser & Birenbaum, 2005, p. 277).

Although mathematics’ importance and application to everyday life is widely acknowledged, it is considered a difficult subject. Many students (and also adults) show an aversion towards mathematics, and the pursuit of the subject may be influenced by the extent to which their “peer culture values or denigrates mathematics” (Tapia & Marsh, 2004, p. 19). Negative affect towards mathematics is not a recent issue for students. Carl Jung (1963) wrote about his mathematics schooling experiences over a century ago:

I was so inhibited by my incomprehension that I did not dare to ask any questions. Mathematics classes became sheer terror and torture to me. Other subjects I found easy; and as, thanks to my good visual memory, I contrived for a long while to swindle my way through mathematics, I usually had good marks. But my fear of failure and my sense of smallness in the face of the vast world around me created in me not only a dislike but a kind of silent despair which completely ruined school for me. (p. 45)

This quotation resonates with current student experiences reported by researchers. When students are marginalised and do not identify themselves as confident learners of mathematics, they are unlikely to map mathematics into their future identities in a positive way and failure in mathematics can have a powerful emotional impact that may extend far beyond the mathematics classroom (Boaler, 1997). The impacts of mathematics instruction remain recognisable for many as having produced in them an enduring state of maths anxiety.

Maths anxiety is an international issue that has been shown to have impacts on students from the earliest levels of schooling. It has been reported that children as young as those

in first grade show maths anxiety (Vukovic, Keiffer, Bailey, & Harari, 2013) and that negative feelings and attitudes towards mathematics are well established in Australian students in their early school years (Larkin & Jorgensen, 2016). This issue also extends to secondary education, for example, in matriculation students in Malaysia (Zakaria & Nordin, 2008). Khatoon and Mahmood (2010) reported that nearly 50 percent of Indian secondary school students studied experienced moderate levels of maths anxiety, and approximately 20 percent demonstrated high math anxiety. Ng (2012) reports that in Singapore, which places great value on performance in mathematics, the highest levels of student anxiety are attributed to tests and examinations. A report of anxiety towards mathematics in the 2012 PISA reports indicated that students in countries that performed well reported the lowest levels, with the exception of Japanese, Korean, Singaporean, and Chinese students who “reported higher levels of anxiety than would have been expected given their performance” (OECD, 2015, p. 1). Hence, although maths anxiety is wide-ranging in international terms, cultural factors need to be considered in studying its causes.

Higher levels of maths anxiety have been reported in female students (see, for example, Ho et al., 2000), although the impact of gender is not clear. Moreover, levels of maths anxiety are negatively correlated with course enrolment, career choices, and lifelong learning in mathematics-related fields; Goetz, Bieg, Lüdtke, Pekrun, and Hall (2013) identify maths anxiety as a contributing factor to the under representation of females in science, technology, engineering, and mathematics (STEM).

There is an assumption that only unsuccessful students suffer from maths anxiety. However, Breen (1991), working with successful mathematics students, stressed “the way in which the past is so easily and frighteningly recalled by students, even when these memories go back to the early years’ of schooling” (p. 33). Yeo (2005) also reported that maths anxiety affected the performance of high ability Singaporean students on a test comprising non-routine problems. According with these findings is Ashcraft, Kirk, and Hopko’s (1998) statement:

early reports suggested that mathematics anxiety is a non-intellectual factor, in the sense that it was observed even in otherwise successful students, which nonetheless had serious consequences for educational and career-related choices. (p. 176)

Nationally and internationally, standardised testing has become an increasingly common form of high stakes student evaluation. The National Assessment Program – Literacy and Numeracy (NAPLAN) has been held in Australia since 2008. In a report on its impacts, Dulfer, Polesel, and Rice (2012) reported increased stress because of school-level expectations and claims of teachers teaching to the test, and negative impacts on students' wellbeing. Internationally, the impacts of maths anxiety have been recognised by PISA in its reports (OECD, 2013, 2015). The 2013 report stated: "for many students, feelings of anxiety and lack of confidence in their own abilities are closely associated with mathematics as a subject" (OECD, 2013, p. 189). Lee's (2009) analysis of PISA results from 41 countries indicated a correlation between maths anxiety levels and PISA scores. Students from 23 countries showed positive scores for maths anxiety and one-third of these (8/23) attained above-average PISA scores. In contrast, two-thirds (12/18) of the countries whose students had negative maths anxiety scores achieved above-average PISA scores.

Maths anxiety also has a long history in studies of students enrolled in tertiary education courses. Dreger and Aitken (1957) reported that approximately one-third of college students studying basic mathematics units experienced number anxiety. Other researchers (Betz, 1978; Richardson & Suinn, 1972) estimated the proportion of college students who were anxious about mathematics as approaching 50 percent. Later, Perry (2004) found that approximately 85 percent of surveyed college students in introductory mathematics courses in the USA reported at least moderate levels of maths anxiety. Maths anxiety continues to be common among modern university students, placing concurrent limits on educational and career choices, particularly for women (Ashcraft 2002; Chipman, Krantz, & Silver, 1992). In a survey of self-reported difficulties, university students ranked difficulties with mathematics concepts second to difficulties with writing (Rachal, Daigle, & Rachal, 2007). Australian universities are researching strategies for coping with the impacts of maths anxiety in a range of disciplines; for example, Dennis, Daly, and Provost (2003) in undergraduate psychology students, and Coady and Rylands (2008) reported on the use of reflective journals in a mathematics unit for students entering a Business course. Maths anxiety impacts on success in higher education (Stubblefield, 2006), affecting the choice of courses in university and the completion of degrees (McGlaughlin, Knoop, & Holliday,

2005). Further research is needed to understand the impacts of maths anxiety on tertiary students' academic performance (Liew, Lench, Kao, Yeh, & Kwok, 2014).

In this global context, as Mayer (2003, p. 3) posits, teachers are “charged with providing a foundation for life in these new complex, diverse and uncertain economic and social environments” for their students. They need to help students to develop skills and knowledge for lifelong learning and participation in modern society, and that includes being mathematically competent. Therefore, it is particularly concerning that Jackson (2008) found that 94 percent of British pre-service teachers agreed it was acceptable to admit to being “no good” at mathematics. Concurrently, critical articles about low pre-service teacher numeracy levels have been published in the media – for example, “Teacher maths skills make for sum disaster” (Bita, 2014). These demonstrate a developing culture of shaming pre-service teachers.

Parallel with these concerns, there is a growing emphasis on teacher quality, and on intensification of accreditation requirements. The National Program Standards for Accreditation of Initial Teacher Education in Australia set the numeracy levels for acceptance into teacher education courses equivalent to the top 30 percent of the population. If institutions accept students below this level, they “must establish satisfactory additional arrangements to ensure that all students are supported to achieve the required standard before graduation” (Australian Institute for Teaching and School Leadership (AITSL), 2011a, p. 13). Also, in 2016, the Australian Government implemented the Lantite (Literacy and Numeracy Test for Initial Teacher Education Students) test, as a mandatory requirement with a standard equivalent to that of the top 30 percent of Australian adults (Australian Council for Educational Research (ACER), 2019). This follows existing international practices; for example, in the USA, Praxis examinations are taken by new teachers entering the profession as part of the certification processes for some states (National Research Council, 2001b). It is likely that these requirements may have a detrimental impact on pre-service teachers who are already anxious about their mathematics skills.

The Australian Professional Standards for Teachers (AITSL, 2011b) “articulate what teachers are expected to know and be able to do at four career stages: Graduate, Proficient, Highly Accomplished and Lead” (AITSL, 2011b, p. 1). This includes the requirement for teachers to know how to develop supportive and safe classroom

environments as an element of high-quality teaching. Soon after their publication, Gannon (2012) raised the concern that, in these Standards, there is more emphasis on management and little emphasis on emotional aspects such as empathy. A similar concern was raised by Whyte and Anthony (2012). They argued that in New Zealand, at the national level, policy is focussed on monitoring and improving student achievement and progress through the use of National Standards and developing teachers' pedagogical content knowledge. "However, to date, there is little policy direction concerning the affective and social outcomes of learning mathematics, especially in relation to those students who are most vulnerable in our classrooms" (p. 6). In contrast, standards developed by the teachers' professional association, the *AAMT Standards for Excellence in Teaching Mathematics in Australia*, listed Professional Attributes as one of the three organising domains and included in this domain a range of Personal Attributes such as "exhibit care and respect for their students" (Australian Association of Mathematics Teachers, 2006). The recent *Standards for Preparing Teachers of Mathematics* developed in the USA (Association of Mathematics Teacher Educators, 2017) have a strong focus on candidates' dispositions, in addition to their knowledge and skills. The related indicators for the first standard include "C.1.3 Exhibit productive mathematical dispositions" (p. 6). The emphasis on dispositions in other countries suggests that revisiting the appropriateness of the Australian Professional Standards for Teachers may be a desirable or even necessary course of action.

Concurrently, the Australian Curriculum, Mathematics (ACARA, 2015) lists Numeracy as one of the seven General Capabilities to be developed by every student and points out in the Introduction that "capability encompasses knowledge, skills, behaviours and dispositions", clearly indicating that numeracy has an affective component. This aligns with Westwood's (2008) indication that recent definitions of numeracy include affective (as well as cognitive) aspects of numeracy, such as "learners' attitudes, confidence and disposition to use numeracy skills independently" (p. 1); and Turner's (2007) emphasis on the importance of affective aspects of numeracy. As part of being numerate, Turner includes inclination, which encompasses desire and motivation to use numeracy skills. He concludes that "having negative feelings about mathematics and one's mathematical ability, implies a reluctance to use mathematics and hence a failure to be fully numerate" (p. 33). This inclusion is

supported by Australian researchers. Recently, Goos, Geiger, and Dole (2012) developed a model of numeracy for the 21st century which highlights the importance of dispositions. Cooke (2015) also supported the contention that disposition is part of numeracy and considered that maths anxiety is a measurable component of disposition. The proficiencies developed by the National Research Council of the United States (2001a) include productive dispositions, and the mathematics framework from the Singapore mathematics syllabus (Ministry of Education, Singapore, 2012, p. 13) includes an affective strand listing attitudes such as interest, appreciation, confidence and perseverance; however, the proficiency strands of the Australian Curriculum Mathematics (ACARA, 2015) do not include an affective component.

Given the national trends of an increasing emphasis on mathematics in primary schools, it is more essential than ever to prepare primary teachers who are skilled in mathematics teaching. This thesis argues for the importance of including affective factors as an aspect of effective teaching of mathematics. During the review of teacher education in Australia, the Australian Association of Mathematics Teachers' (AAMT) submission to the Teacher Education Ministerial Advisory Group (TEMAG) raised the issue that considerable numbers of people currently entering primary pre-service programs have maths anxiety (AAMT, 2014, p. 1). Nevertheless, although the TEMAG report emphasised thorough content knowledge and recommended that primary pre-service teachers graduate "with a subject specialisation giving priority to science, mathematics and languages" (2015, p. x), the issue of maths anxiety was not included. In 2015, the Australian Government Minister for Education announced compulsory numeracy testing of pre-service teachers graduating their courses from 2016 (Pyne, 2015). The emphasis on teacher quality seems to be connected firmly and only to content knowledge and does not acknowledge that mathematics proficiencies encompass other attributes.

At the same time, concerns are being raised about the issue of early career teacher attrition. For example, Buchanan et al. (2013) found that teacher attrition in the first five years of teaching in Australia is an ongoing problem, and early career teacher exits of "epidemic proportions" of 40 to 50 percent have been reported in many countries (Gallant & Riley, 2014, p. 562). While there is no research attributing this directly to maths anxiety, emotional support and identity formation were identified as factors.

1.3 The research problem

The problem that is the focus of this thesis is maths anxiety in primary pre-service teachers. In Australia, the term “pre-service teacher” refers to a student studying an initial teacher education course. Primary pre-service teachers are preparing to teach students from Foundation to Grade 6. The phenomenon of maths anxiety is of particular significance in teacher education, because high maths anxiety among pre-service teachers has been identified as an impediment to their becoming effective teachers of mathematics.

Many pre-service teachers come to teacher education with limited mathematics understandings and a pattern of avoidance and anxiety. This potentially affects not only their pre-service study, but also their future teaching of mathematics and the attitudes of their future students. International researchers of primary pre-service teachers report high levels of maths anxiety, low confidence levels for teaching mathematics, and low mathematics teacher efficacy. Pre-service teachers with mathematics anxiety may avoid mathematics (Isiksal et al., 2009), may have lower mathematics teacher efficacy (Gresham, 2008; Swars, Daane, & Giesen, 2006), and lower confidence to teach both mathematics and science (Bursal & Paznokas, 2006).

Wood (1988) underscores the significance of this issue and the prospects if the higher expectations for more positive teacher attitudes are not realised:

If the scores of the MARS [Mathematics Anxiety Rating Scale] or some other scale are approximately the same for elementary teachers as for the general public, but these levels indicate an overall fear of or distaste for mathematics, then there is still a problem. Elementary teachers are charged with an extremely important role to engender an excitement for learning in all subject areas, including mathematics. Such a perspective implies that elementary teachers have an attitude toward mathematics that is better than the attitudes of the public at large and they should feel more comfortable teaching mathematics than members of the general population. (p. 11)

Teacher education courses recognise the need for units that develop competent teachers of primary mathematics, skilled in curriculum and pedagogy. However, “little consideration is given in their teaching qualification preparation to the anxiety these

pre-service teachers may have towards mathematics” (Cooke, Cavanagh, Hurst, & Sparrow, 2011, p. 1).

This thesis argues that addressing maths anxiety among primary pre-service teachers is important in enabling them to become effective teachers of mathematics. There is great potential for positive outcomes for pre-service teachers when they understand, examine, and reflect on alternative ways of viewing their experiences, and this can potentially translate into more positive experiences for their own students.

1.3.1 The genesis of the problem – the cyclic nature of maths anxiety that is perpetuated in classrooms

Carroll (2005) reported that approximately half of a sample of 108 Australian primary teachers studied had negative feelings about mathematics, and one-third reported negative school experiences in mathematics. Carroll also reported that a significant number of primary school teachers identified their school experiences as a factor in their beliefs about mathematics. Previous research by the current author found that teachers’ beliefs about their own ability are a significant factor in their approach to teaching mathematics and even militate against their willingness to teach upper primary classes (Wilson, 2009).

Maths anxiety limits teacher skill (Swars et al., 2006). Maths-anxious teachers are more likely to use avoidance techniques, which disadvantages their students (Gresham, 2007; Hembree, 1990), and female teachers with maths anxiety may negatively influence the mathematics achievement of their female students (Beilock, Gunderson, Ramirez, & Levine, 2010). Fiore (1999) calls students with maths anxiety “math abused students”, and states: “success for many students is related to how we make them feel in class” (p. 405).

The role of the teacher in increasing maths anxiety in students has been identified consistently. Researchers have found that the high levels of teacher maths anxiety can be perpetuated in classrooms (Furner & Berman, 2005; Hembree, 1990; Martinez, 1987; Sloan, Daane, & Giesen, 2002; Sheila Tobias, 1981; Vinson, 2001; Wood, 1988). Particularly relevant to this study is the potential to pass on teachers’ maths anxiety to primary students (Swars et al., 2006). The transfer of maths anxiety from teacher to student has long-term and far-reaching educational and social implications. It is

important for this cycle to be broken, and Martinez (1987) suggests that “preventing math anxiety begins by helping teachers confront and control their own fears of math” (p. 117). This is particularly true for primary teachers as they are students’ first teachers of mathematics.

Addressing levels of maths anxiety in pre-service teachers during their course can disrupt the maths anxiety cycle and contribute to their development. Given that maths anxiety has been shown to interfere with effective teaching of mathematics, it is important to equip pre-service teachers with understandings and skills that will help them to address their own maths anxiety.

1.3.2 Significance of the problem

This research has the potential to effect progress in the challenge of primary teacher preparation. The study is relevant nationally and internationally as teacher education researchers (for example, Lutomac & Kaasila, 2011) seek strategies to address mathematics anxiety. National Australasian reviews of mathematics education research have included the incidence of maths anxiety (Goos, Smith & Thornton, 2008) and addressing pre-service teachers’ maths anxiety (Lomas, Grootenboer, & Attard, 2012).

Pre-service teachers’ mathematical dispositions may be well-established when they enter teacher education courses (Biddulph, 1999; Swars, Hart, Smith, Smith, & Tolar, 2007). Improving pre-service teachers’ positive affect in mathematics is, within itself, a worthwhile goal, not only because promoting positive change for future teachers strengthens their engagement in the learning process; negotiating this issue also has the potential to transform learning and teaching beyond that of the pre-service teachers to their future students. This is supported by Ingram’s assertion that “research into affect in mathematics education should not be judged worthwhile only in so far as it has clear links to achievement. Improving students’ positive affect and appreciation of mathematics should be considered a goal, even a moral obligation, in mathematics education and in research” (2011, p. 7).

Research into the effectiveness of primary teachers has emphasised the need for them to have a positive view of themselves as learners of mathematics (Askew, Brown, Rhodes, Wiliam, & Johnson, 1997; Ma, 1999). Hattie’s (2009) meta-analysis identified teacher effects as having the greatest influence on student achievement. Primary school

teachers have a profound effect on students' competences in, and beliefs about, mathematics, because they are teachers of mathematics to children at an age when children's beliefs are still at their formative stages (Hannula, Maijala, & Pehkonen, 2004). Teachers' mathematical content knowledge has been identified as a critical factor in the success of students in the early years of schooling (Hill, Rowan, & Ball, 2005). However, their attitudes to, and confidence for, teaching mathematics are often impacted by the way they were taught (Hattie, 2009; McNeal & Simon, 2000).

This issue sits in debates and agendas that have long-term implications. This study is linked to contemporary social and theoretical concerns for inclusion and social justice, because being mathematically literate is an important aspect of equity, not only for progressing to university and having a career in mathematics, but also for developing the attitudes and skills that enable understanding of everyday mathematical concepts. Poor mathematical skills affect people's ability to make informed decisions about their lives, health and the environment, and limit their opportunities to pursue and achieve goals. Maths anxiety has important impacts on people's everyday lives; for example, maths anxiety impacts on understanding consumer warnings and other health information that is presented numerically (Silk & Parrott, 2014). Longer term, the impacts of maths anxiety can be seen as limiting opportunities and choices for individuals. Ashcraft (2002) concluded: "highly math-anxious individuals are characterized by a strong tendency to avoid math, which ultimately undercuts their math competence and forecloses important career paths" (p. 81).

Empowering pre-service teachers contributes to social justice in that it can make a difference not only for them but also for their future students, and hence impact on social change. The impact of how teachers position their students in relation to the subject has profound and lasting consequences for students who are excluded from access to opportunities. For those students who are potential teachers of mathematics this emotional impact becomes doubly significant. It is for these reasons that teacher education has become a crucial subject for further research.

1.4 Purpose and rationale of study

The overall purpose of this mixed method study was to address maths anxiety and the mathematical identity of pre-service teachers in an Australian university, intervening

before the pre-service teachers start teaching, in order to mitigate the potential for passing on their maths anxiety to their students.

The research aimed to investigate the range and extent of pre-service teacher maths anxiety and examine the impact of a bibliotherapy intervention to address maths anxiety during their course. The study firstly investigated levels of maths anxiety in Australian pre-service teachers, to compare them with international studies. It is important to update previous research as the majority of students now coming to teacher education have completed their schooling in the early years of the 21st Century. The objective was to determine these levels at the start of their first year as the first-year experience has implications for student retention.

The research aimed to explore and address pre-service teachers' images of themselves as learners and doers of mathematics through Critical Incident Technique (CIT; Flanagan, 1954). The study explored the impact of reflections and readings, using bibliotherapy (Crothers, 1916), on pre-service teachers' maths anxiety and their mathematical identities. These are significant for their future teaching (Askew et al., 1997; Ma, 1999). According to Brown and McNamara (2005) there is "compelling evidence in the literature to suggest that experiences as a learner of mathematics, conceptions about the nature of mathematics, and instructional practices as a teacher of mathematics are all profoundly interconnected" (p. 59). Hence, consciousness-raising and empowering of pre-service teachers can lead to changes in their identity and professional practice.

Hembree's (1990) meta-analysis of maths anxiety found that effective cognitive-behavioural approaches to addressing maths anxiety, aimed at relieving feelings of dread or worry or at restructuring faulty beliefs, also showed a corresponding increase in mathematics achievement scores, even when the interventions did not include any mathematics instruction or practice. This indicates that relieving maths anxiety may enable a more accurate demonstration of levels of mathematical competency. In light of the introduction of mandatory exit testing of pre-service teachers in Australia, there is a need to understand the potential impacts of maths anxiety on pre-service teachers' results from this testing.

This study is timely, because maths anxiety and its impact on pre-service teachers and the students that they ultimately teach has been reported as a problem over time. Its impact is even more critical in the current technological age. Participation in the study will provide pre-service teachers with greater insight into how children's anxiety about mathematics can be minimised by teachers. This is, as Frenzel, Pekrun, and Goetz (2007) state, "of particular value for educators, for whom the affective well-being of their students should be a desired educational goal in itself" (p. 491). Also, this study will provide better understanding of the phenomenon of maths anxiety for teacher educators and teachers, researchers, and policy makers.

1.4.1 Exploratory studies on CIT and bibliotherapy to address maths anxiety in pre-service teachers

This study was connoted by a previous small research project. A pre-service teacher mooted the possibility that addressing maths anxiety might lead to more effective teaching, by reducing the negative effects identified in the literature. She also broached the idea that she may be more effective because of her previous experiences. This research has built on previous research by the author, which indicated that bibliotherapy has the potential to produce positive outcomes for primary teachers and pre-service teachers (Wilson, 2007; Wilson & Thornton, 2007/2008).

1.4.2 Rationale for research approach

This study challenges the notion that the experiences of maths anxiety in pre-service teachers necessarily have a negative impact on their future teaching. Concluding their study of pre-service teachers' mathematics teaching anxiety Brown, Westenskow, and Moyer-Packenham (2012) question the underlying assumptions about pre-service teachers "that have high mathematics anxiety and will therefore be poor mathematics teachers vs. those that have low levels of mathematics anxiety and therefore have the potential to be effective mathematics teachers" (p. 383). These assumptions are indicative of the common deficit model of maths anxiety wherein it is seen as a problem for pre-service teachers and not as an opportunity to become more effective in their teaching. In addition, the corollary that teachers with no experience of maths anxiety will be effective teachers of mathematics is challenged by the understanding that "pre-service teachers who have experienced only success in school mathematics may find it

hard to understand pupils for whom learning mathematics is not easy” (Kaasila, Lutovac, & Lauriala, 2014, pp. 32–33).

Ball (1988) acknowledged that teacher education students come to their courses with experiences that affect their feelings about mathematics and themselves in relation to the subject. However, these students often:

are viewed as simply lacking particular knowledge and skills without taking into account what they already know and believe. This lack of attention to what teachers bring with them to learning to teach mathematics may help to account for why teacher education is often such a weak intervention – why teachers, in spite of courses and workshops, are most likely to teach math just as they were taught. (p. 40)

In addition, these negative views have an inevitable impact on the way in which pre-service teachers with maths anxiety view themselves. The potential for them to develop a different perception is supported by Solomon’s (2009) contention that students need to develop an identity of inclusion comprised of “particular beliefs about oneself as a learner and about the nature of mathematics, an identity of engagement in mathematics and a perception of oneself as a potential creator of, or participant in, mathematics” (p. 27); and that attaining this may involve “resistance or refiguring when ascribed identities are excluding” (p. 199). This research focussed on an approach to eliciting and understanding the affective responses of primary pre-service teachers, in order to help them challenge their interpretation of these responses to events during their mathematics education. The researcher’s philosophy that underpins the approach taken in this thesis aligns with the suggestion by DeBellis and Goldin (2006) that:

the most important affective goals in mathematics are not to eliminate frustration, remove fear and anxiety or make mathematical activity consistently easy and fun. Rather they are to develop meta-affect where the emotional feelings about the emotions associated with impasse or difficulty are productive of learning and accomplishment. (p. 137)

This resonates even more with the mathematical education of pre-service teachers, and their affective change is even more vital when one considers their future potential impacts as teachers. This thesis argues that, especially because the participants are to be teachers of mathematics to young children, it is not sufficient solely to find strategies

to lessen their maths anxiety. Instead, it is important to find ways to support these pre-service teachers to address their anxiety and overcome its deleterious impacts in ways that are productive to both their own learning and accomplishment and the effectiveness of their teaching. This thesis will argue that part of addressing maths anxiety with pre-service teachers includes refiguring the perception of their maths anxiety so that it is not seen as a deficit model but as an opportunity that offers the potential to become more effective teachers of mathematics.

Meyer and Turner (2002) point out that both teachers' cognitive support and affective responses are important for students at both the academic and interpersonal level (p. 111). Brown and McNamara (2010) emphasise developing awareness of the symptoms of maths anxiety and its potential impacts on their future students. They describe a primary pre-service teacher, "Clare," who will "need to be sensitive to noticing and minimising pupils' anxieties with mathematics, and perhaps, ... attend to some of her own" (p. 1). There is a need for studies to be designed with outcomes that reach beyond the immediate impacts on pre-service teachers' own maths anxiety to awareness of how it might be remediated in their future students. The immediacy of this need is emphasised by Pradeep (2011, p. 2): "it is important that mathematics anxiety is identified in a child as early as possible and that mathematics teachers know how to become aware of mathematics anxiety amongst their pupils and how to deal with it in the classroom". This has implications for teacher education, as Guillory Bryant (2009, p. 13) explains: "because teachers are catalysts for change, it is imperative that teacher education programs have information about math anxiety. Moreover, it is imperative that teacher education programs acknowledge and address math anxiety in pre-service teachers."

The study is thus located at the intersection of three areas of research, those of mathematics anxiety, primary teacher mathematics education and reflective strategies such as CIT and bibliotherapy, as illustrated by Figure 1.1.

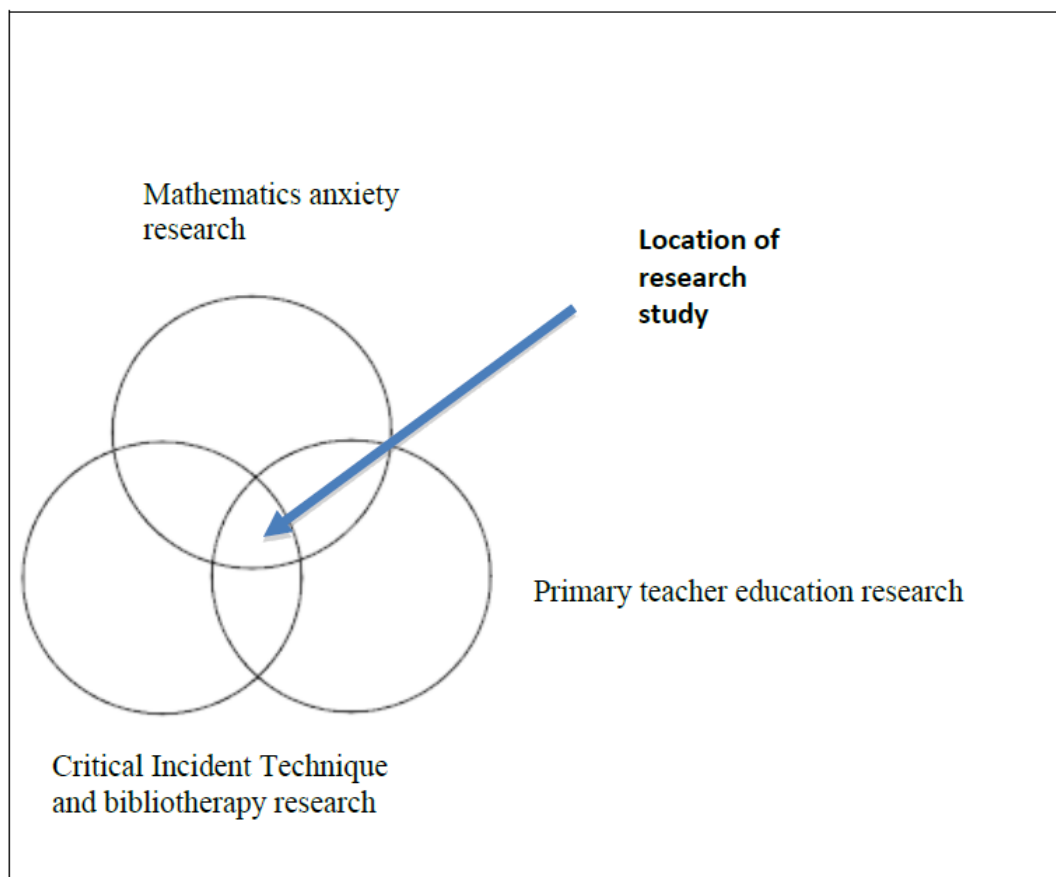


Figure 1.1 Location of study.

The research is underpinned by two streams of research: how teachers' images of themselves as learners and teachers of mathematics impact upon their teaching, and the factors contributing to anxiety about mathematics in primary pre-service teachers.

This study focussed firstly on the level of maths anxiety with which first year pre-service teachers come to their education studies, and what they identify as causes of that anxiety. This will contribute to international research by providing comparisons from the Australian context. The study acknowledges the importance of the first year of the university experience. Student retention and completion of university courses is of concern to universities worldwide because it is a performance indicator of quality assurance (Crosling, Heagney & Thomas, 2009). The first year of study at university is particularly important (Krause, 2005; Williford & Schaller, 2005) as this is when “decisions to stay or leave are still unresolved” (Tinto, 1999, p. 5). Martin (2012) reported success with strategies that aimed to increase engagement and reduce anxiety

in a first-year education unit that linked practical activities with theory. Further studies of first year pre-service teachers are essential.

Demographic information was collected to examine factors such as age, gender and rurality. The study investigated maths anxiety in mature-age students, 25 years and over, as they are more likely to be enrolled part-time and have dependents (Crosling et al., 2009), to have withdrawn from a unit and to “experience money worries and find it stressful managing their study and other commitments” (James, Krause, & Jennings, 2010, p. 69).

The focus on both cognitive and emotional aspects led to the use of the technique of bibliotherapy, which has been employed already by Hebert and Furner (1997) to alleviate mathematics anxiety in school students, using children’s books that have mathematics as a particular focus. The technique has also been used to help high ability students to overcome maths anxiety. “Bibliotherapy is a therapeutic, discussion-generating technique which offers educators appropriate affective strategies for dealing with mathematics anxiety in *secondary* math classrooms so that students achieve success” (Hebert & Furner, 1997, p. 170). Bibliotherapy has been used in preparing pre-service teachers to teach students with emotional and behavioural disorders (Marlowe & Maycock, 2000) and students with special needs (Morawski, 1997). Lutovac and Kaasila (2011) identified connections between the stages of narrative rehabilitation and bibliotherapy in alleviating negative views of mathematics (see also Lutovac & Kaasila, 2019).

The combination of CIT and bibliotherapy is a distinctive approach, proposing a new way of approaching this problem. This research is relevant to the scholarly literature because using bibliotherapy in a new way will add to existing research approaches. It also has the potential to develop a new approach to addressing the cognitive and affective issues related to maths anxiety. This approach will provide a new way of addressing this problem and ascertain if bibliotherapy impacts on the way participants perceive their future identities as teachers of mathematics. Research investigating the use of bibliotherapy, as a tool for addressing primary pre-service teachers’ affective responses to mathematics will add to existing frameworks for the study of affect in mathematics education (Hannula, Evans, Philippou, & Zan, 2004).

In addition, the current study provides an analysis of a workshop to address maths anxiety in pre-service teachers. This will inform the repertoire of strategies for teacher education programs. Thus, the implications of the study relate both to the research design and to the results.

Developing these understandings will allow the researcher to provide and describe a process that others could adopt, making it practical in its potential applications and potentially appropriate for other students, such as nursing students. This could also create the opportunity to transfer the process to other learning areas using it to address issues other than mathematics anxiety, such as anxiety about science.

1.5 Research questions

The following specific research questions were investigated:

1. With what range and extent of maths anxiety do pre-service teachers present?
2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?

The following sub-questions, aligned with the above two research questions, were investigated:

- 1a. What are the indications for influences that have stimulated this anxiety?
- 2a. For the pre-service teachers who participated in cognitive bibliotherapy, what were their responses?
- 2b. For the pre-service teachers who participated in an interactive bibliotherapy workshop, what were their responses?
- 2c. What was the immediate and detectable change in their affect upon completion of the workshop?
- 2d. What was the more lasting impact of the interactive bibliotherapy on the pre-service teachers' maths anxiety?

These questions arise both out of the context of the study and from the results of the author's previous studies. These also give a framework for the literature that will be

reviewed, and the instruments and research method that will be used. The justification for these research questions will be further elaborated as the literature is reviewed.

1.6 Research design

This thesis presents the findings of a phenomenological study investigating the lived experience of pre-service primary teachers. The phenomenon of interest is maths anxiety in primary pre-service teachers.

This research is a descriptive and interpretive mixed methods study (Creswell, 2010) consisting of quantitative and qualitative collection and analysis procedures. The study used a pragmatic interpretive approach in studying the perceptions of the research participants, from their perspective, within a socio-cultural context. It was implemented with pre-service teachers studying a Bachelor of Education (Primary) degree from two campuses of an Australian multi-campus university. These campuses were located in two different states with very different education systems.

An existing survey instrument, the Revised Mathematics Anxiety Scale (RMARS) survey (Alexander & Martray, 1989) was used to establish the levels of maths anxiety in the two cohorts of pre-service teachers, and the study used CIT and bibliotherapy with a focus on examining and addressing personal responses to prior experiences.

In terms of range and scope, this study did not aim to investigate whole-institution or systematic educational changes, focussing rather on positive change in pre-service teachers in order to empower them. The study explored emotions within the construct of identity through the narrative devices of CIT and bibliotherapy, in order to revisit and capture the views of pre-service teachers at early stages of their academic course, deconstructing and reconstructing their beliefs and promoting the formation and reformation of identity. The research had an interpretive philosophical perspective (Creswell, 2010) based on understanding the world from the subjective experiences of the individual participants.

1.6.1 The limitations and delimitations of the study

The study was restricted by factors that were beyond the researcher's control. Limitations included:

- Random selection of participants was not possible because participants self-selected.
- Although the researcher had access to the whole cohort, ethics directed that pre-service teachers could choose whether to participate.
- It was not possible to obtain agreement from all lecturers to access their classes.
- There was an issue with recruitment of pre-service teachers to workshops.
- The study was conducted over a limited timeframe.

Delimitations of the study:

- The measurement of maths anxiety was by one instrument, the RMARS (Alexander & Martray, 1989).
- The research sample was a convenience sample drawn from two campuses of one university.
- Participation in the study was limited to pre-service teachers enrolled in the Bachelor of Education course.
- Participation in the survey and tutorials was limited to first year students.
- The timeframe for the survey and tutorials was limited to two years.
- The CIT and bibliotherapy were conducted in two contexts – tutorials and workshops.

1.7 Organisation of the thesis

The thesis consists of eight chapters. This chapter, Chapter 1, described the context, aim, rationale and implications of the thesis.

Chapter 2 will present a focussed review of the literature about pre-service teachers' maths anxiety and previous research into means of addressing this anxiety.

Chapter 3 will begin with an outline review of the affective domain, then presents the conceptual framework, and finally discusses relevant aspects of maths anxiety that inform the thesis.

Chapter 4 will present an overview of the research design and discusses the theoretical framework and justification for the research methodology and its variables and limitations.

Chapters 5, 6, and 7 will provide the findings and relevant discussions, which locate findings in the broader literature.

The thesis closes with Chapter 8, which will present the conclusions and their implications for educational practice and make recommendations for future research.

CHAPTER 2: REVIEWING THE LITERATURE ON PRIMARY AND ELEMENTARY PRE-SERVICE TEACHERS' MATHS ANXIETY

By ignoring the powerful role that anxiety plays in mathematical situations, we are overlooking an important piece of the equation in terms of understanding how people learn and perform mathematics. (Maloney & Beilock, 2012, p. 405)

Overview

As Chapter 1 explained, the current study was driven by the high rates of primary and elementary pre-service teachers' maths anxiety reported in the literature, and the socio-political changes affecting teacher education. The purpose of this chapter is to present an analysis of the specific literature pertaining to primary and elementary pre-service teachers' maths anxiety, in order to synthesise an overview of the research in this field. The author acknowledges that there is an extensive body of research literature on maths anxiety (see, for example, reviews of maths anxiety by Ashcraft & Ridley, 2005; Buckley, Reid, Goos, Lipp, & Thomson, 2016; Dowker, Sarkar, & Looi, 2016; Flegg, Mohamed, & Trimmer, 2013; Furner & Berman, 2003; Suarez-Pellicioni, Nunez-Pena, & Colome, 2016). These are general reviews, although Flegg et al.'s (2013) review includes a section (pp. 4–5) on maths anxiety in pre-service teachers. A detailed examination of research literature from the entire field of maths anxiety is beyond the scope of this thesis. Accordingly, in this chapter, the author provides a targeted review of the literature concerning the history and nature of maths anxiety in primary and elementary pre-service teachers. This chapter also reviews and critiques the findings and conclusions from the research literature. It examines factors that have been identified as influencing the development of maths anxiety, along with ways to address this maths anxiety.

The following outlines the structure of the review:

- reports of high levels of pre-service teacher maths anxiety (Section 2.2),
- demographic variables impacting pre-service teacher maths anxiety (Section 2.3),
- effects/impacts of pre-service teacher maths anxiety (Section 2.4),

- causes of maths anxiety as perceived and identified by pre-service teachers (Section 2.5),
- previous approaches to address pre-service teachers' maths anxiety (Section 2.6).

The final sections summarise and conclude the chapter (Section 2.7) and outline the progression of the thesis (2.8).

This chapter then leads on to Chapter 3, which situates pre-service teacher maths anxiety in a conceptual framework, and Chapter 4, which reviews methods used by researchers of maths anxiety and outlines the approach taken in this study.

2.1 Introduction

It was argued in Chapter 1 that, given the importance of mathematics, maths anxiety is a vital issue that needs to be addressed in education. It is important that the cycle which transmits maths anxiety from teachers to students be disrupted. Mihalko (1978, p. 36), writing about elementary school teachers, opined that it is logical that they “cannot be expected to generate enthusiasm and excitement for a subject, for which they have fear or anxiety. If the cycle of mathophobia is to be broken, it must be broken in the teacher education institution.” The phenomenon of maths anxiety is of particular significance for teachers who teach students in their earliest years of schooling. For this reason, the researcher has chosen to investigate and address this issue in primary pre-service teachers with a goal of identifying means of addressing this anxiety before they commence their teaching. According to Richardson (1996), in comparison to previous life history, particularly that related to experiences as a student: “pre-service teacher education seems a weak intervention” (p. 113). Hence, it is important to find ways to strengthen the positive influences of teacher education courses.

2.2 International researchers report high levels of pre-service teachers' maths anxiety

Numerous mathematics education researchers have argued that maths anxiety in primary and elementary pre-service teachers is an important issue, which impacts on teacher preparation (see Section 1.1). Although the participants in this study were Australian primary pre-service teachers, research from different countries studied

primary and elementary pre-service teachers and, because these two designations are not identical, the findings have been labelled appropriately.

2.2.1 International research

Ongoing research on maths anxiety in pre-service teachers has been completed in many countries. Hembree's (1990) meta-analysis of 151 research studies on maths anxiety found that the level of mathematics anxiety of pre-service elementary teachers was the highest of any major on university campuses in the USA. According to Brady and Bowd (2005), research into maths anxiety in pre-service teachers had been increasing in prominence in the early years of the 21st Century, and the body of literature has continued to grow. In analysing these studies, the author has initially identified the country of origin of the research, in order to demonstrate the breadth of research.

Researchers of primary and elementary pre-service teachers internationally report high levels of maths anxiety, low confidence levels about teaching mathematics and low mathematics teacher efficacy. These include, for example, researchers who studied primary or elementary pre-service teachers from Britain (Haylock, 2001; Jackson, 2008; Witt, Goode, & Ibbett, 2013); Canada (Brady & Bowd, 2005; Namukasa, Gadanidis, & Cordy, 2009); Chile (Mizala, Martinez, & Martinez, 2015); Finland (Hannula, Kaasila, Laine, & Pehkonen, 2005; Kaasila, 2007a); Italy (Coppola, Di Martino, Pacelli, & Sabena, 2015; Di Martino & Sabena, 2011); Malaysia (Puteh, 2002); New Zealand (Bailey, 2014; Frankcom, 2007; Grootenboer, 2009; Young-Loveridge, Bicknell, & Mills, 2012); Philippines (Ballado, 2014); Singapore (Loh, 2014); Slovenia (Lipovec, & Antolin, 2014; Lutovac & Kaasila, 2013); South Africa (Breen, 2001); The Netherlands (Pradeep, 2011); and Turkey (Bekdemir, 2010; Iksail, 2010). These reports provide strong evidence that it is an issue of international concern that many pre-service primary or elementary teachers fear mathematics and have entrenched negative beliefs about mathematics and their ability to do mathematics competently.

Researchers of U.S. elementary pre-service teachers have consistently dominated the research literature and reported high levels of maths anxiety (Baloglu & Kocak, 2006; Cady & Rearden, 2007; Dunkle, 2010; Gresham, 2010; Hembree, 1990; Kelly & Tomhave, 1985; Lake & Kelly, 2014; Malinsky, Ross, Pannells, & McJunkin, 2006; Sloan et al., 2002; Swars et al., 2006; Trujillo & Hadfield, 1999; Vinson, 2001) and low

confidence in their ability to learn mathematics (e.g., Dogan-Dunlap, Dunlap, Izquierdo, & Kosheleva, 2007). Baloglu and Kocak (2006) investigated maths anxiety levels in a range of American college students and, in line with Hembree's (1990) findings, reported that students from education majors had the highest levels of maths anxiety. Even 20 years after Hembree's meta-analysis, Dunkle reported: "the level of anxiety preservice teachers experience in the content area of mathematics is endemic" (2010, p. 14).

In comparison with the plethora of U.S. studies, Brown and McNamara (2005) reported that studies of teacher preparation in Britain that are mathematical in focus are more fragmentary than in the USA as studies in Britain are often more generic. Nevertheless, Haylock (2001) reported strong evidence that many British primary pre-service teachers have anxiety about mathematics and see themselves as unable to learn effectively. Brown and McNamara (2005) reported that British initial teacher trainees displayed intense emotions that were overwhelmingly negative. The authors interpreted these comments as evidence of anxiety. Also studying British pre-service teachers, Jackson (2008) found similar results to Brown and McNamara (2005) in that 81 percent experienced negative emotional or physical factors or both when engaged in mathematics. In-depth studies have also been conducted by Finnish researchers (see Kaasila 2002, 2007a; Kaasila, Pehkonen, Hannula, & Laine, 2004). Hannula, Kaasila, Laine, and Pehkonen (2005) reported that pre-service teachers had feelings of insecurity about being able to give explanations to students, and about their own level of competence in mathematics. A sequence of Italian studies shows that many Italian primary pre-service teachers continue to fear mathematics and are terrified by the idea of having to teach it (Di Martino & Sabena, 2011; Di Martino & Zan, 2010). For example, in their study of 169 Italian second year pre-service elementary teachers, Di Martino and Sabena (2011) reported that 37 percent showed anxiety towards mathematics, and 49 percent expressed negative emotions towards teaching mathematics.

Catlioğlu, Birgin, Coştu, and Gürbüz (2009) reported that beginning pre-service teachers in Turkey had higher levels of maths anxiety than those in senior years. Ertekin, Dilmac, and Yazici (2009), who investigated the relationship between maths anxiety and learning styles in Turkish pre-service teachers, emphasised the importance

of the social dimension. Uysal and Dede (2016) recently reported low levels of maths anxiety in Turkish elementary pre-service teachers and postulated that this could be the result of new school mathematics curriculum and teacher education reforms which take students' affective development into consideration, targeting enjoyment and active involvement. In other findings from a non-Western context Ballado (2014) surveyed maths anxiety in 88 Filipino junior pre-service teachers and found that 77 percent had moderate to very high anxiety.

2.2.2 Australasian research

In the Australasian region, studies of maths anxiety in pre-service teachers have been regularly shared and discussed between networks developed from the annual conferences of the Mathematics Education Research Group of Australasia (MERGA). New Zealand researchers have studied maths anxiety in pre-service teachers (Bailey, 2014; Frankcom, 2007; Grootenboer, 2003, 2009; Young-Loveridge et al., 2012) and a recently completed follow-up study in beginning teachers (Frankcom-Burgess, (2017). Originally Frankcom (2007) reported that pre-service teachers' maths anxiety remained at high levels, notwithstanding success in their teacher education course. Her recent thesis (2017) followed seven novice teachers in their first two years of teaching and reported competent teaching and a focus on doing the best for students. She suggested: "perhaps this is the other side of maths anxiety that, once faced and accepted, it is possible to mitigate the effects, to work diligently to improve one's mathematical knowledge for teaching and, hopefully, do a competent job of teaching mathematics" (Frankcom-Burgess, 2017, p. 210).

Compared to the number of international studies, there have been relatively few studies of maths anxiety in the Australian teacher education context. Nevertheless, the issue has persisted in the literature. McCormick and Scott (1993) used 15 questions based on the MARS-R (Plake & Parker, 1982) and expressed concern at the levels of maths anxiety found in 113 Australian pre-service teachers. In other early studies (Carroll, 1994; Smith, 2003), researchers reported case studies of maths anxiety in individual pre-service teachers, and Uusimaki and Kidman (2004) investigated emotion in 16 maths-anxious pre-service teachers. The author of this thesis conducted previous studies of small groups ($n < 20$) undertaking initial teacher education units (Wilson,

2007; Wilson & Thornton, 2006). Findings of these small studies indicated the need for further research.

More recent studies attest to the ongoing significance of the issue: Cooke and Hurst (2013) found relationships between maths anxiety, confidence to teach mathematics, and attitudes towards mathematics; Boyd, Foster, Smith, and Boyd (2014) reported that 40 percent of a cohort of 223 first year Australian (early childhood and primary) pre-service teachers experienced anxiety towards teaching mathematics; and Perkins (2016) reported that 39 percent of a cohort of 309 third year primary pre-service teachers self-identified as having maths anxiety. Lozanovski and Poulton (2015) studied maths anxiety in 32 Australian first year pre-service teachers and reported that their maths anxiety aligned with questions about taking tests. Worryingly, Geeves (2014) found that maths anxiety in final year pre-service teachers still affected them as beginning teachers. Itter and Meyers (2017) emphasise emotions when quoting pre-service teachers' responses, for example, two pre-service teachers' "gut-wrenching anxiety" (p. 132).

In summary, international studies completed in a range of different countries indicate that many primary and elementary pre-service teachers come to teacher education with levels of maths anxiety that are concerning, little confidence in their mathematical subject knowledge and negative attitudes towards mathematics. Key issues that emerge from these studies are gender, age and rurality, each of which will now be dealt with in turn.

2.3 Demographic variables impacting pre-service teacher maths anxiety

The main demographic variable that has been studied is gender. Other variables that have been identified are age and rurality.

2.3.1 Gender

Girls' experience of mathematics in schools is generally different to that of boys (Boaler, 1997). Reports of females' maths anxiety correlate with findings that females tend to rate their performance below that of males, even when mathematics achievement is equal (Leder, 1990). In a more recent corroboration of these findings, Goetz et al. (2013) found that female students with the same average grades reported

lower perceived competence than male students. Beilock et al. (2010) reported that teachers' maths anxiety has particular impacts on girls. Consequently, investigating female pre-service teachers' maths anxiety is important as the majority of primary or elementary school teachers are women. In the USA 90 percent of elementary teachers are female (Beilock et al., 2010), in Scotland more than 90 percent of primary pre-service teachers are female (Macnab & Payne, 2003), and in Australia, the trend is no different, with 80 percent of pre-service teachers being female (Weldon, 2015, p. 6).

Gender differences in pre-service teacher maths anxiety have been extensively studied. For example, Kaasila, Pehkonen, Hannula, and Laine (2004) evaluated self-confidence in 269 Finnish elementary pre-service teachers and reported that low self-confidence in 22 percent of participants is attributable to gender and lack of success in school mathematics. However, the results of studies are inconsistent, with a number of studies reporting that females have higher levels of maths anxiety than males (Alexander & Martray, 1989; Brady & Bowd, 2005; Guillory Bryant, 2009; Kelly & Tomhave, 1985; Malinsky et al., 2006), while Hendershot (2000), studying college students in the USA, including pre-service teachers, did not find gender difference in maths anxiety, but did find that much lower numbers of females (23 percent $n = 50$) thought that their mathematics teacher was effective, compared to 72 percent of males ($n = 50$). In addition, 58 percent of females, compared to 50 percent of males, attributed their maths anxiety to a bad teaching experience. In another study, Jackson and Leffingwell (1999) found that pre-service teachers reported that in high school boys were helped to a substantial degree more than girls, regardless of their ability.

Baloglu and Kocak (2006), controlling for mathematics experience, found that gender effects of mathematics anxiety varied with the context. They reported multivariate differences between men and women, after adjusting for the differences in previous mathematics experiences among college students (including elementary pre-service teachers) in the USA. Female students showed significantly higher mathematics test anxiety (MTA), whereas male students were significantly higher in numerical task anxiety (NTA).

Recently, Stoehr's (2017) analysis of three female pre-service elementary teachers' different interpretations of their maths anxiety found that these comprised specific fears of loss – of social belonging, of personal identity and of practical competency. Other

social factors such as stereotype threat have been found to affect research findings, including the commonly held social stereotype that males are more competent in mathematics than females (Maloney, Schaeffer, & Beilock, 2013). Guillory Bryant (2009) concluded that, for female pre-service teachers in her study, “a high level of mathematics anxiety also has its roots in negative societal stereotypes” (p.99).

2.3.2 Age

Age is another factor that has been seen as potentially important, although, as with gender, inconsistent findings have been reported. Hembree (1990) did not identify age-related differences in his review. However, Betz (1978) studied pre-service teachers aged 17–34 and found that levels of maths anxiety increased with age, and Baloglu and Kocak (2006) found that pre-service teachers over 25 years of age exhibited more total maths anxiety than younger ones, particularly in mathematics testing and course situations. Malinsky et al. (2006) found that pre-service teachers aged 25–30 had higher levels of maths anxiety than those aged under 19, but they did not identify a linear relationship overall. In previous Australian research, Owens (2008) reported that mature-aged first year pre-service teachers approached their mathematics unit with more anxiety than did younger ones. It may be that age is not a linear factor, but a co-factor, with recent school leavers or mature-age individuals being a more important indicator. There is also potential for these two factors, gender and age, to interact.

2.3.3 Rurality

The study in this thesis included both urban and rural students. Although the literature available on issues in rural education is not vast, concerns have been identified in several international contexts.

In a U.S. study, Perry (2007) reported that “rural preservice teachers had less confidence and were more likely to view mathematics as a male domain than nonrural preservice elementary teachers” (p. vi). In addition, their performance-avoid goals were significantly higher than their performance-approach goals, resulting in their tendency to avoid unfavourable judgements by strategies such as not seeking help.

Steve Tobias and Itter (2007) reported limited mathematics backgrounds in the intakes of 397 pre-student teachers from rural and regional areas in two Australian universities.

Hlalele (2012) reported that rural South African high school learners generally experience maths anxiety. The implications for teacher education are the increased likelihood that these students will enter their studies with existing levels of maths anxiety.

In summary, these three demographic factors have been identified in the research literature as worthy of note.

2.4 Effects/impacts of pre-service teacher maths anxiety

Maths anxiety is a state of arousal that is experienced through physiological, emotional, and mental changes. Pre-service teachers with maths anxiety report low levels of self-confidence (Kaasila et al., 2004; Perry, 2007) leading to a cycle of fear, failure and avoidance (Sliva & Roddick, 2001). Pre-service teachers with maths anxiety may avoid mathematics (Isiksal et al., 2009). Initially this may manifest itself in seemingly minor ways; for example, Unglaub (1997, p. 70) reported that highly mathematics-anxious pre-service teachers “had avoided any part-time jobs that were mathematics oriented.” But avoidance of mathematics has more significant impacts. High levels of maths anxiety, reported in pre-service teachers, affects their learning, their self-efficacy, their future teaching of mathematics, and hence, the attitudes and performance of their students.

Table 2.1 provides some examples from the literature of the range of locations of impacts of maths anxiety on teachers and pre-service teachers. Findings regarding the impact of maths anxiety on self and identity, learning mathematics, other disciplines, practicum, and future teaching will be discussed in more detail below as they are pertinent to the following study.

Table 2.1:

Examples of impacts of maths anxiety on teachers and pre-service teachers

Location of impact	Author date	Participants/method	Country	Impact
On self and identity	Bibby, 2002	7 primary school teachers, 40 interviews	Great Britain	Strong sense of shame
On learning mathematics	Cooke et al., 2011	169 PST, questionnaire	Australia	Anxiety about evaluation and tests
On other disciplines	Bursal & Paznokas, 2006	65 elementary PST, survey	USA	PST with low maths anxiety had greater confidence to teach mathematics and science
On practicum	Mizala et al., 2015	208 PST, survey	Chile	PSTs' maths anxiety negatively impacted on expectations of their students
On future teaching	Gresham, 2010	52 PST, survey, interview	USA	Teachers with high maths anxiety use more traditional teaching methods e.g., lectures and concentrate on basic skills

Note: PST = pre-service teacher

2.4.1 Impact on self and identity

Pre-service teachers' maths anxiety impacts on their identity as teachers of mathematics (Bursal & Paznokas, 2006; Grootenboer, 2003; Levine, 1993; Swars et al., 2006). Identity is associated with pre-service teachers' beliefs, attitudes, and emotions and affects their ability to learn and teach effectively. Pre-service teachers construct a professional identity that is consistent with their perception of their personal capabilities. For example, Harper and Daane (1998) found that American pre-service teachers in a mathematics methods course had a fear based around making mistakes; and Bibby (2002) describes the strong sense of shame experienced by a participant whose perception was that everyone else could do mathematics.

This study used a model for humiliation in law enforcement cases and civil actions, developed by Torres and Bergner (2010), who made the distinction between embarrassment, caused by minor errors of conduct in social situations, and humiliation, which leads to loss of status, and feelings such as hopelessness and helplessness, anxiety, and powerless rage. In an educational context, these related to Ingleton and O'Regan's (2002) themes identified from descriptions of mathematics learning experiences: "the uses of power in the classroom, the threat of exposure from being publicly shamed, the impact on the teacher's judgement on developing identity as a mathematics learner, and the role of emotions in making self-judgements and decisions" (p. 98).

Previous research by the current author showed that many pre-service teachers described an interaction during their schooling which led them to identify themselves as persons who couldn't learn mathematics, saying that this still impacted on their self-images as future teachers of mathematics (Wilson, 2007; Wilson & Thornton, 2006, 2007/2008).

2.4.2 Impact on learning mathematics

Maths anxiety affects pre-service teachers' learning during their courses. Many pre-service teachers begin their tertiary teacher education with limited mathematics understandings and a pattern of alienation, avoidance and anxiety.

In terms of learning, Jackson (2008) reported that 70 percent of respondents agreed that feeling anxious about mathematics affected their learning, and almost 25 percent were concerned about passing on their negative attitudes to their students. Also related to learning, impacts have been identified on engagement. Pre-service teachers with maths anxiety are less likely to engage with mathematics and more likely to have low confidence, low self-efficacy (Bursal & Paznokas, 2006; Swars et al., 2006), and fear around making mistakes (Harper & Daane, 1998).

Maths anxiety also impacts on achievement in tests and other forms of evaluation. Cavanagh and Sparrow (2010) developed a survey of maths anxiety based on emotions and physiological responses in different situations. Using this survey to investigate the maths anxiety of 169 first year Australian pre-service teachers in different situations, Cooke et al. (2011) found "the majority of pre-service teachers reported the highest

average anxiety for the Assessment/Test situation” (p. 10). These findings are similar to findings of the prominence of maths test/evaluation anxiety by other researchers, (Alexander & Cobb, 1987; Alexander & Martray, 1989; Bessant, 1995; Plake & Parker, 1982; Resnick, Viehe, & Segal, 1982; Rounds & Hendel, 1980; Suinn & Winston, 2003). who reported MTA had the largest eigenvalue (13.02-32.63) and accounted for the most variance, up to 59.2 percent. Interestingly, Cooke and Hurst (2012) investigating 47 first year pre-service teachers reported that they had higher mathematics anxiety for group and teaching situations than for test situations.

Possible mechanisms have been investigated to explain the impacts of maths anxiety on test situations. Ashcraft and Kirk (2001) found that students with poor examination results reported that “they become confused, are unable to focus on the task at hand, or keep thinking about how poor they are at math” in examinations, hence “math anxiety disrupts the on-going, task-relevant activities of working memory, slowing down performance and degrading its accuracy” (p. 236).

2.4.3 Impact on other disciplines

It has been reported that maths anxiety is not just relevant for the studies of mathematics; it impacts on other discipline areas. A significant negative relationship between maths anxiety and mathematics teacher efficacy was reported by Gresham (2008). Utley, Moseley and Bryant (2005) found that mathematics and science efficacy in pre-service teachers are directly related, and Bursal and Paznokas (2006) reported negative correlations between levels of maths anxiety and primary pre-service teachers’ confidence to teach both mathematics and science. In a subsequent study, Bursal (2010) found significant correlation between pre-service teachers’ self-efficacy to teach maths and self-efficacy to teach science. These studies indicate that these impacts have implications for integrated studies in STEM, which have been identified as increasingly important. For instance, Chipman et al. (1992) found that maths anxiety correlated negatively with college students' interest in a scientific career regardless of their level of mathematical skill or their gender.

2.4.4 Impact on practicum

There is evidence that the repercussions of maths anxiety are broader than the effects on learning mathematics. Nicol and Crespo (2003) studied five elementary Canadian

pre-service teachers who reported that they had earned good marks in high school mathematics but did not enjoy doing or learning mathematics. Reflecting on her practicum “Jan” expressed her desire “to make it fun and interesting, and not pass on my own math anxieties to my students” (p. 378).

Maths anxiety limits pre-service teacher skill in mathematics content areas (Gresham, 2007). Uusimaki (2004) reported that apart from testing situations, communicating mathematical knowledge in the teaching of mathematics (such as during practicum) caused pre-service teachers most anxiety. This is supported by Nisbet (2015) who, from case studies of six female pre-service teachers on practicum, found that pre-service teachers with low maths anxiety could impart understanding of the content more clearly than those with high maths anxiety. However, Mizala et al. (2015) reported Chilean pre-service teachers’ maths anxiety negatively impacted on their expectations of their students.

Peker and Halat (2008) stated that fewer studies have been done on mathematics teaching anxiety. They reported on research with later-year pre-service teachers and stated that there may be variables, for example, lack of content knowledge and self-confidence, which relate to both maths anxiety and mathematics teaching anxiety. The implication is that before pre-service teachers can teach effectively, their maths anxiety needs to be reduced.

2.4.5 Impacts on future teaching

Pre-service teachers with maths anxiety may have lower mathematics teacher efficacy (Swars et al., 2006; Gresham, 2008). For instance, Gresham’s 2008 research with 156 pre-service teachers found significant negative relationships between maths anxiety and mathematics teacher efficacy. Namukasa et al. (2009) interpreted mathematics teaching anxiety as a process where “pre-service teachers’ fear of learning mathematics had transferred into a fear of teaching mathematics” (p. 57). That maths anxiety persists into teaching, is shown by McAnallen (2010), who evaluated maths anxiety in 678 elementary in-service teachers in her study, using an instrument she developed. Of the 261 (39 percent) who reported some maths anxiety, 48 percent, 46 percent, and 7 percent rated their maths anxiety as mild, moderate and severe maths anxiety, respectively.

If this anxiety is not ameliorated, it can also limit the grades which pre-service teachers train to teach or are prepared to teach. In the USA, early childhood pre-service teachers routinely state that they chose to teach young children (birth to 8 years) because they do not like mathematics, are not good at mathematics, or will not have to know or teach a lot of mathematics (Lake & Kelly, 2014). In a previous study investigating Australian primary teachers' anxieties about mathematics, the current author reported that maths-anxious teachers avoided teaching upper primary classes (Wilson, 2009).

If pre-service teachers' own maths anxiety is not addressed during teacher education courses, there is the potential for early career teachers to take their anxieties into the classroom. Maths-anxious teachers may teach in ways that affect their students' achievement in mathematics or may pass on their maths anxiety to their students. Hembree (1990) claimed that maths-anxious and avoidant teachers put students at significant disadvantage.

This can translate into their actual teaching strategies. Studies have indicated that maths anxiety has implications for teacher practices in mathematics (Bursal & Paznokas, 2006; Vinson, 2001; Zettle & Raines, 2000). Researchers have reported that teachers' maths anxiety may impact on their ability to teach mathematics effectively (Askew et al., 1997; Ma, 1999). Researchers have reported that maths anxiety, if not addressed, causes teachers to teach mathematical concepts poorly (Brady & Bowd, 2005; Cady, Meier & Lubinski, 2006; Swars et al, 2006). This has implications for them as early career teachers, and for their students. Gresham (2010) found that "teachers with high levels of maths anxiety use more traditional teaching methods, such as lecture. They concentrate more on teaching basic skills rather than concepts and devote more time to seatwork and whole class instruction" (p. 4). This is similar to the teaching Stacey (2003) labelled as shallow teaching syndrome, that is, teaching characterised by low procedural complexity, repetition, reliance on textbooks or worksheets, and lack of mathematical reasoning.

Chapter 1 identified the role of the teacher in increasing maths anxiety in students. If teachers pass on their maths anxiety to their students, teach in ways that produce maths anxiety in their students, or do not provide supportive environments for maths-anxious students, this can have significant implications. Comparatively few negative experiences are needed for students to begin a pattern of mathematics avoidance that

persists for the rest of their lives (Middleton & Jansen, 2011). The origin of maths anxiety can occur early in students' schooling. Children as young as those in first grade show maths anxiety; and impacts of maths anxiety on working memory and mathematics achievement have been identified in elementary school students (Jackson & Leffingwell, 1999). Hadfield and McNeil (1994) state that teachers should address students' negative feelings towards mathematics rather than letting them persist. Therefore, it is important that they know how to do this. Similarly, Reichwein Zientek, Yetkiner, and Thompson (2010) stated "teacher training and professional development programs need to educate teachers on how to reduce mathematics anxiety levels" (p. 436), because of the potential impacts of student maths anxiety on student achievement in mathematics.

Particularly significant for primary pre-service teacher education, with its current gender imbalance in favour of females, is the finding of Beilock et al. (2010) that female teachers' maths anxiety adversely affects girls' mathematics achievement. Uusimaki and Nason, (2004), working with a cohort of predominantly female mature-age pre-service teachers, found that 66 percent of the cohort reported that their issues with maths anxiety started in primary school.

The cyclic nature of these school experiences is illustrated by Carroll (2005), who found that almost one-third of the Australian primary teachers studied identified their own school experience as contributing significantly to their beliefs and emotions about mathematics, some in a negative way. Smith (2003) described an Australian final year pre-service teacher who attributed her poor achievement in school mathematics to lack of communication from teachers, which affected her beliefs and attitudes towards her future teaching of mathematics.

Students with maths anxiety participate less in mathematics classes, demonstrate lower performance, and avoid mathematics in high school and university courses. Studies of maths anxiety in New Zealand school students found that the majority of students were not thriving mathematically, and linked this to maths anxiety (Ingram, 2011). High maths anxiety impacts on performance and achievement in mathematics (Betz, 1978; Ma, 1999; Sheffield & Hunt, 2006, Stubblefield 2006). In their later life, students with high maths anxiety avoid mathematics in their courses and careers (Scarpello 2005).

In summary, this section has shown the range of impacts of maths anxiety on pre-service teachers and describes the cycle of maths anxiety between teachers, students, and pre-service teachers.

2.5 Causes of maths anxiety as perceived and identified by pre-service teachers

The rationale for identifying factors that produce maths anxiety is the need to understand causes of maths anxiety in order to be able to address this phenomenon. Maloney and Beilock (2012) state: “understanding the antecedents of math anxiety provides clues about how to prevent its occurrence” (p. 404). Of necessity, this review analyses literature on causes as identified by pre-service teachers. These studies involved strategies such as asking pre-service teachers to rate statements provided by the researcher, asking them to describe situations that caused their anxiety, or analysing mathematics autobiographies.

Researchers have attempted to categorise causes of maths anxiety from their findings. Hoyles (1982) gives three areas for explanations of anxiety particularly related to mathematics, those:

- derived from the nature of the subject mathematics,
- based on the influence of past experiences in mathematics and the self-concept of ability in the subject,
- concerned with how mathematics is taught and learned. This includes a sub-category of teacher pace and pressure.

These areas can be summed up as the nature of mathematics, students’ past experiences, and how mathematics is taught. Hadfield and McNeil (1994) state that the causes of maths anxiety can be divided into three areas:

- environmental,
- intellectual, and
- personality factors.

Environmental factors include negative experiences in the classroom, parental pressure, insensitive teachers, mathematics presented as rigid sets of rules, and non-participatory

classrooms. Intellectual factors include being taught with mismatched learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability, and lack of perceived usefulness of mathematics. Personality factors include reluctance to ask questions due to shyness, low self-esteem, and viewing mathematics as a male domain. Trujillo and Hadfield (1999) attempted to understand the causes of maths anxiety by carrying out in-depth interviews with five pre-service teachers, identified as having high maths anxiety. They found that “there are several causes of mathematics anxiety, categorized as personal, societal, environmental and pedagogical” (p. 219). The five principal contributing factors identified were: self-perceptions, school experiences relating to mathematics, teachers, family influences and MTA. These categorisations link to De Corte, Op ‘t Ende, and Verschaffel’s (2002) framing of mathematics-related beliefs within beliefs about mathematics education, self, and social context, which will be discussed in Chapter 3.

2.5.1 Self and identity

Many pre-service teachers begin their teacher education courses with limited mathematics understandings and a pattern of alienation, avoidance and anxiety. Beliefs about self and beliefs about mathematics are also associated with maths anxiety, although this correlation does not necessarily imply causality. The sources of these beliefs include their worldview of mathematics, of the way mathematics is presented in schools, and social stereotypes. For example, Cady and Rearden (2007) reported that “preservice teachers saw the mathematics teacher’s role as providing a nurturing environment for students and making sure that students understand” (p. 241).

Maths anxiety is compounded by beliefs about, and attitudes towards, mathematics, as well as limited understanding and lack of confidence (Harper & Daane, 1998). In addition, maths anxiety has been associated with a prevalent belief that success in mathematics is determined by ability rather than effort (Stigler & Hiebert, 1992). In an Australian study, Boyd et al. (2014) reported that 30 percent of a class of 223 early childhood (68) and primary (155) pre-service teachers believed that their inability to do mathematics was a personal characteristic that could not be changed. Brown and McNamara (2005), studied British initial teacher trainees, reporting that in interviews about their school mathematical experiences, first year trainees spoke less of the content and more of their feelings about it. They displayed intense emotions that were

overwhelmingly negative, with approximately 80 percent of the respondents reporting that they disliked or struggled with mathematics. As a result, they thought of themselves as failures, often as compared to their peers. The authors interpreted these comments as evidence of anxiety.

2.5.2 Past mathematics classroom experiences

The sources of maths anxiety for many pre-service teachers are identified in their mathematics learning before they entered their course. More than two decades ago Pajares (1992) reported that pre-service teacher beliefs about mathematics and mathematics teaching are established as a result of their own school experiences, and those beliefs resist change. Subsequent research indicates that pre-service teachers come to their teacher education courses with existing maths anxiety (Malinsky et al., 2006) that developed when they were students – for example, after “unhappy past mathematical experiences” (Bailey, 2014, p. 91). “Impoverished school mathematics experiences have left many pre-service teachers with strong *negative* affective responses about mathematics” (Namukasa et al., 2009, pp. 46-47), and this leads to a cycle of fear, failure and avoidance. Speaking of pre-service teachers, Perry (2007) reported findings that “provide some evidence that a mismatch between the personal achievement goals of students and the classroom goal orientation result in lower confidence in learning mathematics and therefore, higher levels of mathematics anxiety” (pp. 136–7).

Mathematical autobiographies have been used by U.S. researchers as a tool to encourage reflection. Ellsworth and Buss (2000) collected autobiographies from 61 pre-service teachers studying elementary education methods classes. They identified five themes: the powerful effect of teachers, both positive and negative; the impact of family members on attitudes towards mathematics and science; and three facets of the ways mathematics was presented (relevance, comprehension, and emphasis on skills and memorisation). These three facets included the importance of content being relevant to real life situations; the problem of comprehension versus coverage of content; and the effect of classroom emphasis on skills and memorisation, predominately in mathematics (p. 359). Sliva and Roddick (2001) identified five themes from the mathematics autobiographies of 72 pre-service teachers training to teach at primary, middle, and secondary level. They found that almost all students identified the role of

the teacher in the development of their mathematics understanding, placing them on a continuum from “enabling” (patient and understanding, giving full explanations and answers to student questions) to “disabling” (intimidating students, not fully explaining concepts or not considering students’ feelings); and many described a trend of fear, failure and then avoidance in their mathematics experiences. Brown and McNamara (2005) reported that teachers were often perceived as scary. The common factor identified in these studies was the impact of a teacher.

Cady and Rearden’s (2007) study found that 96 percent of the pre-service teachers indicated their mathematics teacher influenced their beliefs about mathematics: primary teachers were seen as having a positive influence on their beliefs while high school and college teachers were viewed as having a negative influence. Lipovec and Antolin (2014) reported that 214 third- and fourth-year Slovenian pre-service teachers’ mathematical autobiographies demonstrated a general pattern of positive mathematical experiences in elementary school, with feelings of competence beginning to be shaken in secondary school and then major turning points in upper secondary, resulting in fear, panic and lower grades. Teachers were the major focus of these reminiscences.

Other studies have identified negative interactions with teachers as responsible for the onset of maths anxiety (Di Martino & Sabena, 2011; Sloan et al. 2010). These may involve personal interactions with a teacher or problematic teaching strategies. Maths anxiety has been associated with the teacher’s attitude (Vinson, 2001). Cady and Rearden (2007) found that many students attribute their high level of anxiety to their prior experiences in mathematics and to their prior teachers (p. 243). Williams (1988) reported that maths anxiety has its roots in teaching and teachers and has been tied to poor academic performance of students, as well as to the effectiveness of elementary teachers. In many cases, a “disabling” teacher plays a powerful role in its development; for example, Hauk (2005) analysed 300 college students’ mathematics autobiographies and found that more than half of non-maths majors (including future school teachers) reported that teachers were boring, discouraging or hampered their progress in mathematics. “In the classroom, math anxiety has been linked to teachers who are hostile, hold gender biases, are indifferent, or who embarrass students in front of peers” (Vukovic & Harari, 2013). Lutovac and Kaasila (2011) described an autobiographical interview with a Finnish pre-service teacher, Ulla, about learning mathematics at

school. In this interview, they identified three grades during her primary and high school experiences in which each time the teacher was the main character in her memories of negative experiences.

Maths anxiety has been associated with inappropriate teaching practices (Hasbee, Sam, Nur & Tan, 2009); such as assigning the same work to everyone in the class (Oberlin, 1982); and use of maths as punishment (Sheila Tobias, 1978). Cornell (1999) examined sources of frustration and failure reported by U.S. pre-service teachers, who were divided evenly between those who had liked and disliked mathematics. They identified factors that impaired their learning as: teachers' assumptions of students' knowledge; incomplete instruction and overemphasis on rote learning; frustration at not being able to keep up with the class; mathematical language and obscure vocabulary; and lack of links to the real world.

Research conducted in different countries has resulted in comparable findings. For example, Jackson and Leffingwell (1999) collected "worst mathematics experiences" from U.S. pre-service teachers and found that they included negative perceptions of the teacher as insensitive and uncaring, quality of instruction, gender bias, and being embarrassed in front of peers. In addition to these teacher-focussed experiences, they reported difficulty of material and experiences associated with tests. Also researching worst experiences, but in Turkey where "culture and atmosphere of the classroom are significantly different" (p. 313), Bekdemir (2010) found that, if Turkish pre-service teachers identified the worst experience in the classroom, it was related to negative experiences such as instructors' hostile behaviour, exam anxiety, inadequacy of instructors, peer pressure, negative attitude towards mathematics, insufficiency, student's personality type, difficulty of content, school, and surrounding context. Bekdemir (2010) examined classroom experiences described by pre-service teachers near the end of their course and reported "that the worst experience and the most troublesome mathematics classroom experience have a direct influence" (p. 311) on their maths anxiety.

There is some evidence that ability grouping in mathematics classes is associated with maths anxiety. Stoehr's (2017) study of three female pre-service elementary teachers' maths anxiety found that "all three reported feeling their earliest experiences with mathematics anxiety in relation to what they perceived as 'ability' grouping" (p. 81).

This relates to reports of the discomfort of being compared with other students. Similarly, Hannula et al. (2005) found that Finnish pre-service teachers had experienced anxiety during their schooling when they felt that they were being compared with other students and had avoided asking questions when they thought that they would be regarded as stupid by their peers.

Compared to the number of international studies, there have been relatively few studies of the causes of maths anxiety in Australian primary pre-service teachers. However, researchers have found teachers and teaching approaches have been identified consistently. Carroll (1994) and Smith (2003) reported case studies of causes of maths anxiety in individual pre-service teachers. Carroll's (1994) case study of one pre-service teacher's experiences learning maths identified the impact of social themes, as well as affective and cognitive themes. Her participant viewed teaching strategies, and embarrassment from teasing and laughing by her peers and siblings, as the source of her failure. Smith (2003) reported that a final year pre-service teacher's experiences in school mathematics affected her beliefs and attitudes towards her future teaching of mathematics, even at the end of her course. In a study of 16 Australian pre-service teachers, Uusimäki (2004) found that most of their maths anxiety could be attributed to experiences in primary school. She also identified initial teacher education programs as sources of maths anxiety. In previous small studies by the researcher (Wilson, 2007; Wilson & Thornton, 2007/2008), pre-service teachers attributed their maths anxiety to an interaction during their schooling. Boyd et al. (2014) found moderate correlation between two items from an *Attitude to Mathematics* survey: "struggled with mathematics at primary school" and "feel anxious about teaching mathematics" (p. 209) and reported that the most common external reason given for pre-service teachers' attitudes to mathematics was the teaching approaches to which they had been exposed in schools.

Many studies have identified interactions with teachers as responsible for onset of maths anxiety. Therefore "preservice teachers should receive instruction regarding the importance of establishing an emotional climate that is inviting and reassuring" (Sloan, 2010, p. 254).

2.5.3 Teacher education courses

Although research findings show that pre-service teachers come to their teacher education courses with existing maths anxiety, Uusimäki (2004) indicated that teacher education also may be a cause of pre-service teacher maths anxiety. Macnab and Payne (2003) studied the beliefs and attitudes of Scottish pre-service teachers, who thought of mathematics teaching as unexciting and difficult compared to other areas. They found that final year pre-service teachers had more negative views towards mathematics than those in their first year. Similarly, Beswick (2006), investigating attitudes and beliefs of pre-service primary teachers, reported a significant increase in two items “Mathematics makes me feel uneasy and nervous” and “The study of mathematics makes me feel anxious and nervous” after participants undertook two mathematics education units with an intervening practicum.

To provide a summary of the causes of maths anxiety identified in the literature, Table 2.2 lists some of the sources identified in studies from the last 20 years. It shows that there are significant similarities between the causes identified by these researchers. In particular, they emphasise the learner and their environment, and especially the role of the teacher.

Table 2.2: *Some causes of pre-service teacher maths anxiety identified by researchers*

Author date	Method/participants	Country	Causes
Harper & Daane (1998)	Interviews.	USA	Emphasis on right answers, timed tests, confidence levels
Jackson & Leffingwell (1999)	Worst mathematics classroom experiences, 157 senior level PSTs.	USA	Difficulty of material, teacher behaviour or verbal statements, gender bias, evaluation/tests
Trujillo & Hadfield (1999)	In-depth interviews, 5 PSTs with high maths anxiety.	USA	Self-perceptions, teachers, family influences, mathematics test anxiety
Hendershot (2000)	Interview and survey, college students including PSTs.	USA	Classroom event that triggered math anxiety
Ellsworth & Buss, (2000)	Mathematics autobiographies, 61 PSTs.	USA	Teachers, family members, attitudes towards mathematics and science
Kaasila (2007b)	Autobiographical narratives, 60 PSTs.	Finland	Impact of teachers
Sliva & Roddick (2001)	Mathematics autobiographies, 72 PSTs.	USA	Role of the teacher
Uusimaki (2004)	Online anxiety survey, 16 maths-anxious third year PSTs.	Australia	Experiences in primary school, Teacher preparation programs
Brady & Bowd (2005)	Open ended questionnaire, 238 PSTs.	Canada	Prior formal mathematics instruction experiences
Guillory Bryant (2009)	132 PSTs.	USA	Negative classroom experiences, negative societal stereotypes
Coppola et al. (2015)	Open ended questionnaire, 189 PSTs.	Italy	Teacher, innate characteristics, emotions caused by failure, disinterest in mathematics
Sloan (2010)	Interviews.	USA	Parental influences, negative school experiences, former maths teachers, low math achievement, test anxiety, lack of confidence
Bekdemir (2010)	Senior level PSTs.	Turkey	Instructor's hostile behaviour, examination anxiety, peer pressure, negative attitudes, difficulty of content
Lutovac & Kaasila (2011)	Autobiographical, narrative interview, second year PSTs.	Finland	Impact of teacher
Perry (2011)	Surveys, 384 PSTs from four universities.	USA	Mismatch between the personal goals of PSTs and traditional classroom goal orientation
Lipovec & Antolin (2014)	Mathematics autobiographies, 214 PSTs.	Slovenia	Teachers
Boyd et al. (2014)	Questionnaire and survey, 223 PSTs.	Australia	Teaching approaches at school, belief that not a maths person
Coppola et al. (2015)	"Crucial events," 145 PSTs' mathematical experiences.	Italy	Teachers, failure experiences
Stoehr (2017)	Personal narratives, 3 female elementary PSTs.	USA	Ability grouping

2.6 Previous approaches to addressing pre-service teachers' maths anxiety

Individual characteristics are important in considering the approaches that might be used to address primary pre-service teachers' maths anxiety. After interviewing five highly maths-anxious individuals who were identified by surveying 50 pre-service teachers about the sources of their maths anxiety, Trujillo and Hadfield (1999) suggested that one solution was not to require maths-anxious teachers to teach mathematics at elementary schools. However, in querying this solution, they commented that these pre-service teachers showed an awareness of their anxiety and a willingness to confront it, which demonstrated that they had potential to become effective teachers of mathematics. Similarly, in the case of a British pre-service teacher successfully completing a postgraduate certificate, Witt, Goode, and Ibbett (2013) identified that, although she was highly anxious, her dispositions, including determination to overcome her anxiety and commitment to her goal of becoming a teacher, were major factors in her success.

Sloan et al. (2002) studied pre-service teachers and found that global learners, who approach problems in an intuitive manner, had higher levels of maths anxiety. Although they could reduce their anxiety by avoiding traditional instruction, this is not always possible for pre-service teachers to avoid. Sloan et al. also emphasised the importance of pre-service teachers understanding that their eventual students will differ in learning styles and recognising the need for a repertoire of multifaceted instruction techniques to reduce the anxiety of their prospective students.

Reviews of approaches that have been tried in order to lessen maths anxiety include Hembree's (1990) review, which included the effects of "mathematics anxiety treatments" (p. 42). He reported that whole class efforts to improve performance such as curriculum changes were not effective in reducing maths anxiety. However, behavioural methods, such as desensitisation and cognitive-behavioural methods, such as restructuring of beliefs, decreased maths anxiety. Iossi's (2007) literature review identified different types of strategies for minimising adult maths anxiety. These include curricular and instructional strategies, along with other strategies that address affect, such as relaxation therapy and psychological treatment. Not all the curricular strategies mentioned (re-testing, self-paced learning, distance education, single-sex

classes, maths anxiety courses) are feasible for teacher education courses. Some institutions offer maths anxiety courses, either as units offered for credit by the faculty or counselling department, or as groups that meet weekly; although some have run long term, literature on their effectiveness is sparse (Iossi, 2007).

In summary, educators can address anxiety in pre-service teachers either by helping them to cope with or address their anxiety in the situation that causes the anxiety or by making the learning context less stressful for them. Both responses are contingent on the educator acknowledging the anxiety. There are two approaches that attempt to make the learning context more comfortable: implementing different curricular or instructional strategies, and affective strategies, each of which will now be discussed.

2.6.1 Approaches using curricular or instructional strategies

Various curricular or instructional strategies have been trialled. These have reported some successes. A number of studies have reported decreased maths anxiety after mathematics methods courses (Brady & Bowd, 2005; Dunkle, 2010; Gresham, 2007, 2010; Harper & Daane, 1998; Levine, 1993; Sloan, 2010; Tooke & Lingstrom, 1998). Researchers have examined a variety of strategies such as using children's literature (Ward, 2005), and manipulatives (Brady & Bowd, 2005; Vinson, 2001). Brown and McNamara (2005) reported that trainees' views of mathematics were repositioned by the different teaching styles used in their mathematics units in their course, compared to those they had experienced at school.

Over time, researchers have reported lowered pre-service teacher maths anxiety after units using a combination of strategies. These included: working with a partner, or in cooperative learning group or in centres, using manipulatives, and writing about mathematics in journals (Harper & Daane, 1998); working in groups and engaging with cooperative education methods (Hendershot, 2000); workshops with collaborative open-ended tasks and discourse (Uusimaki & Nason, 2004); and completing a methods course which focussed on developing conceptual knowledge and used concrete materials (Gresham, 2007).

Kaasila, Hannula, Laine, and Pehkonen (2006) reported on positive changes in four Finnish pre-service teachers' "views of mathematics" through reflection on the experiences of learning and teaching mathematics, including bibliotherapy by reading

mathematical biographies, exploring mathematics with concrete materials, and collaboration with a peer or working as a tutor of mathematics. More recent findings of decreases in maths anxiety were reported by Sloan (2010), with a methods course using manipulatives and peer teaching; Dunkle (2010), with a combination of strategies such as use of children's literature, use of manipulatives, teaching mathematical vocabulary, understanding standards, and practice teaching; and Jackson (2015), with teaching strategies using games, manipulatives and models. Bailey (2014) used mathematical investigations with pre-service teachers who had previously failed. She reported: "the time taken to examine past experiences, associated emotions, and consider beliefs and attitudes, was time well-spent" (p. 98). In the Australian context, Martin (2012) reported success with strategies that aimed to increase engagement and reduce anxiety in a first-year education unit that linked practical activities with theory. At the end of the unit, pre-service teachers responded positively to questions about changes in their feelings about, and confidence levels towards, teaching mathematics.

Although some studies have reported successes with methods that have a cognitive basis, this study focusses on affect, in line with Kagan's (1992) recommendation. Therefore, the remainder of the literature review will focus on strategies that principally address affect as these relate to this study.

2.6.2 Approaches using affective strategies

For some time, researchers have become increasingly aware of the importance of affect and have sought to identify methods to address maths anxiety, based on their understandings of the affective nature of maths anxiety. A number of studies using strategies that focus on affect to address maths anxiety and which have findings that recognise the contribution of affective factors have been reported. Examples are provided in Table 2.3.

Four key notions, *supportive environment*, *lessening physiological responses*, *psychological treatments*, and *reflective strategies*, seem to be important in effecting changes in maths anxiety; each of these will now be discussed.

Table 2.3

Strategies to address maths anxiety that focus on affect

Author date	Participants/method	Country	Findings
Carroll, 1994	1 PST Written reflections	Australia	Participant reported that she felt calmer and less stressed
Kaasila, 2002	32 elementary PSTs Bibliotherapy using 6 PST mathematical biographies	Finland	Changes in beliefs and teaching practices
Flores & Brittain, 2003	PST Reflective writing	USA	Exposure to familiar attitudes and experiences is beneficial
Uusimaki, 2004	16 female PSTs with high maths anxiety Investigated participants' feelings	Australia	Decrease in participant maths anxiety occurred when aware of reasons for their emotions.
Swars et al., 2006	28 elementary PSTs	USA	Need for PST to address past mathematics experiences
Kaasila, 2007a	Narrative inquiry using 4 PSTs mathematical biographies	Finland	Sharing experiences leads PST to change perspectives ("narrative rehabilitation", p. 211)
Lutovac & Kaasila, 2011	Case study 1 PST narrative rehabilitation and bibliotherapy	Finland	Alleviating PST negative view of mathematics.
Lutovac & Kaasila, 2013	Case study 2 PSTs narrative rehabilitation and bibliotherapy	Finland Slovenia	Usefulness of narrative tools for dealing with negative past, and increasing future confidence
Park, Ramirez & Beilock, 2014	80 students identified as high (HMA) or low maths-anxious	USA	Expressive writing before tests increased HMA students' test performance

Note: PST = pre-service teacher

Supportive environment. Wurf and Croft-Piggin (2015) construed lack of emotional engagement as anxiety in their study of Australian first year pre-service teachers. The existence of support networks was a pivotal theme reported by participants as a factor in completing their first year. This demonstrated the importance of social support from peers, family and lecturers.

Lessening physiological responses. Others have attempted to address the physiological symptoms by helping participants learn to relax. For example, Brunye et al. (2013) found that focussed breathing exercises were a useful practical tool before a test.

Psychological treatments. Several published analyses of research indicated the benefits of addressing affective responses. Hembree's (1990) meta-analysis of high school and post-secondary students (including pre-service teachers) found that psychological treatments such as systematic desensitisation, anxiety management training and Cognitive Behavioural Therapy (CBT) are highly successful in reducing maths anxiety levels. CBT (see Hardy, 2014) is based on the relationship between thoughts, behaviour and emotions and proposes that thoughts directly influence feelings, and thence behaviours. CBT is often used because it enables individuals to change the way that they think without having to change the environment. One area of CBT that has been effectively employed in reducing maths anxiety is cognitive restructuring. Cognitive restructuring is the process of replacing negative thought patterns with constructive thoughts.

Reflective strategies. Firstly, there is the issue of awareness – it is important that pre-service teachers examine their own maths anxiety and its origins. Martinez and Martinez (1996) concluded from a review of the literature that it is crucial to assist maths-anxious pre-service students to become aware of their learned negative beliefs and emotions about learning mathematics, and that self-monitoring these emotions allows them to overcome and control maths anxiety. This is important because beliefs are often contradictory and persistent. Similarly, Seaman, Szydlik, Szydlik, and Beam (2005) identified contradictions in pre-service teachers' beliefs about the nature of mathematical behaviour that persisted throughout their program, concluding that teacher education programs should encourage students to reflect on their existing beliefs. Swars et al. (2006) concluded that “results of the interviews in this study seem

to suggest that preservice teachers need experiences within mathematics methods courses which address their past experiences with mathematics” (p. 311).

This fourth approach will be discussed in more depth. A significant area of research in recent years has been professional reflection. Mathematical autobiographies have been used to encourage reflection by pre-service teachers (Ellsworth & Buss, 2000; LoPresto & Drake, 2005; Sliva & Roddick, 2001). The researchers defended the validity of using these recollections, even though they admitted that they could be biased, on the grounds that it was the way that students recalled situations that had a profound influence on their current belief systems, even if their memories were not precise.

Evidence that reflections which assist in identifying and overcoming disparities in beliefs may lead to more comfortable feelings about mathematics has been reported by a range of international researchers. Buerk (1985) found that giving students the opportunity to reflect, on paper, on their feelings about mathematics and to acknowledge negative feelings and reactions relieved them and allowed them to move on. Hackworth (1992) suggested that discussing and writing about feelings towards mathematics would assist in reducing maths anxiety. This was supported by Carroll’s (1994) findings, that the pre-service teacher reported that she felt calmer and less stressed after writing reflections. Fiore (1999) reported that an adult student stated that writing about her maths experiences when she was a girl was a “catharsis for her” (p. 404). Similarly, Breen (2001) described the rationale behind the development of a non-traditional teaching model to address maths anxiety in South African pre-service teachers:

The overarching concern is to confront the huge degree of fear that is present in each class by drawing it out and getting students to engage with that fear rather than relying on old attitudes of accepting failure or escape into denial and further shame.
(p. 48)

The knowledge, insight, and understandings gained from the narrative renderings of the students’ experiences help to elucidate and clarify misconceptions, and thus provide an important way to reduce the accumulated beliefs and impressions gained from the apprenticeship of observation (Lortie, 1975). Flores and Brittain (2003, p.112) describe the use of writing “as a tool to help pre-service teachers reflect on their growth as they learn to teach mathematics”. They indicate that one of the benefits of sharing reflective

writing is that pre-service teachers are exposed to a range of attitudes and experiences that may be familiar. Namukasa et al. (2009) examined the affective responses of Canadian pre-service teachers completing a postgraduate teaching qualification who wrote reflections articulating their responses to being presented with non-routine problems and found changes in how they felt about learning mathematics. With respect to past experiences, reflective thinking is important for developing professional practice as it assists in the identification of the assumptions that underlie their thoughts and actions. When pre-service teachers “discover that the interpretations of events can be changed, it can free them to search for new perspectives on their mathematical past and future” (Kaasila, Hannula, & Laine, 2012, p. 991). Park et al. (2014) found that expressive writing by U.S. university students about their worries and concerns before a mathematics test boosted the performance of maths-anxious students. Beilock and Willingham (2014, p. 32) proposed a mechanism for this change: “writing is thought to alleviate the burden that negative thoughts place on working memory by affording people an opportunity to re-evaluate the stressful experience.”

Previous research by the author with small groups ($n < 20$) of pre-service teachers at two metropolitan universities has investigated the use of CIT and bibliotherapy to elucidate and address pre-service teachers’ maths anxiety (Wilson, 2007; Wilson & Thornton, 2006, 2007/2008). Participants identified interactions or demeaning encounters (often with a teacher) where they felt that they were identified or defined as persons who couldn’t learn mathematics or started to think of themselves as such. Steve Tobias, Serow, and Schmude (2010) identified “crucial moments” in the responses of 106 first-year Australian pre-service teachers which they defined as turning points; sharp increases or decreases in positive or negative feelings towards mathematics. They found that the most important positive or negative influence was the teacher.

Although these strategies were designed to find causes of maths anxiety, there was some evidence that there are benefits because they impact on maths anxiety. Loh (2014) used narratives with Singaporean pre-service teachers who wrote about a critical event in their own experience that connected to one of the unit readings. These functioned to enhance their understanding of themselves as future teachers, to reframe their experiences and “to accept that their previous perspectives may not have been the most appropriate ones” (p. 206). Coppola et al. (2015) studied “crucial events” in 145 Italian

pre-service teachers' mathematical experiences that they identified as significant for the development of their relationships with mathematics.

Bibliotherapy. Bibliotherapy can be a stimulus for reflective practices at both the pre-service and in-service levels (Morawski, 1997). The bibliotherapy process is an innovative way of eliciting pre-service teacher reflections. Previous small research projects (Wilson, 2007; Wilson & Thornton, 2007/2008) found that the readings provided a powerful element in addressing some of the anxiety felt by pre-service teachers. This led to a change in the way they perceived themselves as potential teachers of mathematics, termed “projective identity” by the authors (Wilson & Thornton, 2007/2008). The research literature supports the contention that conscious reflection on images that pre-service teachers bring to teacher education strengthens the development of teacher identity (McNay & Graham, 2007).

Not all pre-service teachers have the opportunity to participate in a unit focusing on students' learning difficulties in mathematics. In a small study ($n = 13$) to ascertain how bibliotherapy might be used during a mathematics unit (Wilson, 2007) the extent of voluntary take-up varied. Pre-service teachers who self-identified with high levels of anxiety showed a high level of engagement with the bibliotherapy process.

Concerned by findings that 20–30 percent of Finnish elementary school teacher students have negative Views of Mathematics (VOM) at the beginning of their studies, Hannula et al. (2005) sought to address this negativity in further research. They described an application of bibliotherapy during a mathematics education course. As pre-service teachers wrote their mathematical autobiographies, they read six mathematical biographies and selected the one that most closely resembled their own background (Kaasila, Hannula, Laine, & Pehkonen, 2008, p. 7). The authors concluded that pre-service teachers' identification with a peer with a similar background can significantly contribute to changes in their mathematical identity. In a more detailed report Lutovac and Kassila (2009) used narratives and bibliotherapy with pre-service teachers who had reported negative school mathematics experiences.

They concluded:

If students remember from their past mainly failure, and if they see only menace in their mathematical future, they unconsciously interpret their mathematical

autobiography from a viewpoint of a tragic story. When students reflect occasions and have an insight that the interpretation can be changed, it can free them to search new aspects into their mathematical past and future, and their self-confidence as mathematics learner and teacher might improve. (p. 357)

In continuing studies, Lutovac and Kaasila (2011) investigated the use of narratives in a mathematics education course as a way of alleviating a pre-service teacher's negative view of mathematics. They examined pre-service teachers' mathematical ability and developed a narrative form of rehabilitation and bibliotherapy in an effort to overcome mathematical anxiety (Lutovac & Kaasila, 2011). In an identity-based approach, they investigated past and future mathematical identities (Lutovac & Kaasila, 2013) and future-oriented mathematical identity work (Lutovac & Kaasila, 2014). During this time, Kaasila and Lauriala (2010, 2012) also identified positive changes in the views of pre-service teachers who had been exposed to bibliotherapy readings before their practicum.

Other researchers have stressed the importance of incorporating discussions and reflection into teacher education courses. Liu (2008) investigated the use of on-line discussions of anxiety towards teaching mathematics in methods courses, using a sample of 39 American elementary teacher candidates. After eight weeks of on-line discussion some aspects of their anxiety towards teaching mathematics were lessened.

There have been comparatively few studies on addressing maths anxiety in the Australian teacher education context, although issues of maths anxiety have been raised for several decades (Carroll, 1994; McCormick & Scott, 1993; Smith, 2003; Uusimaki, 2004), and especially in the last 10 years (Cooke et al., 2011; Cooke & Hurst, 2012; Perkins, 2016). Perkins (2016) reported on a pilot mentorship program that connects pairs of pre-service teachers with maths anxiety with individual experienced and skilled teachers, outside the practicum time. Participants reported feeling more comfortable and confident and having a reduction in stress after interactions with an expert teacher that did not involve the high stakes expectations of the practicum.

Although this section targets the literature on pre-service teacher maths anxiety, the author acknowledges that, because of its cyclic nature, the causes of maths anxiety in pre-service teachers are embedded in their schooling as students, and their maths anxiety has implications, not only for their teacher education course, but also has far-

reaching implications for their teaching. As previously discussed, Carroll (2005) illustrated the ongoing impact of these school experiences on Australian primary teachers who identified the contribution of their own school experience to their beliefs and negative emotions about mathematics. However, Hadley and Dorward (2011) found that, when elementary teachers exhibited higher maths anxiety, it did not necessarily mean that they felt anxiety about teaching mathematics. As maths anxiety increased, some teachers did show an increase in anxiety about teaching mathematics, but others did not. This attests to the complexity of this multivalent issue.

2.7 Conclusions

Many overseas researchers have contributed to the findings about pre-service teacher maths anxiety. The reports of findings have demonstrated consistencies for more than thirty years. This review and critique substantiate the need for further studies, particularly in the local context.

Although the preceding analysis has identified some consistent patterns from the results and conclusions of the research on primary or elementary pre-service teachers' maths anxiety, some factors must be taken into consideration when comparing these results:

- The different research reports are not based on consistent definitions of maths anxiety. These definitions are discussed in Chapter 3, Section 3.4, as part of the conceptual framework.
- A range of instruments has been used to assess levels of maths anxiety by these researchers. Although most of the surveys that have been used are based on the original MARS (Richardson & Suinn, 1972), some of these have different emphases. Others are based on the situation that causes a specific aspect of anxiety (e.g., Cavanagh & Sparrow, 2010). These instruments will be discussed in the Methodology chapter, Chapter 4, Section 4.6.
- There is not consistent agreement, based on the commonly-used scales, as to what constitutes “high” levels of maths anxiety, and in some cases the judgement is based on the mean score of the cohort rather than the descriptors of the scale.
- Despite the development of surveys in the 1980s that identified the multi-dimensional nature of maths anxiety, many researchers have continued to report

their findings on the results of overall maths anxiety levels, rather than analysing the effects of different factors.

- It is not known how the common view of maths anxiety as a negative attribute for primary and elementary pre-service teachers might influence researchers' interpretations of their results.
- In many studies, the participants are limited to pre-service teachers who have been identified with "high" levels of maths anxiety.
- There is a predominance of Western studies, particularly from the USA, and fewer studies that compare pre-service teachers from different cultures. There is a lack of studies that investigate cultural factors such as the importance of success in examinations.

In summary, maths anxiety in primary pre-service teachers has been identified over a long period of time as an important issue, with significant impacts on teacher preparation. Kagan (1992) reported that, despite completing coursework and practicum, pre-service teachers' images of themselves as future teachers and memories of themselves as pupils in classrooms remained unchanged during the pre-service program. Therefore, pre-service teacher education is a crucial site for further research. Maths anxiety has been long recognised and across many countries as a significant issue for teacher education. It seems non-contestable, in these circumstances, to take the advice of Hadfield and McNeil (1994) that prospective primary teachers should be tested for maths anxiety and have a plan developed to address it if it exists.

Furthermore, Wolodko, Willson, and Johnson (2003) wrote:

... our challenge is to help pre-service teachers confront their past experiences and anxieties about teaching and learning of mathematics. If these are openly dealt with during their university education, fewer teachers may be content to teach just as they have been taught. (p. 224)

Although extensive research has been done to identify the causes of maths anxiety in pre-service teachers, the issue persists. More research specifically focussed on addressing this maths anxiety would add to the repertoire of strategies available to teacher educators.

2.8 Progression of the thesis

The thesis consists of eight chapters.

Chapter 1 described the context, rationale, purpose, and potential implications of the research. It presented the global and educational framework. The purpose was to understand the impact of a bibliotherapy intervention to address maths anxiety on the mathematical identity of pre-service teachers. The research explores the use of bibliotherapy as a tool for reflecting on, and changing, affective responses to mathematics and enhancing primary pre-service teachers' projective identity. The research questions were then provided.

Chapter 2 presented a focussed review of the literature about pre-service teacher maths anxiety. The focussed literature review highlighted previous findings and previous research into means of addressing this anxiety.

Chapter 3 will present the conceptual framework. The extensive literature review aligns with the development of a conceptual framework which underpins the understanding of the research purpose (Section 3.2) and presents the theoretical framework for the research, along with its variables and limitations.

Chapter 4 will offer a justification and outline of research methodology. It will present an overview of the research design and discuss the theoretical framework for the research and its variables and limitations. A variety of tasks which purport to measure maths anxiety have been used in previous research, and this chapter will provide a justification for the research methods chosen including the choice of the RMARS (Alexander & Martray, 1989).

Chapters 5, 6 and 7 will provide the results and discuss findings as they relate to the broader research literature.

Chapter 8 will summarise the contributions of the research, and the implications for educational practice, and will make recommendations for future research.

CHAPTER 3: DEVELOPING THE CONCEPTUAL FRAMEWORK

Math anxiety appears to be a reaction to mathematical content, to some of its distinctive features as an intellectual activity and its connotative meanings for many persons in our society as well as a reaction to the evaluative form of mathematics tests. The science of mathematics, “being good” at math or liking it connotes certainty, perfection, high intelligence, genius, arcane wisdom, highly specialized knowledge remote from common sense, monotonous and mechanical problem solving, the key to ultimate truth, something antagonistic to humanistic values, the essence of practicality, something essentially irrelevant to everyday life, a characteristically masculine activity or a decidedly unfeminine activity – in varying and more or less consistent combinations of meanings. The nature and extremity of these meanings make it evident that mathematics and math tests have considerable potential for debilitating emotional arousal. They invite perfectionism, feelings of inferiority, and intense concerns about social and sexual acceptability, all reliable producers of anxiety and stress. (Richardson & Woolfolk, 1980, p. 271)

Overview

Chapter 1 explained that, although the global societal context is rapidly changing, mathematics retains an important place in modern society. Despite this, maths anxiety is a widespread and pervasive element of the global and educational context. Given the importance of mathematics, maths anxiety is a vital issue that needs to be addressed. Chapter 2 provided a review of research evidence of the impacts of maths anxiety in teacher education and the cyclic nature of its development.

The purpose of this chapter is to explain the conceptual framework which guides the methodological approach and through which the data will be observed and examined. Background concepts are analysed and supplemented in this chapter. It is structured in three parts:

- Firstly, the affective domain is described (Section 3.2).
- Secondly, the conceptual framework is developed. As Chapter 1 foreshadowed, research into the impacts of pre-service teachers’ self-images as learners and teachers of mathematics underpins this study. Therefore, an important focus of the conceptual framework (Section 3.3) is identity (Section 3.4).

- Thirdly, the concept of maths anxiety is elaborated, and the nature of maths anxiety and issues with the alignment of definitions of maths anxiety and strategies used in its study are discussed (Section 3.5).

In order to develop an appropriate and useful conceptual framework that is helpful to the investigation of the research problem, the author took into account the theoretical foundations, the philosophical perspective, the theoretical concepts, and the transformative view of the identity literature in education.

3.1 Introduction

This chapter aims to situate and justify the author's approach to the research questions presented in Section 1.5, namely:

1. With what range and extent of maths anxiety do pre-service teachers present?
2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?

It then foreshadows the need for the strategies to be described in Chapter 4.

As Chapter 1 indicated, this study is based on the philosophical stance that this research should not be defined by the widely-accepted assumption that maths anxiety is a negative attribute for pre-service teachers. This is common in the rhetoric surrounding this issue. Iossi (2007), for example, states that “math educators dream for the day when students can confidently say, ‘I enjoy math!’ This dream will only be realized when the entire educational community strives to prevent, recognize, and treat math anxiety” (p. 34). In addition, Belbase (2013) summarises “the consequences of being anxious toward mathematics, including the inability to do mathematics, the deterioration in mathematics achievement, the escaping of mathematics courses, the limitation of students in selecting college mathematics majors and related future careers, and the extremely deleterious feelings of guilt and humiliation” (p. 232). In fact, anxieties can have positive or negative impacts. They may promote progressive thinking when puzzling over interesting problems. However, anxiety is perceived by many as negative, associated with regressive thinking in which a person having anxiety avoids or gets rid of the problem (Belbase, 2013). These quotations show that the premise is of a problem and the language about maths anxiety commonly presupposes that it is something that needs to be “fixed”.

Many pre-service teachers come to their courses with existing issues of exclusion and non-participation in mathematics. The social construction of maths anxiety as invariably negative may impede their development and impact on their views of themselves as learners and potential teachers of mathematics. Learning about the latent negative impacts on their future students becomes, for them, a twofold setback. This thesis seeks to challenge the dominant mindset of the way in which maths anxiety in pre-service teachers is theorized and being open to exploring more positive constructions of how maths anxiety is experienced. This alternative mindset frames maths anxiety in pre-service teachers in a different light, for example, in terms of how maths anxiety might enable engagement and empathy with others. This is particularly relevant to pre-service teachers because of the implications of their future role.

Supporting the challenge to the idea of maths anxiety in pre-service teachers as uncompromisingly negative is the work of Yerkes and Dodson (1908). They demonstrated that moderate anxiety produces high performance, and that performance is curtailed, not only by high levels of anxiety, but also at low levels of arousal. This is shown by the classic inverted u-shape in Figure 3.1, demonstrating that both high and low levels of anxiety produce reduced performance.

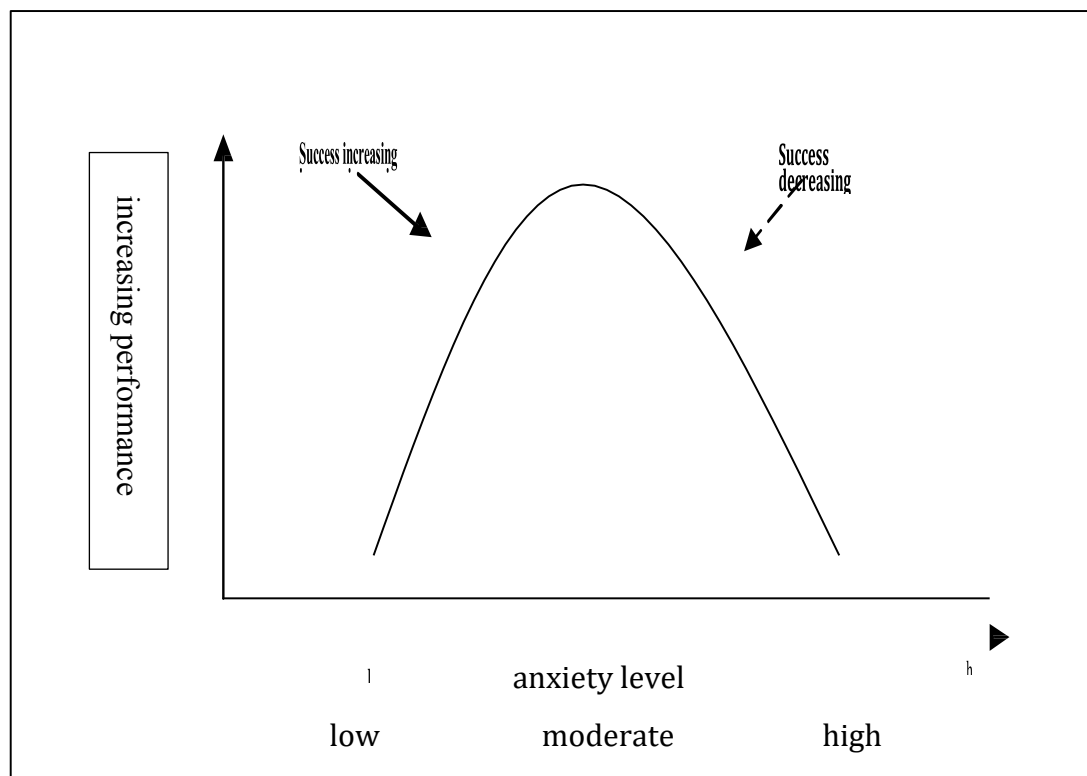


Figure 3.1 The Yerkes-Dodson Law – the relationship between arousal and performance (Yerkes & Dodson, 1908).

Chaman and Callingham (2013) reported that a degree of maths anxiety can yield stimulus and impetus. Where there is no interest, and arousal is low, there may be no anxiety, but performance is low. When students describe their affective relationship to mathematics, one of the most debilitating emotions, and one of the most commonly mentioned, is boredom (Brown, Brown, & Bibby, 2008) if students do not find mathematics stimulating. Maths anxiety is related inversely to the anxiety drive that facilitates evaluation performance as mild levels activate increased cognitive performance, but high levels are debilitating and disrupt performance (Alpert & Haber, 1960).

The philosophical perspective of this study reflects a socio-constructivist view of teaching and learning and emphasises the importance of reflective inquiry. The study views the addressing and amelioration of maths anxiety as identity development. The perspective of identity development emphasises the role that emotion, particularly maths anxiety, plays in the development of identity as a learner and potential teacher of mathematics, and in the transformation of identity. This transformative view sees reflection as a key element in teacher education. Morawski (1997) states:

Personal and professional transformation is a critical factor in teacher education, where intrapersonal awareness and growth need to become an integral part of the ongoing construction of knowledge and practice. In particular, teachers need to gain an understanding of their perceptions as well as the influence that these perceptions can have on their attitudes and actions in the educational setting. (pp. 255-6)

Martinez (1987) suggested that maths anxiety might have a more deleterious impact on learning than presumed deficiencies in curriculum or initial teacher education courses. Hence, increasing pre-service teachers' knowledge and understanding of the impacts of maths anxiety is a tactic to support them in developing empathy towards their future students. Accordingly, this study was located within the framework of the affective domain of mathematics education. The overall purpose of this mixed method study was to examine the use of bibliotherapy to address maths anxiety and its impact on the mathematical identity of pre-service teachers in an Australian university. For the most part, the conceptual framework, which will be presented in Section 3.4, relates to concepts of emotion and identity; it is based on a theoretical foundation that reflects the fundamental values, beliefs, assumptions and principles that underpin this study. The theoretical framework is founded on identity development and transformative learning. Identity is seen as a complex theoretical concept, having cognitive, emotional and constructive aspects (Grootenboer, 2009).

This study identifies pre-service teacher education as a critical stage in the context of identity development in young teachers. Identity is understood through stories (Bruner, 1987) which help them to interpret and make sense of their lives as they re-tell and re-live stories about their life experiences (Connelly & Clandinnin, 1990). This concept was developed as "telling identities" by Sfard and Prusak (2005, p. 14). Bunning (2007, p. 27) developed "storied identity" as a foundation of the conceptual framework that guided her study. The framework of identity as story is a usable and useful device for this study because it links the conceptual framework with the methodological approach; hence, the dual use of stories as both a conceptual construct and a method of data collection, in this thesis.

This research study seeks to illuminate the social and relational dynamics of pre-service teachers' experiences, as they explore new ways of understanding their feelings about mathematics, and to find ways to reduce the detrimental impacts of maths anxiety. It

explores the use of tools for identifying, reflecting on, and enhancing pre-service teachers' affective responses towards mathematics. As Farrell (2006) stated, research is needed, firstly to measure the amount of maths anxiety in pre-service teachers, and then to explore remediation techniques. Accordingly, this research firstly surveyed the levels of maths anxiety with which two cohorts of Australian first year primary pre-service teachers entered their education studies. Secondly, it examined the factors that they identified as impacting on their images of themselves as learners and potential teachers of mathematics, using CIT (Flanagan, 1954) and examined these for perceived causes of their maths anxiety. Thirdly, the research explored the impact of reading and reflections, using bibliotherapy (Crothers, 1916), on their anxiety towards mathematics. This process is important because it has the potential to change the way students feel about themselves, and think about themselves as learners and potential teachers, and so impact on their identity. The aim is to identify and to describe a process that other educators could adopt.

However, as this thesis will argue, addressing maths anxiety in pre-service teachers needs to go beyond minimising the pre-service teachers' own anxiety. It may not be possible for all maths-anxious pre-service teachers to eliminate their maths anxiety; indeed, this thesis argues that a more appropriate and desirable outcome for prospective teachers is to support them to deal with and harness their maths anxiety in ways that produce productive outcomes, both for themselves and for their future students.

3.2 The affective domain – background to the conceptual framework

This study is located within the affective domain of mathematics education. The affective domain encompasses values, beliefs, attitudes, and emotions and, therefore, includes cognitive and affective aspects. These aspects of the affective domain, along with dispositions, are integrated into the construct of identity. This thesis examines maths anxiety using a socio-cultural perspective, which relates to considerations of identity, equity, and the process of inclusion/exclusion.

To introduce the conceptual framework, the basic concepts comprising the affective domain will be explored, and interconnections between the basic concepts will be discussed. This will provide a rationale for the methodological approach.

Much of the research into the affective domain has used McLeod's (1992) framework which identified three major categories. These concepts of beliefs, attitudes and emotions in the learning of mathematics have been the subject of significant research for many years (e.g., Schuck & Grootenboer, 2004). According to Hannula (2012) "McLeod's framework became the norm in the field, and even today it provides a structure that can be used to synthesise much of the research that has been completed around mathematics-related affect" (p. 138). Underlying beliefs and assumptions, about both teachers and students, impact on the learning and teaching of mathematics. Based on McLeod's framework, Figure 3.2 summarises the relationship between beliefs, attitudes and emotions in mathematics education. In particular, it shows that these categories each have both a cognitive and an affective component.

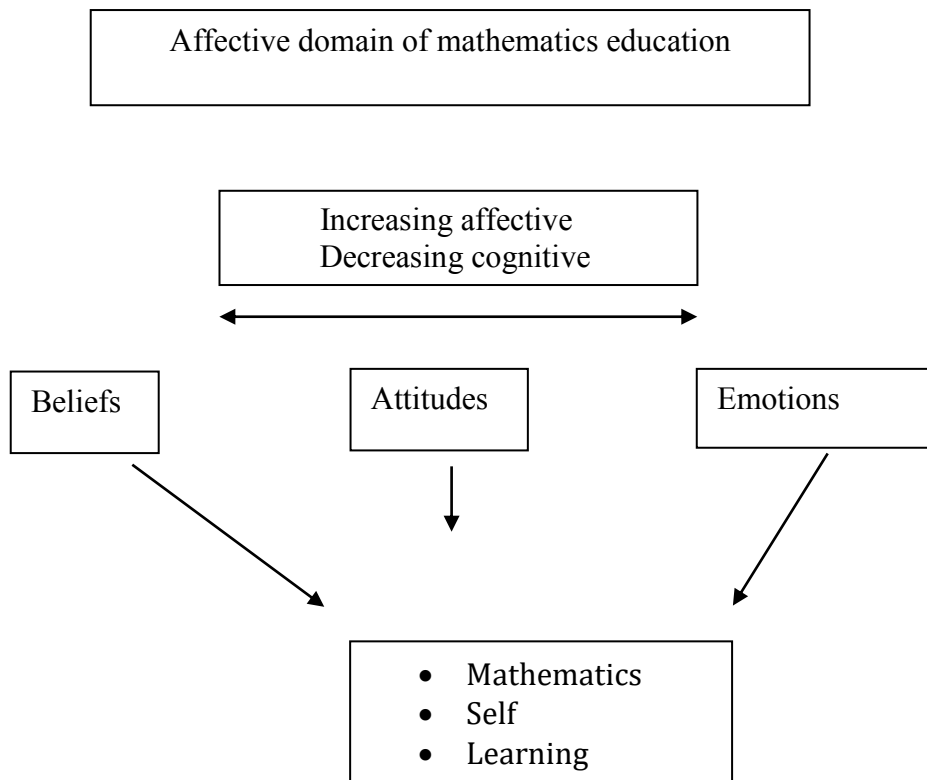


Figure 3.2 The relation between beliefs, attitudes and emotions (after McLeod, 1992).

3.2.1 Beliefs

Beliefs represent the understandings or premises a person holds about the world. According to researchers, (for example, Grootenboer, 2009), beliefs have both a cognitive and an affective dimension and are hard to change. They are generally based

on evidence, are held in good faith (Wilson & Cooney, 2002) and act as a regulating system (Hart, 2002). Dysfunctional mathematics beliefs relate to the scope and nature of mathematics activities and the nature and origin of mathematical knowledge (Borasi, 1990). Muis (2004), in a meta-analysis of 33 studies on students' beliefs, identified a common misconception that an above-average brain is required for success in mathematics and the school mathematics curriculum is not designed for students with average ability. Also, mathematics understanding requires a higher ability than other subjects do, requiring innate ability. Macnab and Payne (2003), studying the beliefs and attitudes of Scottish pre-service teachers, found that they thought of mathematics teaching as unexciting and difficult, compared to other subject areas. Beliefs about mathematics can result in emotional impacts. Buerk (1982) described mathematics-avoidant women who believed that being good at mathematics required being quick and competitive, and who still felt embarrassment years later when recalling experiences with timed tests or flash cards. She also reported that many students believe that mathematics is "only rules to be memorised, skills to be practiced, and methods to be followed precisely" and that their view of mathematics knowledge may be inconsistent with their general view of knowledge, causing discomfort because of these disparate views (Buerk, 1982, p. 19).

Previous research has focussed on how their courses impact on pre-service teachers' beliefs and attitudes (Chick, 2002; Frid, 2000; Szydlik et al., 2003). Many pre-service teachers enter teacher education programs with entrenched beliefs about mathematics and their ability to do mathematics and with well-established images of school (Vacc & Bright 1999). Because significant numbers of pre-service primary teachers approach mathematics with beliefs influenced by memories of unhappy school experiences (Boyd et al., 2014), investigating and addressing these beliefs during teacher education courses is vital. Borasi (1990, p. 179) emphasised "the key importance for students to *become aware of, and reflect on, their beliefs, as well as possible alternatives* [italics in original], since beliefs are more powerful the more they are held unconscious and unquestioned." Investigating pre-service primary teachers' perceptions of these experiences is also an important stage in addressing their potential anxieties about mathematics.

Studies of self-efficacy beliefs (Bandura, 1997) support the effect of internalisation of an individual's perceived ability to successfully perform tasks. Whether a person can perform a task is affected by how they feel about that ability, their perceived reality, and whether they ascribe failure to insufficient effort or low ability. Bandura (1997) identified the four main influences on self-efficacy beliefs as mastery experiences, verbal persuasion, vicarious experiences, and physiological arousal. Self-efficacy influences an individual's personal approach to mathematics. Based on Bandura's (1997) theory, Warwick (2008, pp 31–32) lists the four main areas of mathematical self-efficacy as comprising:

- performance experience derived from the level of success in mathematics where successful achievement strengthens self-efficacy, and repeated failures weaken it,
- vicarious experience obtained when students compare themselves with others on mathematics scores, which affects self-efficacy negatively or positively,
- verbal persuasion that relates to feedback from others on one's mathematical ability, and
- emotional arousal and anxiety about performance of doing/teaching mathematical tasks. Lower levels of anxiety are associated with increased self-efficacy and higher levels of confidence.

Self-efficacy beliefs are foundational. Pendergast, Garvis and Keogh (2011, p. 54) examined self-efficacy beliefs of pre-service teachers undertaking one-year graduate diplomas at an Australian university, at the beginning of their course, and were surprised at their high assessment of their teaching capabilities, considering their lack of classroom experience as teachers. These assessments were lower at the end of the course, after pre-service teachers had had practical experience in classrooms, and the authors raise concerns that “over-estimated levels of teacher self-efficacy can be detrimental” (p. 56). However, according to Grootenboer (2009) beliefs can be difficult to change.

In terms of the propensity to change their beliefs, Pajares (1992) has described pre-service teachers as “insiders in a strange land.” Pajares stated that, unlike medical or law students, for whom the process of defining new surroundings and recreating their world is not threatening as they do not hold strong prior expectations and allegiances,

pre-service teachers enter an environment that is familiar, and hence changing conceptions of teaching can be taxing and threatening.

Fullan (2001) has identified three primary elements fundamental to substantive change in educational institutions. They are new materials, new teaching approaches and alteration of beliefs. This study is relevant to the third aspect, that of changing beliefs. Change in the beliefs of Australian pre-service teachers has been studied by Beswick (2006) who collected true/false answers to a list of statements described as “maths myths” (p. 40). She reported difficulty in achieving lasting change. Christensen, Massey, Isaacs and Synott (1995), studying 20 Australian pre-service teachers, found that their beliefs about teaching were embedded in their beliefs about their own learning, indicating a need to address both of these in teacher education programs in order to facilitate change in their belief structures.

Kagan (1992) identified three conditions for changing beliefs: making personal beliefs explicit, challenging the adequacy of those beliefs, and providing extended opportunities to examine, elaborate and integrate new beliefs. Ambrose (2004) described four potential mechanisms for stimulating belief change that extended these conditions. These were:

- providing emotion-packed, vivid experiences that may leave a lasting impression,
- becoming immersed in a community and hence becoming enculturated into new beliefs,
- reflecting on beliefs so that hidden beliefs become overt, and
- developing more elaborated and less undifferentiated attitudes that help them connect beliefs.

Ambrose (2004) also identified a fifth strategy, that of reversing beliefs, noting it as being very difficult.

Strategies used in this research, such as the CIT (Flanagan, 1954) described later in this thesis in Chapter 4 (Section 4.6.2) which provided initial opportunities for reflection, and bibliotherapy (Crothers, 1916) meet Kagan and Ambrose’s criteria; together, they require participants to reflect on and describe their own vivid experiences, to articulate

their own beliefs and emotions about learning mathematics, and to reflect on how these were formed and on how they might impact upon their future as teachers of mathematics.

3.2.2 Attitudes

The word “attitude” is commonly used when something is regarded with favour or disfavour. Attitudes are affected by beliefs (Di Martino & Zan, 2010). Negative attitudes can be manifestations of feelings and emotions. Pre-service teachers display more negative attitudes to mathematics than do the general college population (Kelly & Tomhave, 1985). It is important that pre-service teachers learn mathematics content and pedagogical strategies, but their attitudes are also important as these influence instructional methods in their future classrooms (Malinsky et al., 2006) and can lead to maths anxiety in their students. Sweeting (2011) studied the critical influence of their own classroom mathematics experiences on the formation of attitudes of Australian Early Years teachers and concluded that tertiary institutions have a vital role in altering resultant negative attitudes. Young-Loveridge, Bicknell, and Mills (2012) studied mathematical attitudes of 248 New Zealand pre-service primary teachers beginning their course. They found that these pre-service teachers’ liking for mathematics had decreased from 76 percent (who said they had liked it in primary school) to 46 percent (who had liked it in secondary school). The authors reported that achieving high scores (over 90 percent) did not necessarily mean that pre-service teachers liked mathematics. More than 27 percent of the high scorers disliked it, mainly attributed this to secondary school experiences. The authors concluded that “secondary school experiences can be very powerful in shaping students’ views about mathematics” (p. 9). More recently, Itter and Meyers (2017) reported from their study of the attitudes of 152 third year pre-service teachers that nearly three-quarters of the “participants reported fear, loathing, and ambivalence towards mathematics” (p. 136).

Furthermore, with respect to attitudes, Di Martino and Zan (2010) have raised the issue of the positive and negative characterisation of attitudes. They suggest that an instrument consistent with an interpretive approach would give voice to participants by enabling them to identify “the aspects *they* [italics in original] considered relevant for their own experience with mathematics” (p. 32). The authors subsequently raise the issue of the dichotomy of positive/negative attitudes and assert: “Classic studies

regarding the relationship between attitude and achievement investigate the correlation between *positive* [italics in original] attitude and success” (Di Martino & Zan, 2015, p. 51).

3.2.3 Emotions

This thesis is underpinned by an appreciation of the importance of emotion as a determining factor in learning. Emotions are a major focus of the study. Emotions affect learning (Zan, Brown, Evans, & Hannula, 2006), cognitive processing and actions (Hannula, 2002), and can reify into more stable manifestations of hatred, anxiety and fear (DiMartino & Zan, 2012). Emotions involve physiological reactions. They also affect cognitive processing biasing attention and memory and activating tendencies towards action. Furthermore, emotions are functional, with an important role in coping and adaptation (DeBellis & Goldin, 2006; Hannula, 2002).

Research on teacher emotions is less extensive than that on teacher beliefs (Grootenboer, 2009). Emotions have a stronger affective element than beliefs and a less obvious cognitive aspect (see Fig. 3.2). They may be more temporary than beliefs as they are stored in episodic memory (Tillema, 2000). In mathematics education research in general, and in research on affect in particular, emotions remain a largely unresearched and not-well-understood construct (Liljedahl, 2014).

Emotions drive thinking in powerful ways. Emotion disrupts cognitive processes, but emotional confrontations also offer learning opportunities. Pre-service teachers learn when their beliefs, knowledge and skills are challenged in specific situations. The fact that such confrontations induce emotions underscores their personal and professional importance. Emotional responses are not determined by objective reality, but by *interpretation* of events – by subjective reality – and people make decisions based on their emotions. Emotions intensify memories. Identifying individuals’ emotions towards mathematics is as important as identifying their cognitive skills (Zambo & Zambo, 2006). Goetz, Pekrun, Hall, and Haag (2006) justify studies of emotions because of the direct relationship between emotional experiences and subjective well-being, the impact of emotions on learning and achievement, the influence of emotions on communication and teacher–student interactions in classrooms and the potential to develop theory-driven intervention programs to foster emotions, learning and achievement. From his research with pre-service teachers, Liljedahl (2014) concluded

that emotions are not simply fleeting abstract notions; by anchoring them in the phenomena that caused them, it is possible to show that emotions are robust and powerful contributors to future actions.

Bandura's socio-cognitive (1986) theory linked emotion to cognitive and motivational processes in learning, stimulating research on emotions. DeBellis and Goldin (1997) view emotions as a system that is highly connected with cognition as emotions are generated and guided by cognitive appraisals. Cognition interprets sensory information. The structural model of emotion, called the "transactional model of emotion" (Lazarus, 1991), is commonly used in education. The model and principles provide a framework for understanding the role of contextual and personal factors. Contextual factors include resources and constraints of the environment (social, material, temporal and spatial). Personal factors are individual and motivational features that influence values, beliefs, and goals and, also self-esteem and self-efficacy.

The transactional model links motivational, social, and cognitive dimensions, and suggests that emotions are based on the person's cognitive assessment of the situation and the meaning they assign to it (called an "appraisal pattern"). According to Lazarus (1991), a lived experience consists of contextual and personal factors, and the appraisal of these factors determines whether the event is primarily appraised as harmful or threatening (when the emotion will be negative), or challenging or beneficial (when the emotion will be positive). At the secondary level of evaluation, the person assesses the likely future outcomes and their coping strategies. Lazarus' model divides coping strategies into either emotion-focussed (perception that nothing can be done to modify a threatening or challenging event) or problem-focussed (the person appraises the situation as able to be changed and takes direct action).

Table 3.2 shows how the analysis of responses from Vandercleyen, Boudreau, Carlier, and Delens (2013, p. 10) based on the Transactional Model of Stress and Coping (Lazarus, 1991) can be applied to a situation involving a critical incident. For example, when incidents are perceived as a threat, the outcome can be a lack of action, leading to the emotion-focussed coping strategy of minimisation. In this situation, individuals feel inadequate, blame themselves and anticipate negative consequences; anxiety dominates the emotions, increasing the level of discomfort, which is resolved by avoiding the situation.

Table 3.1

Extremes on continuum of responses

Response	Emotion-focussed	Problem-focussed
Context or environment	Critical incident	Critical incident
Primary appraisal	Stressful Threat to well-being Situation can't be modified	Challenging Opportunity Situation is changeable
Emotion	Anxiety	Pressured/Motivated
Secondary appraisal – Blame	Blame self	No blame
Personal factors – goals	Unclear goals	Clear goals
Self-efficacy perception	Low self-efficacy	High self-efficacy
Coping strategies	Emotion focussed – lessening emotional distress, distancing, avoidance	Problem focussed – monitor/adapt/act
Orientation	Ego-defensive orientation	Task orientation
Secondary appraisal – Future expectancies	Negative expectations	Positive expectations

An anxious response to mathematics is a significant concern to educators, in terms of the research evidence that high anxiety will relate to avoidance of mathematics. “It is clear that there is a need to address these attitudinal, belief, and anxiety issues before expecting meaningful participation in mathematics activities” (Dogan-Dunlap et al., 2007, p. 1).

Certain situations can evoke anxiety in one individual but not in another. Izard (2007) proposed that *emotion schemas*, or “complex emotion-cognition-action systems,” as components of the regulation of emotions that are activated when an individual appraises a situation (p. 265). These schemas are shaped by previous experiences and cultural factors. Also relevant to appraisal is the role of attentional biases in making an anxious individual hyper-vigilant to threatening stimuli (Hofmann, Ellard, & Siegle, 2012).

Nussbaum (2001) contributed an integrated, complete framework for understanding the relationships between emotions, beliefs and values. She views emotions as appraisals or value judgements about important objects which are essential to a person's well-being, expressing this as: "this view holds that emotions are appraisals or value judgments, which ascribe to things and persons outside the person's own control great importance for that person's own flourishing" (Nussbaum, 2001, p. 4). The notion of well-being may offer a new way of recognising the importance of the emotional aspects of mathematics learning, and where the emotional can be the driver of affect and cognition. Clarkson, Bishop, and Seah (2010) use "mathematical well-being" to talk about students' affective constructs when asked to engage in mathematics education. The concept of "mathematical well-being" is constructed as an analytical framework which links the cognitive, the affective and the emotional aspects of students' mathematical educational experiences with a focus on students' values in their relationships with mathematics and mathematics education.

A person's awareness of their emotions is important. The concept of meta-affect was first described by DeBellis and Goldin (1997) as a way of understanding people's awareness of, and emotions about, their emotional states, and as a way of monitoring and regulating emotion. Goldin (2002) contrasted the young child's debilitating fear of the dark with the fear experienced on a rollercoaster, which, providing the person feels safe, enhances the thrill of the ride. He claimed that the different meta-affective states associated with fear arise from different cognitive beliefs and values. As Chapter 1 pointed out, it is a useful construct for an alternative basis of thinking about and theorising maths anxiety in a positive manner.

The addition of values to the affective domain framework (DeBellis & Goldin, 1997) is represented in Figure 3.3.

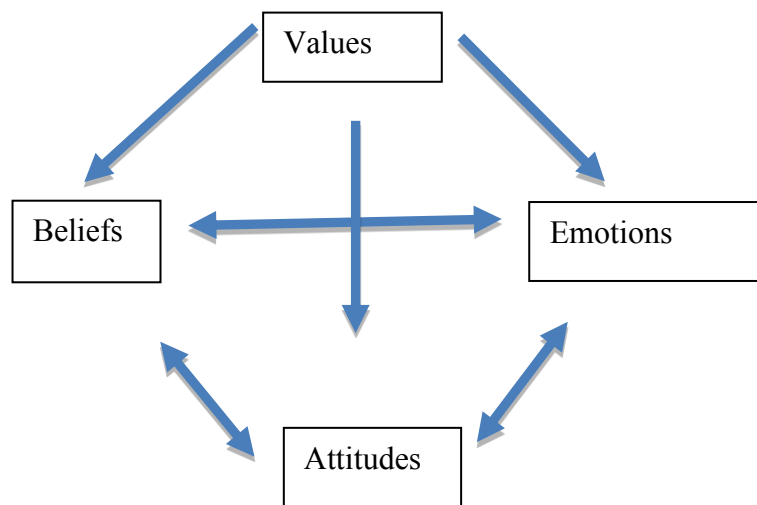


Figure 3.3 The affective domain incorporating values.

It should be noted that these concepts are not separate, but interwoven (Nussbaum, 2001). The double-sided arrows represent reciprocal relationships. Researchers have sought to represent the complexity of these interrelationships. In response to the diversity of definitions and the investigation of a range of concepts beyond those in McLeod's (1992) framework of beliefs, attitudes and emotions, Hannula (2012) reviewed theoretical approaches for research on affect related to mathematics and developed an 18-grid meta-theory for the affective domain that was based on three dimensions: aspects of affect (cognition, motivation and emotion), nature of affect (social, psychological and physiological), and stability (state or trait). This complex framework aims to add affective concepts such as values, identity and motivation to McLeod's framework. Whilst located within the complex framework of the affective domain, the conceptual framework for this thesis is founded on the unifying affective concept of identity.

3.3 Building the conceptual framework

The conceptual framework for this study is based on the affective concept of identity, which incorporates dispositions, orientations and emotions.

3.3.1 Dispositions

Dispositions, regarded as the natural qualities of a person's character, help to capture the complexity of the affective domain. In the United States, the National Research Council (2001a) has identified productive disposition as important for mathematical proficiency both for learning and teaching. "*Productive disposition* refers to the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics" (p. 131). Furthermore, motivation, a component of productive disposition, influences learning. The Council acknowledges that much of the research related to dispositions has not examined all the aspects of productive dispositions, (such as Dweck, 2016, and Johnston-Wilder and Lee, 2010) focussing rather on attitudes towards mathematics, and beliefs about the nature of mathematics and individuals' beliefs in their ability. Dweck's work on mindsets (Dweck, 2016) allows growth mindsets to feature productive disposition and task orientation; and Johnston-Wilder and Lee's (2010) construct of mathematical resilience encompasses a positive affective stance towards mathematics.

It is noteworthy that although the proficiency strands of the Australian Curriculum – Mathematics (ACARA, 2015) were informed by the proficiencies developed by the National Research Council (2001a), the proficiency of productive dispositions, was not included. Despite this, dispositions comprise an important element in the identity of pre-service teachers. For example, positive teacher dispositions include being accepting and encouraging. However, Katz and Rath (1985) report that poor teachers are described "in terms of such dispositions as impatience, remoteness, being rejecting, cold, and so forth" (p. 305). As Chapter 1 noted, the AAMT standards include Professional Attributes, which include positive dispositions, as an important aspect of teaching.

3.3.2 Orientations

Orientations, regarded as basic attitudes, beliefs or feelings towards something, have been investigated using different models. Schoenfeld (2015) regards orientations as including aspects of affect such as preferences, values, and habits of mind (p. 399). Dweck (1986) proposed two types of goal orientation, learning orientation and performance orientation, based on the distinction between a focus on learning or on

performance outcomes such as obtaining grades. VandeWalle (1997) conceptualised performance orientation as either demonstrating achievement or avoiding negative judgements or grades. Underlying beliefs and assumptions about mathematics learning and teaching professional knowledge and practice are important, especially if there is a mismatch of pedagogical assumptions and theories. Perry (2011), studying achievement goal orientations, used the terms mastery, performance-approach and performance-avoid. She identified the potential for a similar mismatch in pre-service teacher education, which, she claimed, could lead to “negative attitudes and the adoption of maladaptive performance-avoid goals” (p. 1). Lehtinen, Vauras, Salonen, Olkinuora, and Kinnunen (1995) developed a theoretical model of school student coping strategies, the Socio-emotional Orientations Model of learning orientations, comprising task orientation, ego-defensive orientation and social-dependence coping. Lazarus’ (1991) extremes of problem-focussed or emotion-responses align with the first two of the three categories of socio-emotional orientations respectively. Task orientation is dominated by an intrinsically motivated tendency to explore and master the challenge and demands of a learning task. In contrast, ego-defensive orientation is dominated by self-defensive and self-protective motives. In this case, sensitised to the threat of failure, the student does not concentrate intensively on the task and may try to compensate with other tactics. Roth and Walshaw’s (2015) comparison of two students’ behaviours also illustrates these orientations: one persists in the face of frustration in a mathematics class, but another puts her head down on her arms and disengages from the task, stating that she will never understand. According to Kaasila et al. (2006), the model of socio-emotional learning orientations as task, ego-defensive or social-dependence (Lehtinen et al. 1995) describes how such dispositions develop.

3.4 Identity

The above concepts are interrelated, and a focus on identity enables them to be considered together. Grootenboer and Zevenbergen (2008, p. 248) contend that “it is essential that teachers of mathematics (at all levels) have well-developed personal mathematical identities.” In order to achieve this, it is important as Walshaw (2004) argued, that: “teacher education must engage the identities of pre-service students” (p. 557). Lerseth (2013), in her study of identity development in pre-service teachers, concluded that the continuum of identity is individual and “each student’s path to identity development is individual and personal” (p. 129). She recommended

“providing the space, time, and experiences to allow pre-service teacher candidates to examine their own personal identity and the growth that they need to make individually” (p. 129)

The construct of identity connects the affective framework to the research on maths anxiety. As Grootenboer et al. (2006) have indicated, identity is a term that is used by researchers from a range of perspectives and is seen as a multifaceted construct. Gee (2001), for example, listed four ways to view identity, as:

- developed from natural forces (Nature-identity),
- authorised by an institution (Institution-identity),
- recognised in dialogue with other individuals (Discourse-identity), and
- shared practice with a group (Affinity-identity).

Socio-cultural models of identity propose that identity is located both within and external to the individual, developed by social and cultural practices (Grootenboer, Smith, & Lowrie, 2006). Thus, identity links the individual with the social and cultural. Hence, identity can be examined within and externally. Furthermore, identity can be viewed as “how individuals know and name themselves ... and how an individual is recognised and looked upon by others” (Grootenboer et al., 2006, p. 612). Akkerman and Meijer (2011) summarise the characterization of identity in terms of multiplicity, discontinuity and social nature. These characterisations “stress that identity is not a fixed and stable entity, but rather shifts with time and context” (Akkerman & Meijer, 2011, p. 309).

Emotions connect people’s thoughts, judgements, and beliefs and thus emotion is central to the construction of identity. Hence, identity is associated with pre-service teachers’ beliefs, attitudes and emotions, and affects their ability to teach effectively. These are not separate but interact. Grootenboer and Zevenbergen (2008) summarise: “identity is a unifying and connective concept that brings together elements such as life histories, affective qualities and cognitive dimensions” (p. 243). There is thus a strong link between memory and identity. People’s current self-views are influenced by how they recall previous episodes in their lives. In this way, reconstructed evaluations of memories play a role in the construction of identity (Wilson & Ross, 2003).

In discussing teacher education, Beauchamp and Thomas (2009, p. 176) point out: “discussion of emotion and identity, for example, overlaps with discussion of the self and also with discussion of the factors that enter into the shaping and the expression of identity.” They identify “the need to more effectively address identity as a component in teacher education” (p.176). Walkington (2005) advises that teacher educators “must seek to continually encourage the formation of a teacher identity by facilitating pre-service teacher activity that empowers them to explicitly build upon and challenge their experiences and beliefs” (p. 63). These statements support the concerns raised in Franzak’s (2002, p. 259) contention that “the development of a professional identity is best seen as a by-product of teacher education programs rather than a targeted outcome, at least from the student teacher’s perspective.” These researchers contend that transformation comes through the learning that takes place through this purposeful building upon, and challenging of, ideas. Hence, these comments indicate the importance of the development of mathematical identities during teacher education programs.

3.4.1 Mathematical identity

The way pre-service teachers perceive themselves is integral to their continued learning of mathematics and to their future teaching. Mathematical identity encompasses beliefs, attitudes, emotions and dispositions about and towards mathematics (Grootenboer & Zevenbergen, 2008). Lutovac and Kaasila (2014, p. 131) explain that they “see narrative mathematical identity as a product of reflective processes: as such, it changes over time and is constantly under construction.” Pre-service teachers construct a professional identity (Vloet & Van Swet, 2010) through engagement that is consistent with their perception of their personal capabilities. Their views of themselves as learners of mathematics impact on the identities they construct. The work of Mendick, Moreau, and Epstein (2009) shows how “a position as mathematically able confers an identity as different and special” (p. 72). Successful students construct identities of being “special and rare”, (p. 72), and societal discourses of “specialness” (p. 81) maintain boundaries around the ability to do mathematics.

Pre-service teachers’ identities are shaped by their perception of their capacity to perform in mathematical contexts. Mahlios (2002) emphasised that teacher educators need to be aware of the images pre-service teachers bring with them and explicitly

address these. The way individuals perceive themselves as learners of mathematics is integral to their subsequent identity as teachers. With respect to long-term outcomes, a positive identity is also important for addressing the international issue of falling numbers of teachers of mathematics, identified in Chapter 1 as Kardos and Johnson (2007) contend that a strong professional identity contributes to teacher retention.

For the purposes of this thesis and the investigations of how previous research might be extended, Gee's (2001) view of identity as "recognised in dialogue with other individuals" will be further explored. One way that identity can be viewed is in terms of the narratives that teachers create to explain themselves and their teaching lives to both themselves and to others (see Connelley & Clandinin, 1990; Sfard & Prusak, 2005). Connelly and Clandinin (1990) see education as "the construction and reconstruction of personal and social stories" (p. 2). People often develop their sense of identity by seeing themselves as protagonists in different stories. Sfard and Prusak (2005) define identities as stories about people, especially narratives that are reifying, endorsable and significant. Reification is indicated by verbs such as "be", "have" or "can" (as opposed to "do") and with adverbs that indicate repetition such as "always", "never" and "usually". Sfard and Prusak (2005) divide identity narratives into actual identities and designated identities. *Actual identities* are identities told in the present tense, stating the current ideas, whereas *designated identities* are those expected or desired to become actual identities in future and influence one's actions. They are usually told in the future tense with words expressing wishes, commitments or necessities. They state: "identity talk *makes us able to cope with new situations in terms of our past experience and gives us tools to plan for the future* [emphasis in original]" (p. 16).

In the same way, storied identities have developed through pre-service teachers' own mathematics learning experiences. Reliving these experiences in telling the stories of these experiences may begin the process of changing their identity. Doyle and Carter (2003) argue that, in order "to understand pre-service teachers' development, it is necessary to capture the stories within which this knowledge and understanding are embedded" (p.131).

Because these are personal stories, they involve the emotions of pre-service teachers. Bunning (2007, p. 47) states "emotions, being very personal and intense, play a key

role in the development of storied identities and thus have an important effect on the development of prospective teachers' mathematics teaching selves." The role of emotions in developing pre-service teachers' professional identity has been confirmed (Timostsuk & Ugaste, 2010). According to Alsup (2006), affect-related discourses help to "integrate personal and professional identities and beliefs, and heighten metacognitive awareness of self," and "engagement in transformative discourse was central to beginning the development of a professional identity" (p. 188) for the pre-service teachers in her study. She also suggests that forming a professional identity is pivotal to becoming an effective teacher.

Wenger (1998) focussed on the situated and social nature of identity, as something that individuals build within communities of practice. Boaler and Greeno (2000) described senior secondary students' "figured social worlds of the mathematics classroom" (p. 175), seeking their perceptions of the mathematics classroom environments in which they studied and the characteristics of mathematics in those classrooms. They described how these students positioned themselves within these figured worlds, calling these their "authored identities" (p. 183). Most saw themselves as receivers rather than creators of knowledge and saw mathematics as a set of rules to be followed. The students suggested that a certain type of person, one who is passive, patient and obedient, was likely to be successful at mathematics. Many students wanted to be able to express creativity and agency yet felt unable to do so in the reality of the mathematics classroom. However, they were able to articulate a "projective identity" (Gee, 2003), which contradicted their actual identity in the mathematics classroom. Studying video gaming, Gee (2003) identified the game-player's real-world identity, virtual identity and projective identity. He described how game players project their own values onto their virtual characters and see the characters as what they want to be and become. Gee suggested that projective identity creates ownership; players feel what it is like to have the capacity to be the sort of character they have created and built their character to be. This is a transformative experience, touching on beliefs and emotions as well as future actions. Similarly, McInerney (2004) described future-oriented students who "projected themselves into a college course and career" (pp. 164–165). Teacher educators report that pre-service teachers are engaged and motivated when using avatars in mathematics education units (Muir, 2012; Valcke, Van Steenbrugge, & Veeragoudar Harrell, 2008).

Previously the current author applied the concept of “projective identity” (Gee, 2003) to the development of primary pre-service teachers’ identity (Wilson & Thornton, 2007/2008). In keeping with the dynamic nature of mathematical identity alluded to previously, Figure 3.4 shows this relationship – where pre-service teachers project values and desires into their future as a teacher and see becoming a teacher as an ongoing process.

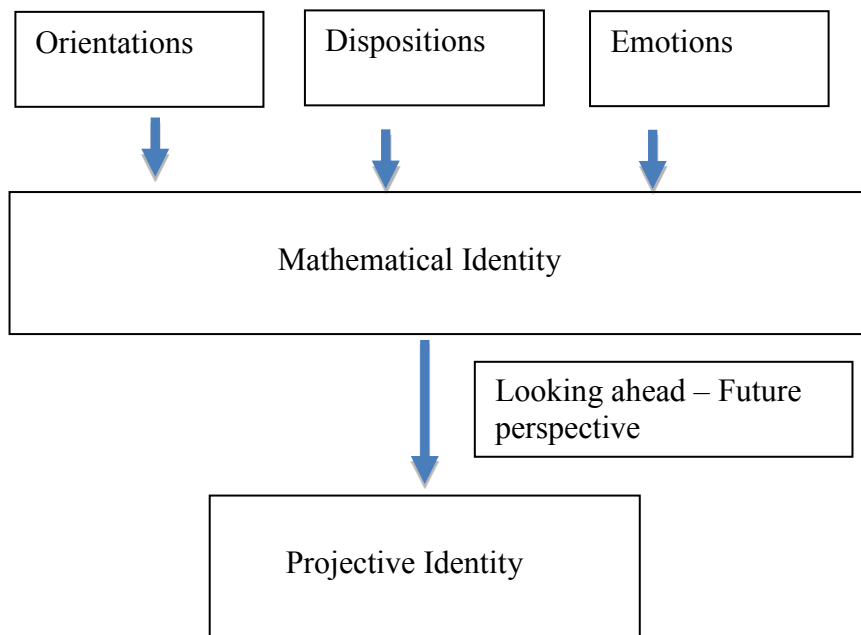


Figure 3.4 Identity and projective identity.

Identity, especially its past and present aspects, has been widely addressed in mathematics education research (Kaasila, 2007a). The future aspect, when exploring reflection and teacher identity however, has mostly been overlooked until recently (Di Martino & Sabena, 2011; Lutovac & Kaasila, 2013). Lutovac and Kaasila (2014) state that “when pre-service teachers’ identity talk is future-oriented, it reveals future-oriented reflection that projects a future identity” (p. 132). In this future orientation, Markus and Nurius (1986) state that people imagine themselves as they would like to become as well as avoiding unwanted aspects. Pre-service teachers’ identity includes their self-perception as learners of mathematics and looking ahead to “future selves” (Franken, 2002) as was shown in Figure 3.4. Walshaw (2004) captures the prospective and transformative nature of this shaping of identity, when she describes the journey of

a pre-service secondary teacher, Helen, who, “through a process of formation and transformation, finally at the end of the year, understood who she might become” (p. 563).

3.4.2 Views

Research into primary teachers’ effectiveness has emphasised the importance of deep and connected knowledge and a positive view of themselves as learners of mathematics (Askew et al., 1997). Nicol and Crespo (2003) found that elementary pre-service teachers’ images of themselves as mathematics teachers were closely related to their identities as learners and knowers of mathematics. A range of methods has been used to examine pre-service teachers’ views. For example, Utley and Showalter (2007) focussed on the teaching of mathematics and asked participants to draw and describe themselves teaching mathematics, in order to find out how American pre-service elementary teachers viewed themselves as mathematics teachers. They found that 64 percent drew a teacher-centred activity and 71 percent did not identify themselves as the teacher in the drawing.

According to Kaasila et al. (2006), their construct of “View of Mathematics” (VOM) is an important part of a person’s mathematical identity, consisting of the amalgam of one’s knowledge, beliefs, conceptions, attitudes and emotions. In VOM they distinguish three components: 1) The view of oneself as a learner and teacher of mathematics, 2) the view of mathematics and its teaching and learning and 3) the view of the social context of learning and teaching mathematics. This construct of VOM includes emotions about oneself as a learner of mathematics, making it relevant to this study. Hence, their construct informed the analysis of critical incidents in this study. It is described in more detail in Chapter 4.

3.4.3 Views, reflection, and transformative learning theory

The theoretical learning framework that informs this study is *Transformative learning* (Cranton, 2006). According to Cranton (p. vi), “Transformative learning is defined as a process by which previously uncritical assimilated assumptions, beliefs, values, and perspectives are questioned and thereby become more open, permeable and better justified.” It is a process of perspective transformation, which has three dimensions:

- psychological (understanding of self),

- convictional (belief systems), and
- behavioural (actions, lifestyle).

Reflection has connections and significance for emotional and social aspects of learning. Barth (2003) stated that the purpose of reflection is “nothing less than an internal dialogue with oneself. It is the process of bringing past experiences to a conscious level, analysing them, and determining better ways to think and behave in the future” (p. xxi). Researchers have suggested scaffolds to elicit detailed reflections. One such example is Gibbs’ (1988) reflective model, which can be summarised under six headings:

- (1) Description – what happened?
- (2) Feelings – what were you feeling?
- (3) Evaluation – what was good or bad about the experience?
- (4) Analysis – what sense can be made of the situation?
- (5) Conclusion – what else could you have done?
- (6) Action plan – if the situation arises again what would you do?

These will be further elaborated in Chapter 4.

The concept of reflection was extended by Mezirow (1991). Transformative learning is a process often studied within real life crises (Mezirow, 1991; Taylor, 2001) and Mezirow suggests that transformational learning results from a disorienting dilemma. Transformative learning links to concepts of “meaning making” and “critical thinking” of pre-service teachers, because:

Personal and professional transformation is a critical factor in teacher education, where intrapersonal awareness and growth need to become an integral part of the ongoing construction of knowledge and practice. In particular, teachers need to gain an understanding of their perceptions as well as the influence that these perceptions can have on their attitudes and actions in the educational setting. (Morawski, 1997, pp. 255-6)

Mezirow’s theory has been criticised for concentrating on the cognitive aspects of learning at the expense of emotional and social aspects (Taylor, 2001). Recent discussions have aimed at extending the view of transformative learning towards a more holistic, integrative, integral and comprehensive conception of learning (Gunnlaugson,

2007), because research has shown that emotions are an important factor in transformation and reflection (Taylor, 2001).

It is important that individuals change their frame of reference by critically reflecting on their beliefs and assumptions. Mezirow's theory concentrates on rational critical reflection but there needs to be emotional transformation as well. Any emotional transformation that involves undoing attitudes can be painful and emotional. In the past these individuals have developed attitudes to help them to cope, but now they are vulnerable, because they take risks to have attitudes and assumptions challenged. O'Sullivan (2003) explains:

Transformative learning involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. It is a shift of consciousness that dramatically and irreversibly alters our way of being in the world. Such a shift involves our understanding of ourselves and our self-locations; our relationships with other humans and with the natural world; our understanding of relations of power in interlocking structures of class, race and gender; our body awarenesses, our visions of alternative approaches to living; and our sense of possibilities for social justice and peace and personal joy. (p. 326)

Malinen (2000) acknowledged that the significance of emotions and feelings in learning has been missing from the theories of experiential learning, despite highlighting reflection as being at the heart of learning. Reflection relates to both the social and personal dimensions. In a social environment where there is support and acceptance for both challenging viewpoints and questioning assumptions, the risks of reflection can be mitigated by reducing the social risks and providing emotional support (Malinen, 2000; Mezirow, 1991). More public reflection may be oriented by the need for social acceptance and integration rather than the need to understand one's experience. Personal meanings are socially embedded and both social and cognitive dimensions are part of the emotional dimension.

The more one is able to reflect, and identify one's assumptions, the more one can be aware that, although the questioning of assumptions can feel like a threat to oneself, this questioning enables deeper understanding. This transforms one's "taken for granted frames of reference (meaning perspectives, habits of mind, mind sets) in order to make

them more inclusive, discriminating, open, reflective, emotionally capable of change, and reflective” (Mezirow, 2000, p. 8).

In their exploration of the development of professional identity, Vloet and Van Swet (2010) used biographical interviews in which the participant “reflects on his or her life-history and their whole career and focuses on meaningful so-called ‘critical’ experiences like stages, persons or events and on their influence in work and life” (p. 159). The identification of, and reflection on, critical incidents as a research method in this study will be described in Chapter 4.

The conceptual framework for the thesis draws these concepts together and relates them to maths anxiety in pre-service teachers. This framework is presented in Figure 3.5.

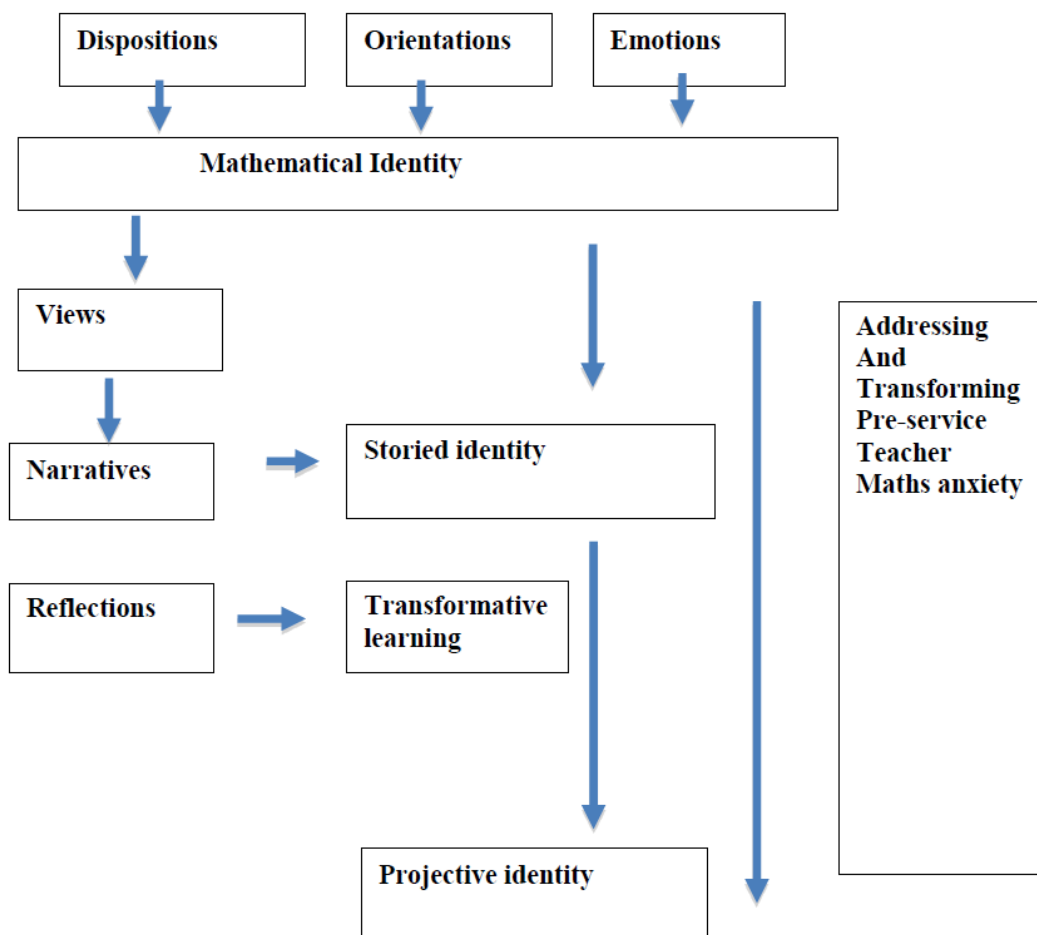


Figure 3.5 Conceptual framework for the thesis.

The conceptual framework illustrated in Figure 3.5 demonstrates how the future perspective of identity development, shown in Figure 3.4, is incorporated into the study. Addressing and transforming pre-service teacher maths anxiety is the major focus of this identity development throughout this framework. This process is shown by the participants' mathematical identity (revealed through their views), their storied identity (revealed through the narratives of CIT) and the transformation of their projective identity (resulting from their bibliotherapy reflections).

The penultimate section of this chapter will discuss the construct of maths anxiety as it pertains to this thesis.

3.5 Maths anxiety

Anxiety is commonly experienced. It “is a state of arousal that surfaces through bodily, emotional, and mental changes an individual undergoes when faced with a stimulus” (Ertekin et al., 2009, p. 1189). Anxiety can have negative effects on psychological health, learning behaviours, self-regulation, and academic achievement (Goetz et al., 2013).

3.5.1 The construct of maths anxiety

Chapter 2 reviewed the specific research literature on maths anxiety in primary and elementary pre-service teachers. There have been a number of reviews that deal with the broad field of maths anxiety. A review by Furner and Berman (2003) focussed on reviewing research on maths anxiety and school students' performance. As well, a general review of research on maths anxiety was produced by Ashcraft and Ridley in 2005. Recently, Gunduz (2015) reviewed the causes and neurological basis of maths anxiety, and Dowker et al. (2016) reviewed the last 60 years of research on maths anxiety. This review included definitions, measurement, impacting factors and treatment in adults and students. Although they commented on research involving teachers and students, which is relevant to the context of this thesis, they did not review research on pre-service teachers. In the same year, Suarez-Pellicioni, Nunez-Pena, and Colome (2016) produced a general review of the field that ranged from initial studies on the effect of maths anxiety on numerical cognition to recent neuroscientific research. They also examined proposed explanations for the impact of maths anxiety on performance. In 2016, Buckley et al. (2016) reviewed perspectives from education,

psychology and neuroscience to build understanding of maths anxiety. These reviews show that maths anxiety continues to cause disquiet in the research community.

Analysis of the PISA 2003 students' questionnaire data confirmed that maths anxiety was a construct distinguishable from maths self-concept and maths self-efficacy (Lee, 2009). Maths anxiety is a constructed concept, understood differently by various researchers and applied across a range of research settings. These researchers have sought to model and define different aspects of maths anxiety. Researchers who study maths anxiety have developed a range of definitions with a variety of emphases.

The literature on models of maths anxiety and factors that comprise maths anxiety are derived from research on how it is experienced and situations in which it is manifested. Among the early researchers of maths anxiety, Dreger and Atkin (1957, p. 344) identified "emotional reactions to arithmetic and mathematics". Richardson and Suinn (1972, p. 551) elaborated on these reactions as being "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations." Sheila Tobias (1978) reported that many students found it difficult or impossible to overcome the feelings of utter defeat associated with maths anxiety. These early researchers found that maths anxiety was characterised by negative feelings of tension and defeat.

Bessant (1995) identified maths anxiety as a multidimensional concept, having both cognitive and affective roots. The cognitive domain contributes to the learning-approach framework for exploring the students' difficulties in learning mathematics and for linking maths anxiety with evaluation of mathematical skills. The affective domain contributes to the framework for examining mathematics affect, attitudes and anxiety. Maths anxiety is commonly accepted as referring to feelings of tension and fear that interfere with mathematical situations in school and in everyday life. Other symptoms include nervousness, worrying, edginess, impatience, confusion, and developing a mental block. Vinson (2001) characterised maths anxiety in a number of ways, ranging from uneasiness when asked to perform mathematical tasks, to avoidance, feelings of physical illness, dread and panic. These researchers found that maths anxiety involved feelings that mathematics cannot make sense, of helplessness in the face of mathematics, and an inability to take control of one's own learning.

Maths anxiety is more than a dislike for mathematics (Vinson, 2001). It is a learned emotional response, with multiple symptoms, which include at least some of:

- physiological symptoms (e.g., nausea, sweating, rapid heartbeat, short breath, increased blood pressure),
- psychological effects including memory loss, paralysis of thought, lack of self-confidence, negative self-talk, and isolation,
- avoidance behaviours (e.g., excuses to miss mathematics class), and
- poor cognitive performance.

Theoretical models of maths anxiety have multidimensional forms that incorporate attitudinal (e.g., dislike), cognitive (e.g., worry) and emotional (e.g., fear) aspects (Cavanagh & Sparrow, 2010; Hart, 1989; Wigfield & Meece, 1988). An alternative approach has been to identify maths anxiety as a specific learning difficulty in mathematics (Dossel, 1993). This thesis interprets maths anxiety as a developmental impairment, rather than a clinical disorder. Baxter et al. (2014) tested the widespread perception that the prevalence of anxiety disorders is increasing and attributed this perception to factors such as the “use of terms such as anxiety and depression in a context where they do not represent clinical disorders” (p. 506).

Although there is a history of researchers referring to maths anxiety as a phobia, (for example, Lazarus (1974) referred to mathophobia, and Burns (1998, p. ix) characterised maths anxiety as a phobia “right up there with snakes, public speaking and heights”) maths anxiety is not listed as a disorder in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V). The 4th edition (American Psychiatric Association, 2000) used the term Math Difficulty (MD) to refer to poor achievement that could have a variety of causes including environmental causes such as poor instruction (Mazzocco, 2007). Mazzocco (2007) stated that MDs are common in university students and can affect their study and career choices. However, the latest edition of the manual, the 5th edition, (DSM-V), refers to Specific Learning Disorder, which is an overall diagnosis that incorporates deficits that adversely affect academic achievement (American Psychiatric Association, 2013). This includes detailed specifiers in the area of mathematics, but it does not refer to maths anxiety in the section on anxiety and phobias. Nevertheless, some publications continue to refer to phobia or mathophobia

when referring to maths anxiety. In this thesis, maths anxiety is not perceived as a clinical disorder and the terms “phobia” or “mathsphobia” will only be used in direct quotations from other authors.

Researchers commonly use Richardson and Suinn’s (1972) definition of maths anxiety. However, maths test anxiety is an important factor in maths anxiety, and Richardson and Suinn’s (1972) definition lacks any reference to anxiety caused by tests. Therefore, the author examined the dimensions of maths anxiety that have been identified in the research literature.

3.5.2 The dimensions of maths anxiety

The last section argued that maths anxiety is now regarded as a multidimensional construct, and this is the approach taken in this thesis. A range of surveys to measure maths anxiety were developed over the years. Factors contributing to the construct of maths anxiety were identified through surveys to identify situations that elicit maths anxiety, which meant the evolution from models assuming that maths anxiety was unidimensional (e.g., Richardson & Suinn, 1972) to a construct that was multidimensional (e.g., Alexander & Martray, 1989). The original Mathematics Anxiety Rating Scale (MARS: Richardson & Suinn, 1972) regarded maths anxiety as unidimensional. Since then, numerous studies (including further studies of the original MARS) have identified distinct dimensions using factor analysis (see Table 3.2 for a list of such studies in chronological order). In particular, factors involved with testing or evaluating mathematics have been recognised as important factors.

Table 3.2

Dimensions that comprise the construct of maths anxiety

Authors	Survey	Dimensions
Richardson & Suinn, 1972	Mathematics Anxiety Rating Scale (MARS) 98 items	Unidimensional
Brush, 1978	MARS 98 items	Evaluation anxiety Problem-solving anxiety
Morris, Kellaway, & Smith, 1978	MARS 98 items	Maths test anxiety Math class anxiety Math studying anxiety
Rounds & Hendel, 1980	MARS 94 items	Maths test anxiety Numerical anxiety
Resnick et al., 1982	MARS 98 items	Evaluation anxiety Social responsibility anxiety Arithmetic computation anxiety
Plake & Parker, 1982	MARS-R 24 items	Mathematics evaluation anxiety Learning mathematics anxiety (related to studying statistics)
Alexander & Cobb, 1987	MARS 98 items	Mathematics test/course Anxiety Numerical task anxiety.
Alexander & Martray, 1989	Abbreviated MARS (RMARS) 25 items	Mathematics test anxiety (MTA) Numerical anxiety (NA) Mathematics course anxiety (MCA)
Bessant, 1995	MARS 80 item version	General evaluation anxiety Everyday numerical anxiety Passive observation anxiety Performance anxiety Mathematics test anxiety Problem-solving anxiety
Kazelskis, 1998	Review of MARS-R (Plake & Parker, 1982), MAS (Betz, 1978), and Mathematics Anxiety Questionnaire (Wigfield & Meece, 1988)	Mathematics test anxiety, Numerical anxiety, Mathematics course anxiety, worry, Positive affect toward mathematics, Negative affect toward mathematics.
Hopko, Mahadevan, Bare, & Hunt, 2003	Abbreviated Mathematics Anxiety Scale (AMAS) 9 items	Learning mathematics anxiety (LMA) Mathematics evaluation anxiety (MEA)
Suinn & Winston, 2003	MARS- 30 item (MARS – S, MARS-SV)	Mathematics test anxiety Numerical anxiety
Baloglu & Zelhart, 2007	Revised MARS (20 items from RMARS Alexander & Martray, 1989)	Mathematics test anxiety Numerical anxiety Mathematics course anxiety

(continued)

Authors	Survey	Dimensions
Baloglu, 2010	Turkish version of MARS-SV (Suinn & Winston, 2003)	Mathematics test anxiety Mathematics course anxiety Application anxiety Social anxiety Computation anxiety
Wilder, 2012	MARS-brief (MARS –S Suinn & Winston, 2003)	Maths test anxiety Numerical anxiety Math learning anxiety Math grade anxiety

In an early review of the MARS (Richardson & Suinn, 1972), Rounds and Hendel (1980) identified mathematics test anxiety as a major component. Later Hembree (1990) and Brady and Bowd (2005) confirmed the contribution of mathematics testing to maths anxiety. Maths test anxiety has been incorporated into other definitions, such as Hembree’s definition as “a general fear of contact with mathematics, including classes, homework, and tests” (Hembree, 1990, p. 34). However, this definition focuses on academic situations and does not include the aspect of “ordinary life” (Richardson & Suinn, 1972) or the stress caused by being required to use mathematics in public (Sheila Tobias, 1981), both of which are important to the understanding of maths anxiety in terms of social justice and lifelong learning.

Factor analysis does not identify the definitive number of dimensions that comprise maths anxiety. It is not that there are two, three, or more underlying dimensions of maths anxiety, but rather a particular survey taps into that many. In other words, these are the dimensions identified by the survey, not necessarily all the dimensions that there are (Bessant, 1995). For example, the MAQ (Wigfield & Meece, 1988) does not identify mathematics test anxiety as a dimension. However, an examination of the items shows that only two of the 11 items refer to tests. Both refer to feelings, and those items load onto negative affective reactions in a two-factor analysis. This distinction is not always made in the literature. It needs to be emphasised that “the complexity of mathematics anxiety cannot be limited to factors identified in the MARS” survey (Bessant, 1995, p. 327). In addition, papers continue to present the results for total maths anxiety and not the separate dimensions. This is surprising in the light of the recommendation by Kazelskis et al. (2000) that, because of the substantial weighting of maths test anxiety in these surveys, researchers “would be well advised to use the individual factors of the measures rather than an omnibus total score” (p. 144); and Adeyemi’s (2015) recommendation that “research should also consider the multi-

dimensionality of mathematics anxiety as some groups of participants may experience mathematics test anxiety while others may have numerical task anxiety or mathematics course anxiety”(p. 135).

It is important to note that although numbers of dimensions varied, in almost every case maths test anxiety or mathematics evaluation anxiety was a dimension. The continued use of Richardson and Suinn’s (1972) definition of maths anxiety in a wide variety of studies using these surveys suggests that the instruments used to assess emotions lack consistency with the definition used. It is important that the definition and survey instrument take mathematics test anxiety (MTA) into account. As an example of a definition that includes MTA, Brady and Bowd (2005) state that maths anxiety combines “debilitating test stress, low self-confidence, fear of failure, and negative attitudes towards mathematics learning” (2005, p. 38). This supports Alexander and Martray (1989) who considered that “apprehension about taking math tests should be the most salient feature of a revised definition of math anxiety” (p. 148). This informed their choice of items, including items that assess anxiety in test situations, for the RMARS survey (Alexander & Matray, 1989).

3.5.3 The construct of maths anxiety in this study

This thesis argues that it is important to recognise that the negative construction of maths anxiety influences not only the way educators think about pre-service teachers with maths anxiety, but also the way these pre-service teachers think about themselves. Such labelling may have iatrogenic effects. The prevalent view that maths anxiety is a negative aspect that must be eliminated before pre-service teachers can become effective teachers of mathematics, can contribute to a double bind. There is evidence that pre-service teachers internalise these limiting notions of maths anxiety and that this impacts on their learning in initial teacher education courses and on their future teaching. Educators are attempting to address levels of maths anxiety in pre-service teachers but there is limited evidence that they are attempting to challenge the negative stereotypes of maths anxiety.

The current study aimed to investigate and highlight the potential for experiences of maths anxiety, when addressed, to be instrumental in the development of pre-service teachers’ effectiveness as teachers of mathematics. The author has followed Di Martino and Zan’s (2010) suggestion of choosing a functional definition of maths anxiety that

is assessed in terms of suitability to support the research questions in the interrogation of the specific research problem, as opposed to arguing for correctness of a particular definition.

Hence, this thesis regards maths anxiety as a multidimensional affective response to mathematics comprising cognitive, emotional, physiological, and behavioural dimensions which may include low self-confidence, fear of failure, stress in test situations, and feeling threatened when performing tasks in public. Maths anxiety manifests as a range of responses from discomfort and uneasiness to debilitating dread, panic, and paralysis.

3.6 Conclusions

This chapter firstly described the affective domain within which the study is situated in order to provide a background against which the conceptual framework was developed. An important focus of the conceptual framework is mathematical identity. In particular, the future focus is emphasised by the discussion of the concept of projective identity. This links with the research into the impacts of pre-service teachers' images of themselves as learners and teachers of mathematics discussed in the literature review in Chapter 2.

This framework provides the background against which the concept of maths anxiety used in this thesis was elaborated. It is important to clarify the nature and dimensions of maths anxiety to be used in the study as issues arise with the alignment of definitions of maths anxiety and the research methods used.

3.7 Progression of the thesis

The thesis consists of eight chapters.

Chapter 1 described the context, rationale, purpose, and potential implications of the research. It presented the global and educational framework. The purpose of the study, to understand the impact of bibliotherapy to address maths anxiety on the mathematical identity of pre-service teachers, guided the research questions.

Chapter 2 presented a focussed review of the literature about pre-service teacher maths anxiety, reviewing previous research into means of addressing this anxiety. The focussed literature review highlighted previous relevant findings.

Chapter 3 presented the conceptual framework, which underpins the understanding of the research purpose, and presented the theoretical framework for the research and its variables and limitations.

Chapter 4 will present a justification and outline of research methodology. It will offer an overview of the research design and discuss the theoretical framework for the research and its variables and limitations. A variety of tasks that purport to measure maths anxiety have been used in previous research and this chapter will provide a justification for the research methods, including the choice of the RMARS (Alexander & Martray, 1989).

Chapters 5, 6 and 7 will provide the results, and will locate findings in the broader literature.

Chapter 8 will discuss the connections between the results and the conclusions, summarise the contributions of the research, noting their implications for educational practice, and make recommendations for future research.

CHAPTER 4: DESIGNING THE RESEARCH METHODS

Affective issues play a central role in mathematics learning and instruction.... If research on learning and instruction is to maximize its impact on students and teachers, affective issues need to occupy a more central position in the minds of researchers. (McLeod, 1992, p. 575)

Overview

To this point in the thesis, the general issue of maths anxiety has been introduced in Chapter 1, and the current research on maths anxiety in pre-service teachers has been reviewed in Chapter 2. The concept of maths anxiety has been positioned in Chapter 3, in order to introduce the relevant concepts aligned with the theoretical work on maths anxiety and explain the conceptual framework for the thesis.

The purpose of this study was to investigate a way to address maths anxiety in pre-service teachers and to ameliorate its impacts on their mathematical identity. The methodology of the study ascertained how pre-service teachers in an Australian university perceived themselves as learners and future teachers of mathematics. It investigated strategies by which their maths anxiety might be addressed, by identifying insights into the impact of maths anxiety on their mathematical identity. It examined the impact of bibliotherapy on primary pre-service teachers' affective responses to mathematics, especially the factors that temper their maths anxiety, to ascertain how the use of bibliotherapy changed their mathematical identity. To address the research questions, the researcher adopted a mixed methods approach.

This chapter defines the range and scope of the study and explains and justifies the research design and methods used for investigating the research questions. The following outline presents the structure of the chapter:

- details of the research questions and the philosophical, conceptual and theoretical foundations (Sections 4.1, 4.2, and 4.3),
- explanation of the methodology used to undertake the research and ethical considerations (Section 4.4),
- description of the setting, participants and sample (Section 4.5),

- details of the instruments used for data collection, including a clarification of terms used and an examination of the instrument used to measure maths anxiety, continuing with the justification for each of the methods (Section 4.6),
- details of the mixed methods approach used for data collection and analysis (Section 4.7),
- details of the data analysis (Section 4.8),
- discussion of the validity and reliability of the data collection and analysis instruments, and presentation of appropriate criteria to ensure trustworthiness (Section 4.9),
- summary of the chapter (Section 4.10), and
- progression of the thesis (Section 4.11).

4.1 Introduction

The methodological approach was developed to reflect the conceptual framework. Based on the conceptual framework and methodological approach the author designed data collection methods that would collect multiple forms of data. These were designed to focus on maths anxiety and identity formation in pre-service teachers; and, at the same time, to allow the affective domain to be accessed and acknowledged. This study involved a multiphase mixed method based on an exploratory sequential design (Yin, 2006). Both quantitative and qualitative data were collected in the participants' settings, and analysed from the subjective perspectives of the participants, using their own words. The participants were pre-service teachers studying Bachelor of Education (Primary) degree courses at two campuses of an Australian university. One was a large metropolitan campus and the other was in a regional city.

4.2 Aims of study

The purpose of this study was to investigate a way to address maths anxiety in pre-service teachers and to ameliorate its impacts on their mathematical identity. This study aimed to elucidate the phenomenon of maths anxiety, as manifested by pre-service primary teachers, through accessing the meaning that participants give to it. Connelly and Clandinin (1990) describe research as the development of a narrative with the "capacity to render life experiences, both personal and social, in relevant and meaningful ways" (p. 10).

4.3 Background to methodology

The theoretical framework of this study is a lens through which the issues and questions raised by the research are examined. It is, therefore, important that this be articulated before the methods of analysis are presented. Figure 4.1 shows a diagrammatic representation of the research process.

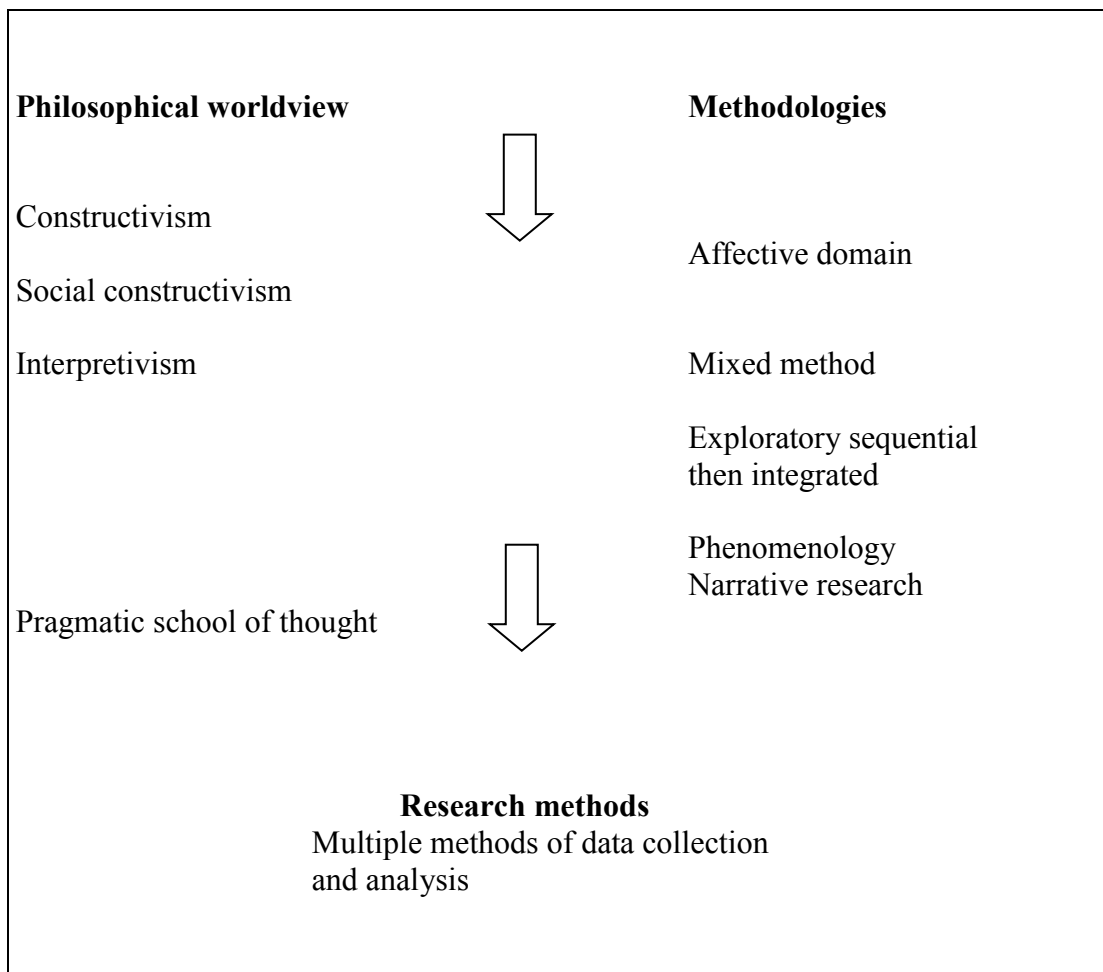


Figure 4.1 Research methods drawing on philosophy and research design.

The study was based within the constructivist ontology and the social constructionist epistemology (Creswell, 2013), because the area of interest was the pre-service teachers' self-reported anxiety. This research is informed by Vygotsky's sociocultural theory (Vygotsky, 1978). Differences in human actions, interactions and responses are ways that humans shape their world. People create and associate their own meanings for their interactions with the world; hence, "actions are embedded in interactions – past, present and imagined future" (Corbin & Strauss, 2008, p. 6). The study

investigates these perspectives. The research paradigm underpinning this study is interpretivism (Cohen, Manion & Morrison, 2007). Social constructivism combined with interpretivism, allows insight into lived experience from the point of view of the participants. It assumes that reality is socially constructed (Creswell, 2013). The interpretive tradition is characterised by the prioritising of lived experiences with a focus on the meaning of interactions and events. Cohen et al. (2007) describe the interpretive paradigm as being concerned with the individual; as seeking to understand subjective human experience, while retaining the integrity of the phenomena being investigated. The research begins “with individuals and sets out to understand their interpretations of the world around them” (p. 23). Denzin (2002) suggests that interpretive approaches allow the researcher to determine how individuals interact with experiences, and how they organise, perceive and construct meaning from them. One aim of this study was to investigate the experiences of participants during their mathematics learning and how they perceived and constructed meaning from these experiences. This fits into the interpretive tradition since that tradition is characterised by the prioritising of lived experiences, and assumes that reality is socially constructed, complex and continually changing (Glesne, 2011). The interpretive tradition recognises that there is not one truth, but the findings must be logical and plausible within the framework of the study. Therefore, an interpretive approach is appropriate for this thesis.

As shown by Figure 4.1, the methodology is drawn from the phenomenological tradition (van Manen, 1997). The researcher’s role is “accessing others’ interpretations of some social phenomenon and of interpreting, themselves, other’s [sic] actions and intentions” (Glesne, 2011, p. 8). The researcher attempts to understand a phenomenon by accessing the meaning that the participant gives to it, with a focus on the meaning of interactions and events. According to Glesne (2011), in addition to existing in the mind of the individual, these constructed realities are viewed also as social constructions, in that individuals’ perspectives interact. She concludes: “accessing the perspectives of several members of the same social group about some phenomenon can begin to say something about cultural patterns of thought and action for that group” (p. 8).

In this study, the researcher attempted to understand maths anxiety in pre-service teachers from their own perspectives and to identify what meaning their experiences had for them. The study aimed to access the narrative or storied nature of pre-service teachers' experiences, as narratives are important for meaning construction and identity. Connelly and Clandinin (1987) note:

narrative is concerned with specific, concrete events in a person's life and is concerned to give an account of a person. Furthermore, through the construction of personal philosophies, images and narratives unities, narrative method offers an interpretive reconstruction of parts of a person's life. (p. 134)

The study involved recollections of past incidents in pre-service teachers' lives. The specific method will be described in Section 4.6. Webster and Mertova (2007) discuss the emerging prominence of narrative in educational research as researchers acknowledge the narrative complexities needed to represent educational experience. They state: "stories allow us to watch what an experience can do to people who are living that experience" (p. 20).

The research methodology aimed to produce a description as well as an explanation of why things are the way they are and offer insights into what they could be, based on the interpretation of texts. Meaning and significance for the participants (as articulated by them) was used for the general abstraction of actions and interactions. Because this involved the generation of abstractions, it is suitable for a sensitive topic.

4.3.1 Research questions

The following research questions were investigated:

1. With what range and extent of maths anxiety do pre-service teachers present?
 - 1a. What are the indications for influences that have stimulated this anxiety?
2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?
 - 2a. For the pre-service teachers who participated in cognitive bibliotherapy, what were their responses?
 - 2b. For the pre-service teachers who participated in an interactive bibliotherapy workshop, what were their responses?

2c. What was the **immediate** and detectable change in their affect upon completion of the workshop?

2d. What was the **more lasting** impact of the interactive bibliotherapy on the pre-service teachers' maths anxiety?

4.4 Research methodology

The research methodology was designed to allow the researcher to explore the research problem of maths anxiety in pre-service teachers and provide insights into its significance for them.

4.4.1 Rationale for methodology

To elicit the participants' perspectives and gain understanding of their lived experiences, the epistemological framework of social constructivism (Creswell, 2013) was used. The methodology was from the phenomenological tradition of research. The research methodology was mixed method, drawn from the pragmatist school of thought (Dewey, 1933) because it allows integration of quantitative and qualitative methods. The pragmatic approach provides "justification for the use of mixed approaches to the degree that they work in practice and produce desired outcomes" (Christensen, Johnson & Turner, 2011, p. 381)

The researcher designed a mixed methods approach (Yin, 2006) including both quantitative (collection of survey data) and qualitative (CIT, bibliotherapy, and semi-structured interviews) methods. In arguing for a qualitatively driven approach to mixed methods approaches for researching lived experience, Mason (2006, p. 10) explains "social experience and lived realities are multi-dimensional and ... our understandings are impoverished and may be inadequate if we view these phenomena only along a single continuum."

Given the complex and multivalent nature of the phenomenon, and the aim of the study to access the narrative or storied nature of experience, it was appropriate that the mixed methods approach was qualitatively driven. Webster and Mertova (2007) explain: "stories are constantly being restructured in the light of new events, because stories do not exist in a vacuum but are shaped by lifelong personal and community narratives" (p. 20). The approach gives insight into lived experience from the point of view of the

participant and presents the researcher's own constructions as well as those of the participants. However, alongside the qualitative data collection methods used, quantitative methods provided important data. The quantitative research was appropriate because, through a survey, standardised items were used; the characteristics of a large sample were investigated; similar data were collected for groups that were separated geographically and temporally, and these could be compared across groups; and researcher subjectivity was reduced (Wallen & Frankel, 2001). The survey method allowed the contact by the researcher with the participants to be indirect, as did the design of the tutorial reflections.

The justification underlying the mixed methods research strategy is that integrating different methods has the potential to produce better results in terms of quality and scope and provides a more complete understanding of this phenomenon than would either method by itself. Methodological diversity also provides a way of increasing rigour, so a combination of methods was appropriate. This provided a means of triangulating data. There are benefits to drawing on both qualitative and quantitative research and minimising the limitations of both. Greene, Kreider and Mayer (2004). highlight five major purposes for mixed method design that potentially enhance the evaluation. Three of these, triangulation, complementarity and development, are relevant to this research. These will be summarised in Section 4.7, Table 4.11 and Section 4.9.

The researcher began by gathering quantitative data through a survey evaluating levels of maths anxiety. This was followed by the collection of qualitative data to address the detailed research questions. The strength of this design lies in the potential of the qualitative aspect of the study to extend the quantitative findings. These two forms of data were integrated in the design, and analysis connected the data. The survey provided quantitative data that were then analysed by descriptive statistical methods. Qualitative approaches allow the researcher to work with a small number of people, interpret experiences within contexts, and generate theory by following inductive principles. In addition, qualitative approaches allow the researcher to celebrate diversity and difference, and to value personal involvement and partiality. These principles match the intent of this study, because it aims to elicit information about mathematics teaching from the perspective of the pre-service teachers. The qualitative methods then allowed

investigation of pre-service teachers' perceptions of the phenomenon of maths anxiety through their lived experiences and the range of ways the phenomenon was experienced within their own contexts; this encouraged pre-service teachers to examine the ways in which they constructed and interpreted their experiences. Different perspectives can be compared, and the quantitative results can be elaborated, by incorporating the perspectives of individuals. The focus is on the complexity of views, not on narrowing meanings into a few categories. This will lead to a more complete understanding of the impact of the phenomenon and the outcomes of the intervention.

The researcher used a multiphase exploratory sequential mixed method design (Creswell & Plano Clark, 2011) to answer the research questions. The research design was sequential because, chronologically, quantitative and qualitative data were collected both alternately and simultaneously (see Table 4.2 in the data collection techniques section). However, the data are not merged for presentation in this thesis. The quantitative data are presented first, then the qualitative data are used to explore the meaning individual pre-service teachers ascribe to the problem of maths anxiety. The methods are parallel for the first part of the study, and then integrated (Yin, 2006). Although the data collected from the quantitative part of the methodology are numerical, the data are not discrete because maths anxiety as a variable is operationalised as the rating given to the questions on the survey. So, in this case, the quantitative and qualitative methods have some similarities in their foundation. The use of the survey is pragmatic to answer the research question concerning the levels of anxiety. The analysis of the quantitative data is followed by the analysis of the qualitative data. Qualitative methods were used in the explanatory phase. The explanatory aspect of the design will come from using mixed methods for complementarity, development, and expansion (Greene et al., 2004).

Underlying the study was the view that narrative inquiry is a collaboration between researcher and participants in which the researcher is trying to understand the experiences of the participants (Clandinin & Connelly, 2000). According to Hanrahan, Cooper, and Burroughs-Lange (1995), narrative inquiry allows change during the research process, and the researcher is not pressured to present just one consistent story; so, it presents the researcher's own constructions as well as those of the participant (Walsham, 1995). "It is inevitable that researchers' assumptions and expertise are

reflected in the selection of critical incidents used to highlight research and in the interpretations of themes represented in the content analysis” (Brookfield, 1995, p. 3) as “it can, of course, be argued that the choice of the specific questions used necessarily reflects a perspective, that any such lists are to some extent subjective and open to criticism on the grounds that other questions might have been chosen, or the questions might have been framed in an alternative way” (Macnab & Payne, 2003, p. 57).

The researcher does not claim to be able to identify with the participants in the study but can experience empathy for them. Selecting the role of the researcher in qualitative research requires critical examination of the research question, and consideration of the context of the research and power relationships between researcher and participant (Ravitch & Wirth, 2007). The researcher is aware of the necessity for bracketing – not imposing herself on the study, negotiating her role as a researcher and navigating between the aim of facilitating change and avoiding emphasising her own beliefs and values. However, it is necessary to acknowledge that the results are a product of the researcher’s interpretations.

4.4.2 Ethical considerations

It is important that all research be conducted ethically. The researcher recognises that she has a moral obligation to members of her profession. The following actions have been completed:

- Ethics approval, based on accepted informed consent procedures, was received from the university’s ethics committee (see Appendix A).
- Participating pre-service teachers received information about the aims of the research and the procedures, and their right to withdraw at any time, thus meeting requirements for informed consent (see consent forms, Appendix B).
- Participants’ identities were protected. Information collected by the survey and tutorials was not re-identifiable. Codes were used for matching purposes only. Information collected during tutorials was either collected by the researcher or placed immediately in envelopes and sealed and sent to the researcher. All participants were identified by codes or pseudonyms in research reports and this thesis.

- Written agreement to use the RMARS survey was received from the author (see Appendix C).

4.5 Participants

In Australia, primary teachers are generalists who traditionally teach all subjects in the curriculum to students until grade 6. However, there are local variations on this model. There are specialist teachers in some primary schools. Although there is a national Australian Curriculum (Australian Curriculum, Assessment and Reporting Authority (ACARA), 2015), different states' educational systems vary, for example in whether the final year of high school has state-based examinations or school-based assessment.

The most common primary teacher preparation program is the Bachelor of Education (Primary), a four-year undergraduate degree. From 2011, all universities providing teacher education programs in Australia were required to meet the Australian Institute of Teaching and School Leadership (AITSL) requirements for accredited teacher education programs.

The majority of pre-service teachers enter their teacher education course after high school or after a one-year break (known colloquially as a “gap year”), usually at the age of 18 or 19 years. There are also a smaller number of mature-age entrants who begin teacher education as a career change or after having a family. Although the study does not claim representativeness in gender and age distribution, participants in this research are typical of primary pre-service teachers in universities across Australia.

4.5.1 *Research population*

The initial research study population consisted of cohorts of pre-service teachers undertaking their first-year mathematics unit from a four-year Bachelor of Education (Primary) degree course on a smaller regional campus (Campus 1) and a major metropolitan campus (Campus 2) of an Australian university, across two consecutive years. The two campuses are in two different states, and the majority of the pre-service teachers in each case had come through their local education systems. These comprised two different systems, one school-based, and one centralised. The end-of-school assessment systems also differ. One state has a formal examination system, combined with continuous school-based assessment, and the other has school-based assessment,

moderated by a general skills test. These locations were chosen in order to compare pre-service teachers from a regional city with those from a large metropolitan city who were undertaking the same course.

The pre-service teacher groups were labelled A to D denoting their campus and the year when their course started. In addition, three pre-service teachers who started their course in the next year (2014) volunteered to take part in a workshop about maths anxiety. These are labelled Group E. Participants from five different groups were therefore involved in the study, as Table 4.1 shows.

Table 4.1

Groups of participants

Group	Campus	Year group began course
A	1	2012
B	2	2012
C	1	2013
D	2	2013
E	1	2014

4.5.2 Research sample

The research samples consisted of pre-service teachers who agreed to take part in the research project. The researcher aimed to survey all pre-service teachers enrolled in the course for two years at the beginning of their course, by accessing them at lectures for the whole cohort.

This research investigated a complicated issue, so the researcher selected a limited number of approaches and sites for data collection. Sampling was voluntary (Creswell, 2013), based on the preparedness of pre-service teachers to participate. Representativeness was not an issue, because there is no claim that the sample was a random sample, or a sample designed to represent certain demographic characteristics. Pre-service teachers were recruited to the study through a 3-pronged justification, which outlined the value of the study to themselves, to teacher educators and their peers, and to their future students. Although many pre-service teachers were willing to

complete the survey component of the study in a lecture (see Table 4.2), recruitment to the workshops where the interactive bibliotherapy and interviews took place remained an issue, and the initial proposed research plan was adjusted to include the tutorials and another round of workshop data collection. Table 4.2 provides information on the sample sizes for each stage of the study. The instruments will be described in the following section.

Table 4.2

Sample sizes and instruments for groups in the study

Year	Campus	Group	Academic year	Number of participants in sample	Data collection instrument
2012	1	A	1	57	Survey
	2	B	1	162	Survey
	2	B	1	268	CIT and cognitive bibliotherapy (Tutorials)
2013	1	C	1	63	Survey
	2	D	1	145	Survey
	1	A	2	6	CIT and interactive bibliotherapy (Workshop)
	1	A	2	2	Semi-structured interview
2015	1	A	4	3	CIT and interactive bibliotherapy (Workshop)
	1	E	2	3	CIT and interactive bibliotherapy (Workshop)
	1	A	4	2	Semi-structured interview

Table 4.2 shows the number of participants in the study cohorts.

4.6 Description of, and justification for, data collection methods

The nature of the instruments and techniques used in data collection will now be elaborated in detail.

4.6.1 *Quantitative techniques*

The quantitative techniques used were the RMARS, the abbreviated Mathematics Anxiety Rating Scale, (Alexander & Martray, 1989) and the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

Maths Anxiety Survey – abbreviated Mathematics Anxiety Rating Scale (RMARS). In Phase 1, to ascertain the level of maths anxiety in primary pre-service teachers commencing their studies, the RMARS (Alexander & Martray, 1989) was used (see Appendix B). A complication arose in reviewing the literature, because the RMARS survey is also referred to as the MARS-R (Nisbet, 2015), sMARS (Ashcraft & Kirk, 2001), and AMARS (Mizala et al., 2015). The survey data included level of maths anxiety, gender, age and school background.

Researchers have sought ways to assess levels of maths anxiety as anxiety is a construct and unable to be measured directly. Attempting to quantify a construct such as anxiety is problematic. In anxiety scales, observed or reported activities lead to inference of anxiety, and this is how the construct is operationalised. A variety of tasks that purport to measure maths anxiety have been used in previous research. More detailed histories of scales and their development can be found in Preston (1986) and Franz (2005). There is potential for confusion with the various abbreviations used for the scales; for example, the RMARS to which Preston refers is Plake and Parker's (1982) 24-item scale, which is also referred to as the MARS-R. The researcher has given some relevant details of the scales in this section in order to justify the use of the RMARS (Alexander & Martray, 1989).

The MARS, a major scale used in research and clinical studies, was developed by Richardson and Suinn in 1972. They developed the MARS as a 98-item inventory to provide a measure of anxiety associated with the manipulation of numbers and use of mathematical concepts. Although the instrument was validated with tertiary students, one of the major shortcomings of the scale was its length. This led to the development

of shorter versions. The MARS (either the original or one of the shorter versions) is the most commonly used measure of maths anxiety, being supported by extensive data on the validity and reliability of the scale (Plake & Parker, 1982). Another major issue with the original MARS (Richardson & Suinn, 1972) was the underlying assumption that maths anxiety is unidimensional, while more recent studies have identified it as multidimensional. Alexander and Martray developed the abbreviated MARS (RMARS) in 1989 by reducing the original 98-item MARS to 25 items. For this study, a range of maths anxiety surveys was considered (see Table 4.3).

Table 4.3

Examples of mathematics anxiety scales

Author	Year	Number of items	Instrument
Dreger & Aitken	1957		Number Anxiety Scale
Richardson & Suinn	1972	98	Mathematics Anxiety Rating Scale (MARS)
Fennema & Sherman	1976	10	Mathematics Attitude Scale - Anxiety (MAS-A)
Plake & Parker	1982	24	Revised Mathematics Anxiety Rating Scale–Revised (RMARS, also MARS-R)
Wigfield & Meece	1988	11	Mathematics Anxiety Questionnaire (MAQ) - revised
Alexander & Martray	1989	25	Abbreviated or Revised Mathematics Anxiety Rating Scale (RMARS, sMARS or AMARS)
Suinn & Winston	2003	30	Mathematics Anxiety Rating Scale – Short Version (MARS-SV, MARS-Brief)
Hopko et al	2003	9	Abbreviated Mathematics Anxiety Scale (AMAS)
Bursal & Paznokas	2006	30	Revised-Mathematics Anxiety Survey (R-MANX)

In order to assess levels of maths anxiety, the RMARS (Alexander & Martray 1989) was selected for this study, as it has been widely used in academic research, rigorously tested, and found to be psychometrically sound (Baloglu & Kocak, 2006; Bowd & Brady, 2002; Haynes, 2003; Revak, 1996). This instrument was found to have valid and reliable results in measuring maths anxiety in teacher education students (Baloglu & Kocak, 2006; Brady & Bowd, 2005; Dunkle, 2010). In comparison, Plake and Parker’s (1982) version of the MARS aimed to provide a more efficient way of measuring maths anxiety in a statistics course; therefore, the wording was not appropriate for this study. Bowd and Brady’s (2002) factor analysis of survey results

from 357 final year Bachelor of Education students found that three factors accounted for 73 percent of the variation and they concluded that the RMARS gives three meaningful constructs. Dunkle (2010) used the RMARS to provide valid and reliable results for measuring pre-service teacher maths anxiety over time after surveying existing instruments and several confirmatory psychometric studies. The RMARS (Alexander & Martray, 1989) was chosen because of its shorter length, its fit with the research questions, its appropriateness for groups and its strong psychometric information.

Alexander and Martray, (1989) found three factors defining the dimensions of maths anxiety. These factors were mathematics test anxiety, numerical task anxiety and mathematics course anxiety. Twenty-five items from the original 98-item MARS were found to have statistically significant differences. “Coefficient alpha was .96 for the fifteen items associated with Factor I (Math Test Anxiety), .86 for the five Factor II (Numerical Task Anxiety) items, and .84 for the five Factor III (Math Course Anxiety) items. These coefficients compare favorably with the .97 coefficient alpha reported by Richardson and Suinn (1972) for the full scale 98-item MARS” (p. 147). Ashcraft and Kirk (2001, p. 226) reported that, in testing of several abbreviated forms of the MARS, Alexander and Martray’s 25-item RMARS (which they called sMARS) yielded “a very high correlation with participants' overall MARS scores ($r = .96$) and acceptable test-retest reliability ($r = .746$ at a 2-week retest interval).”

In summary, the RMARS was appropriate for four reasons. Firstly, it is made up of only 25 items, compared to 98 items on the original MARS. The shorter scale made this instrument more efficient. Secondly, the RMARS is focussed more broadly, compared to the statistics focus of Plake and Parker’s (1982) revised version of the MARS. Thirdly, the RMARS is designed for college students, unlike Fennema and Sherman’s (1976) Mathematics Attitude Scale for high school students. Fourthly, the three factors of mathematics anxiety measured by the RMARS were relevant to this study of pre-service teacher maths anxiety.

The RMARS is a 25-item, five-point (1 = not at all, to 5 = very much) Likert-type instrument. Thus, potential Total Anxiety scores range from 25 to 125. Chapter 3 explained that the RMARS assumes the multidimensionality of the construct (Alexander & Martray, 1989; Baloglu, 2002) and has three subscales, for mathematics

test anxiety (MTA, items 1–15), numerical task anxiety (NTA, items 16–20), and mathematics course anxiety (MCA, items 21–25). Possible scores for MTA range from 5 to 75, and for NTA and MCA from 5 to 25. The RMARS was used with minor modifications for the Australian context (see Appendix B), and as part of the analysis, confirmatory factor analysis was carried out.

In addition to the RMARS survey, the participants were asked to rate their general maths anxiety level and confidence before completing the questions, and current maths anxiety level after completing the questions. They were asked to use a scale between 0 and 100, where higher scores related to higher levels. Because the literature suggests that maths anxiety is a transitory-state construct (Baloglu & Zelhart, 2007), these questions sought to obtain a measure of the maths anxiety that pre-service teachers were currently experiencing at that time.

The RMARS rating forms and a set of demographic questions were used in the study. Demographic characteristics were gathered by self-reporting in the survey. The demographics background questionnaire asked participants for information such as age and gender, mathematics courses studied in high school, and the number of years/months since their last mathematics course. For this research, gender was regarded as dichotomous (male or female) and age was collected in years, and then analysed as dichotomous (less than 25 years or mature-aged, 25 years and older); and participants were asked if they identified as Indigenous (a term that refers to Australian Aboriginal and Torres Strait Islander people); and asked for the postcode of the high school they had attended, in order to investigate the variable of rurality.

The Positive and Negative Affect Schedule (PANAS). As part of a workshop exploring maths anxiety, the PANAS (Watson et al., 1988) was used to enable participants to describe their immediate feelings in words (e.g., interested, excited, nervous, afraid). Participants were asked to rate the extent to which the word described the way they were feeling at that moment, from 1: *Very slightly or not at all* to 5: *Extremely*. The PANAS was used at the start and end of the workshop to identify any “immediate and detectable change in their affect upon completion of the workshop” (Research question 2b). It is a tool that gave a snapshot summary of positive and negative affect at the time, by asking participants to give each of 10 positive and 10 negative affect terms a rating out of five. Results were summed, and a higher summed

score indicated higher levels of positive or negative affect. This instrument had a similar function to Kidman and Uusimaki's (2004) use of a 30-second online survey to record six affective/feeling responses (three positive and three negative) via a sliding scale, pre-activity and post-activity, to investigate changes in affect.

4.6.2 *Qualitative techniques*

In line with the conceptual framework of the thesis, the qualitative techniques centre around reflective methods. According to Dewey (1933), "we do not learn from experience. We learn from reflection on experience. Reliving of an experience leads to making connections between information and feelings produced by the experience" (p. 78). The combination of CIT and bibliotherapy in this study is innovative, so these two methods will be described in some detail. A third technique, semi-structured interviews, was also used and this well-known technique will be described in much less detail.

CIT. A particular focus of the qualitative data collection is pre-service primary teachers' critical incidents. The questions sought to elicit and check different individuals' perception, and to identify commonalities found among the participants' responses. The rationale for choosing CIT was that the study aimed to use bibliotherapy as a means of challenging pre-service teachers' interpretations of the memories that influenced their mathematical identities.

Qualitative methods, such as collecting autobiographical data, presuppose longer-term engagement with participants and result in large volumes of data which researchers select from and analyse. Angelides (2001, p. 430) identifies the analysis of critical incidents as an efficient technique by which a researcher "can quickly gather rich data in a way which otherwise would need a longer-term engagement".

The critical incident approach was selected in order to access the narrative or storied nature of experience. The questions that comprised the critical incident prompts were informed by Hannula et al.'s (2005) study. The participants were asked to reflect on their views of themselves as a mathematics learner and potential teacher of mathematics. They were then asked to identify incidents that they felt had impacted on these views (see Appendix D). Critical incidents were defined, for this study, as situations or events that are vividly remembered and hold special significance for the

writer. The narratives and vignettes reflect real experiences written by the pre-service teachers.

This research extends the use of CIT (Flanagan, 1954) which was developed initially to study human actions objectively. The CIT is a robust research technique that is commonly used where evidence-based evaluation is necessary. Hughes, Williamson, and Lloyd (2007) indicate:

Critical incident technique (CIT) is a well proven qualitative research approach that offers a practical step-by-step approach to collecting and analysing information about human activities and their significance to the people involved. It is capable of yielding rich, contextualized data that reflect real-life experiences. (p. 49)

Analysis of critical incidents written by participants in a study can also be used as a tool for triggering reflections on beliefs. The CIT focuses on real-life incidents. Although it has a well-defined set of procedures that make it straightforward to apply, it also has the flexibility to enable it to be used in a variety of situations.

Flanagan (1954) was first to describe CIT. He identified skills required by aircrews by asking observers to recount incidents where a subject had succeeded or failed in dealing with an incident. He sought to establish facts in situations where the consequences were definite, and his critical incidents relied on accurate and truthful reporting. He later adapted his technique to education. In the sixty years since Flanagan introduced the technique as a set of principles which were flexible and could “be modified and adapted to meet the specific situation at hand” (1954, p. 335), CIT has been extended and modified by researchers in various ways. For example, Table 4.4 shows how Flanagan’s principles were used in a study by Hughes et al. (2007). Their CIT analysis aimed to develop students’ information literacy learning and practical problem-solving.

Table 4.4

Use of Flanagan's model of CIT by Hughes et al. (2007)

Flanagan (1954)	Hughes et al. (2007)
Establish the general aim	Create a “functional description” that indicates the objective of the activity
Develop plans and specifications	Situation Relevance Extent Observers
Collect the data	Participants Data collection activity Interviews Observed set task
Analyse the data	Working inductively Frame of reference Category formulation Specificity
Interpret and report the data.	Thematic narrative, Recommendations, Tabulations and Graphics

Hughes et al. (2007) have taken Flanagan's (1954) five principles and adapted them for their study. For example, they have taken the second principle “Develop plans and specifications,” and elaborated it for their specific study under the headings of situation, relevance, extent and observers.

Researchers have suggested many scaffolds to elicit detailed reflections. One such example is Gibbs' (1988) reflective model (see Section 3.4.3). More recently, Serratt (2010) stated that when analysing a critical incident, reflective individuals ask five questions. Table 4.5 shows alignment between Serratt's five questions and Gibbs' reflective model.

Table 4.5

Alignment between Gibbs' model and Serratt's CIT

Gibbs' (1988) reflective model		(Serratt, 2010)
Description	What happened?	
Feelings	What were you feeling?	
Evaluation	What was good or bad about the experience?	
Analysis	What sense can be made of the situation?	Why did I view the original situation in that way? What assumptions about it did I make? How else could I have interpreted it?
Conclusion	What else could you have done?	What other action(s) might I have taken that could have been more helpful?
Action plan	If the situation arises again what would you do?	What will I do if I am faced again with a similar situation?

Note: This table was previously published in Wilson (2009)

Both Serratt's and Gibbs' models provide useful resources for this thesis. The comparison in Table 4.5 demonstrates that both authors highlight the importance of analysis. However, Serratt's model provides more descriptive reflection on the actual occurrence while Gibbs' model draws out questions that inform the analysis.

Reflective thinking is important in professional practice to identify the assumptions that underlie thoughts and actions. The importance of the written account of a critical incident, together with the support of a structured learning conversation, is a way of both recording and verifying details and reshaping the account. This accounting may then include a consideration of social and material things (Harrison & Lee, 2011, p. 213).

Critical events can be traumatic and impact on the protagonist (Webster & Mertova, 2007). Although they may not be major catastrophes, critical incidents are descriptions of vivid events that people remember as being meaningful in their experience; they often can be identified, upon looking back, as a crisis or tipping point.

The critical incident technique is intended for qualitative and subjective descriptions of people, the situations they encounter, and participants' interpretations of their experiences. It is inevitable that researchers' assumptions and expertise are reflected

in the selection of critical incidents used to highlight research and in the interpretations of themes represented in the content analysis. (Brookfield, 1995, p. 3)

The advantages of using critical incidents in this study come from their focus on behaviours (Pedersen, 1995) and participants' lived experiences. The method used in this study is open-ended inquiry which does not force participants into a given framework – as happens if lists of positive or negative feelings or attitudes are given (see, e.g., Macnab & Payne, 2003). However, it does keep them focussed on their experiences and allows researchers to examine common situations, shared by a group, from the individuals' unique perspectives and in their own words. At the same time the use of CIT provided the opportunity to identify and analyse even quite rare events, which may have had devastating effects on vulnerable individuals. Another advantage of using critical incidents is that they allow for the experiences to be represented in rich and vivid ways.

Some of the disadvantages identified for using the CIT include the following:

- It is a time-consuming process.
- Critical incidents represent unique experiences, and thus may be more difficult to code and to classify into categories or patterns.
- A variety of interpretations could be made about the meanings associated with a critical incident (Pedersen, 1995).

According to Hughes et al. (2007), the technique also can be challenged in terms of accuracy (for evaluative studies), subjectivity, selectivity, and the limited generalisability of the results (for exploratory studies). They recommend that these aspects can be mediated by close attention to analysis, a careful explanation of the process followed and provision of rich detail as a basis for judging the applicability and transferability of the research. These recommendations were followed in this study although the researcher did not aim to generalise from the findings. Another disadvantage of traditional CIT is that people can remember better more recent actions. However, in this study, participants were asked to identify the ones that still impacted, so timing of the original incident was not an issue.

Flanagan (1954) was concerned with making sure that descriptions were factually correct, so he looked for the same judgement from independent observers. His use of CIT relied on events being remembered. However, in other research, such as reflection on the impacts of beliefs and values on actions, what is important is not what happened but what the individuals remembered. In these studies, critical incidents are descriptions of remembered vivid events which people view as being meaningful in their experience. The study that formed the basis of this thesis was this type of study, so factual correctness of recall was not an issue.

According to Baumeister, Stillwell, and Wotman (1990), an issue with autobiographical narratives is that respondents may not report their emotions accurately or may lie. Nevertheless, such narratives provide insights into how the respondents construct their experiences, and the advantage of narrative data is that they relate authentic situations. People will construct and describe an event differently, depending on their language, their culture, their motivation and previous experience; therefore, the reality of the event will be different for them, depending on how it fits into their view of the world. Individuals may remember details that confirm their existing beliefs, fill in details because of stereotyping, and edit or reinforce memories (Reyna & Lloyd, 1997). It is not important to establish whether the memory is correct, because the way in which a person interprets an event is real in its consequences, as Tripp (2012) points out:

... like all data, critical incidents are created. Incidents happen, but critical incidents are produced by the way we look at a situation: a critical incident is an interpretation of the significance of an event. To take something as a critical incident is a value judgement we make, and the basis of that judgement is the significance we attach to the meaning of the incident. (p. 8)

Hence, the aim of this writing is not to determine whether an event actually happened as remembered. It is to help participants to reflect on their perception of that event, its impact on their construction of what it means to learn mathematics and on themselves as a learner of mathematics, and how these perceptions have been reinforced by other experiences that followed. Pre-service teachers' current experiences are filtered through their perceptions, reinforcing their attitudes. Mason (2006, p. 10) explains: "social experience and lived realities are multi-dimensional and ... our understandings are impoverished and may be inadequate if we view these phenomena only along a

single continuum.” A lived experience consists of contextual and personal factors, and the appraisal of these determines whether the event is emotionally laden. For example, the way in which participants perceived mathematics is affected if they did not feel safe and supported in their classroom environment. The exploration of critical incidents allows participants to process memories and to put them in context. These events “provoke the individual into selecting particular kinds of actions, they in turn lead them in particular directions, and they end up having implications for identity” (Measor, 1985, p. 61). They challenge participants’ concepts of self, and their personal and professional values.

Van Manen (1997) developed a phenomenological research method relying not on entire life histories, but on using description and reflection on an experience in order to develop an understanding of the deeper meaning or significance of an aspect of human experience. He used “thick description” data, derived from rich detailed information from memories of an incident. According to van Manen (1997), “writing mediates reflection and action” (p. 124). He explains that consciousness is created by the act of writing. The writing itself creates and fixes our reflective cognitive stance. He explains that writing “creates a space for pedagogic reflecting” to allow a person to return “with a deepened understanding of the significance of certain realities of the lifeworld” (p. 128). When pre-service teachers put their experiences into written form, it highlights their perceptions in a different way. LoPresto and Drake (2005) asked U.S. elementary pre-service teachers to write their mathematics stories about “critical events” describing peak, nadir and turning point experiences as well as their greatest challenge and alternative positive and negative futures (p. 269). Participants also shared parts of their stories, strengthening their feelings of community. They emphasised the value of future reflection.

Other researchers have reported reflections on recent experiences. Lerman (1994), using critical incidents to foster reflection in teaching, developed “the idea of reflective mathematics teaching, offering the ‘critical incident’ as a device to stimulate reflection on teaching” (p. 52). CIT has been used by researchers in a range of contexts. Goodell (2006) asked secondary pre-service teachers to identify critical incidents during a methods and field placement course. McAllister, Whiteford, Hill, Thomas, and Fitzgerald (2006) analysed critical incidents reported by education and health students

undertaking fieldwork in Asian countries. Uusimäki (2009) used CIT with recent experiences to reflect on practicum. These gave educators insights into participants' experiences for their planning.

The definition of the term "critical incident" varies between researchers. Vandercleyen et al., (2012) defined a 'critical incident' as one on which the pre-service teacher critically reflects. However, this thesis defines critical incident as it is used as by Hughes et al. (2007): in the sense of an incident that the pre-service teacher selects and defines as having had an impact. The aim is to understand pre-service teachers' lived experiences and the meaning they attach to them.

A written account of a critical incident, together with the support of a structured learning conversation, is an important way of both recording and verifying details and reshaping the account. By recording thoughts and the event(s), the pre-service teacher moves from an account of "what happened was ..." towards "it happened because ..." (Harrison & Lee, 2011, p. 213). This accounting may then include a consideration of social and material things

The CIT permits a degree of replication, in that the context and outcomes may be apparent in other pre-service teachers' experiences. The purpose of the study described in this thesis was to illuminate key factors in the development of mathematics anxiety through exploring the experiences of pre-service teachers, in order to address Research Question 1a: What are the indications for influences that have stimulated this anxiety? by exploring how pre-service teachers describe their mathematics experiences. The CIT was used in two contexts. Firstly, in the tutorial, in the normal mathematics content units of their courses, pre-service teachers from Campus 2 were asked to respond to prompts asking how they felt about and saw themselves as learners and potential teachers of mathematics. They were then asked to describe a critical incident (positive or negative) from their own school mathematics education that impacted on their image of themselves as learners of mathematics. This involved participants in: recalling critical incidents in their mathematics learning; reviewing the associated emotions; and having brief opportunities to reflect on the situations. Participants were identified only by a code used to match CIT reflections with other data collected. The reflections were sealed in envelopes immediately and sent to the researcher.

The participants' responses were examined for evidence of anxiety, using content analysis. Initial analysis coded the critical incidents for themes emerging from the data, and then for those identified from the literature. Further analysis of the critical incidents used Leximancer text analysis software (Leximancer, 2018) to identify concepts and themes.

Secondly, in small-group workshops, pre-service teachers were asked to describe and share a more detailed reflection of a critical incident. There were two reasons for the lower numbers in the workshops. Firstly, the workshops were designed as small-group workshops, on the advice of the student counsellor; and secondly, there was an ongoing issue of recruitment of participants for these workshops. Encouraging participants to write about and reflect on a critical incident in their own schooling was part of the reflection questions. The discussion of the qualitative CIT in the workshop added breadth and scope and is the method by which the researcher explored and made sense of the experiences of the participants.

Bibliotherapy. The distinctive focus of this part of the study was the exploration of using bibliotherapy to address mathematics anxiety in pre-service teachers.

Bibliotherapy is a technique developed in psychology and library science. It has been defined as “the guided reading of written materials in gaining understanding or solving problems relevant to a person’s therapeutic needs” (Riordan & Wilson, 1989, p. 506). The purpose of bibliotherapy is to assist individuals to overcome emotional turmoil related to a real-life problem by readings (Lenkowsky 1987), in which people address their problems by reading about the situations of a third person. The technique of bibliotherapy has been used previously in educational settings to help high ability secondary students overcome maths anxiety (Furner & Duffy, 2002; Hebert & Furner, 1997), to assist children with learning disabilities (Forgan, 2002; McTague, 1998) and to remediate children’s social difficulties (Sullivan & Strang, 2003).

There have been debates about the use of terms in the literature, for example, Smith (1989) claimed that it was difficult to distinguish between reading guidance and bibliotherapy. Bibliotherapy has been used to indicate a variety of practices on a continuum from simple reading guidance to clinical programs of psychotherapy (Doll & Doll, 1997) and thus may have a developmental or a clinical focus. The term

“developmental bibliotherapy” refers to the use of guided reading (Hebert & Furner, 1997), focussed on developmental growth, whereas clinical bibliotherapy refers to a clinical intervention where a therapist works with individuals with serious emotional or behavioural problems. Developmental bibliotherapy was the focus of this study. Cognitive bibliotherapy (Shechtman, 2009) focusses on positive or negative individual reactions to readings – an earlier term is “reading bibliotherapy” (Cohen, 1994). Readers make connections between their personal and intellectual experiences, reflecting the relationship between the affective and cognitive dimensions of learning. This is the type of bibliotherapy that this study used to access the reflections in the tutorials.

The act of reading alone does not comprise the full process of affective bibliotherapy. Cognitive or “reading bibliotherapy” involves “the therapist guiding the reader to literature but not discussing the response of the reader to the material” whereas affective or “interactive bibliotherapy” involves interaction between the reader and therapist or facilitator (Cohen, 1994, p. 37). More recent studies aim for an interactive rather than a reactive approach. In the interactive process another person, often a teacher, facilitates participants’ involvement. Students engage in reflective activities such as journal writing and group discussions, becoming part of the interactive process (Morawski & Gilbert, 2000). Hebert and Furner (1997) stress that “successful bibliotherapy requires a meaningful follow-up discussion” (p. 169). It is important for the reader to become involved in discussions and follow-up activities, such as journal writing in order to develop self-awareness, an enhanced self-concept and improved personal and social judgement. Flores and Brittain (2003) indicate that one of the benefits of sharing reflective writing is that students are exposed to a range of attitudes and experiences that may be familiar. Shechtman (2009) reviews the history and implementation of bibliotherapy, concluding that it is a productive activity, with outcomes of changes in perception and increased empathy. Affective bibliotherapy provides comfort and allows participants to share connectedness. According to Shechtman, the function of the therapist or facilitator is to provide a “safe climate for the bibliotherapy process” (p. 30), in order to encourage participants to identify and express emotions and to understand them in a non-judgemental way.

In this study, the tutorials were the context for cognitive bibliotherapy (see Appendix E), and the workshops (the detailed development of which will be described in Chapter 7) were the vehicle for developmental interactive bibliotherapy with a focus on examining personal responses to readings and relating them to prior experiences. This second context provided an extended time for participants to write their reflections, and the opportunity to share them with their peers. Van Manen describes anecdotal narratives as significant because they recruit our attention, lead to reflection, involve us personally and transform or teach us. They also allow participants to measure their ability to make interpretive sense of the anecdote (1997, p. 121). These outcomes relate to the stages of bibliotherapy, outlined below. This extended type of bibliotherapy described by Schrodes (1957) which includes more time, and the opportunity for exploration of feelings was termed “affective bibliotherapy” by Shechtman (2009). The term “interactive bibliotherapy” (Cohen, 1994) was used in this study, because discussions with the facilitators were an important feature,

Underlying the application of bibliotherapy is the assumption that reading is a dynamic process, and the reader is an active participant in the process. The active, dynamic process of reading enables the person to identify with the protagonist in the story and to interpret the situation and actions according to their own experiences. This may be followed by individual or group discussion in a non-threatening environment (Hebert & Furner, 1997). From this, the reader can develop self-awareness, an enhanced self-concept and improved personal and social judgement (Hebert & Furner, 1997). People make sense of their own personal identities by their life stories (Sfard & Prusak, 2005). Identities are mobile and remain open to revision. The potential of bibliotherapy is that it is a stimulus for this revision. In addition, Lenkowsky (1987) identified “that reading could affect an individual’s attitude and behavior and is thus an important influence in shaping, molding, and altering values” (p. 123).

Halstead (1991) referred to three stages of bibliotherapy: identification, catharsis and insight, as “recognising”, “feeling,” and “thinking” (p. 80). These link to affective and cognitive aspects. A fourth stage, universalisation, has been described (Hebert & Furner, 1997), and a fifth stage, “projection”, was identified by Wilson and Thornton (2007/2008). These stages of bibliotherapy can be summarised as:

Identification – the reader identifies with and relates to the protagonist in the reading. The reader recognises themselves and their situation in the readings. “Examining the behaviours and related motives of another individual can act as a transition into the exploration of one’s own perceptions and actions” (Morawski, 1997, p. 247).

Catharsis – the reader becomes emotionally involved and releases pent-up emotions. Tension is released, identification becomes stronger, and the reader can review the feelings associated with the incidents. Addressing these feelings helps “them to experience and benefit from catharsis” (Morawski, 1997, p. 247).

Insight – this stage moves the reader’s emphasis to themselves. “Insight is the reader’s application of the character’s situation to her own life” (Halstead, 1991, p. 67). The reader envisages new ways of looking at the issues that they face (Hebert & Furner, 1997). Release from some of the emotional tension makes the reader able to approach their issue on an intellectual level, deconstruct their past views and come to an awareness of their motivations or the reasons behind attitudes and behaviours (Morawski, 1997). The reader learns through the character’s experiences, becoming aware that their own problems might also be addressed or solved.

Universalisation – the recognition that the reader is not alone in having these problems and shares the experience with others (Hebert & Furner, 1997). One of the reasons for using the technique of bibliotherapy is for individuals to come to the realisation that they are not the only ones who have the problem.

Projection – the readers can envisage having a different concept of their professional identity. Wilson and Thornton (2007/2008) related this fifth stage to the literature on projective identity (Gee, 2001) which was explained previously in Section 3.4.1.

The process of bibliotherapy has been summarised in Lenkowsky’s (1987) review as:

... identification with characters, situations, or elements of a story enables the reader to view his or her problem from a new and different perspective and thus gain hope and tension release (catharsis). Such tension reduction allows the reader to gain

insight into his or her own motivations and actions and allows for positive change in attitude and behavior. (pp. 123-124)

Lenkowsky (1987) identified four areas of applications, previously suggested by Sclabassi (1973). These are:

Self-Actualisation and Problem-Solving – objectives designed to promote self-understanding and successful problem solving.

Social – includes the objectives of affecting attitudes, social acceptance, social standing.

Psycho-therapeutic – incorporates objectives of developing emotional and psychological insight and growth, improving self-concept, and redirecting inappropriate behaviours and impulses; and

Educational/Didactic – includes objectives such as teaching others how to use bibliotherapy, what books or alternative materials to employ, what instructional techniques are most beneficial, or relating experiences using the process. The applications were relevant to this study.

The bibliotherapy was carried out in two contexts. Firstly, pre-service teachers from Campus 1 wrote guided reflections, in tutorials in their usual mathematics content units of their degree program, which encouraged them to think about the reading and their own experience of school mathematics (cognitive bibliotherapy). The time available was circumscribed by the need to complete the tutorial activities. Secondly, pre-service teachers from Campus 2 wrote bibliotherapy reflections in the small-group workshop. Encouraging participants to share their reflections on a reading aimed to extend the insights from their written reflections (interactive bibliotherapy).

In the tutorials, as an indication of their views of mathematics itself, the pre-service teachers were asked to write about their feelings towards mathematics before the first bibliotherapy reading. Then, they were given a synopsis of Dossel (1993), a carefully selected reading that related to the experience of learning mathematics in a classroom, particularly for those students who might find it difficult or suffer anxiety. The participants then wrote about their views in response to the reading. Stewart and Ames (2014) emphasise the need to choose readings “which match the specific situational needs of the person or persons” (p. 234), since, when reading materials provide

“thematically appropriate support, the participants were able to legitimize their funds of knowledge and lived experiences” (p. 234). The Dossel (1993) reading that formed the stimulus for the written reflections had been identified in preliminary research as the one that provoked an emotional response (Wilson, 2007).

Although bibliotherapy was originally conceived as an interaction between the reader and the reading, researchers recommend interaction with a facilitator. The small-group workshops on Campus 1 enabled the bibliotherapy process to be extended to include the sharing of experiences, in the form of self-selected sections of the responses to the readings. In the workshops, when more time was available, participants wrote and then shared as much of their reflections as they felt comfortable sharing. They also shared their stories.

Stories, whether fictional, biographical or autobiographical are integral to how we learn about ourselves and the world in which we live. ... As teacher educators, our process of reflecting through story– telling and discussion helps us to make sense of our practice, and mirror to our students that teaching is a lifelong journey of self-reflection and transformation. (Forrest Keener, & Harkins, 2010, p. 88)

This part of the study on Campus 1 used interactive bibliotherapy to elicit pre-service teachers’ affective responses and provide a framework and language to analyse them.

Semi-structured Interviews. Qualitative data were also collected through in-depth semi-structured interviews (Cohen et al., 2007) conducted by the researcher. Interviews focussed on how pre-service teachers understood and interpreted their actions and related them to identity, that is, the meaning ascribed by the participants.

Individual interviews took place with four pre-service teachers from Campus 1 who had completed the workshop and who agreed to be interviewed. These provided a means of clarifying any changes in maths anxiety in the time after the workshop. Questions focussed on the impact of the workshop, and how they imagined their future actions. The interview protocol (see Appendix L) was a guide for the interviews. The interviews were semi-structured, therefore some questions that arose are not included in the list. For example, further questions about practicum were added when the participant indicated that these experiences had been significant.

The indicators of the robustness of the changes in identity were the answers to the interviews regarding experiences with mathematics in units completed since the workshop. For each pre-service teacher who completed the interview an individual data set was established using their surveys, workshop reflections and interview.

4.6.3 *Outline of the small-group workshop*

The researcher invited the student counsellor to take part in a professional collaboration to develop a small-group maths anxiety workshop for teacher education students. This joint initiative aimed to bring together their two fields of expertise – mathematics education and psychology – in a collaborative process that would benefit participants. Liew, Lench, Kao, Yeh, and Kwok, (2014, p. 1) suggested that “interventions targeting emotion regulation and stress management skills may help individuals reduce their math and test anxieties.” The workshops offered participants more time to reflect and write than the tutorials, although they required greater commitment (see Section 4.7.1, Phase 3). More details will be provided in Chapter 7, which explains the development of the workshop.

Although the workshop was designed for small groups of fewer than 10 participants, there was an issue with recruitment to the workshops. Pre-service teachers who volunteered to participate in the workshop (see Table 4.6 for details) completed the PANAS (Watson et al., 1988) before and after the workshop. The results from the pre and post-workshop PANAS were used as an indication of the immediate impact of the workshop on positive and negative affect.

Table 4.6

Small-group workshops participants

Date	Attendance
April 2013	5 second year PSTs
April 2013	1 second year PST
February 2015	3 fourth year and 1 second year PSTs
April 2015	2 second year PSTs

Note: PST = pre-service teacher

Data were collected from the perspectives of the participants, using their own words, by asking them to identify and discuss critical incidents and then by further exploration through interactive bibliotherapy. The reflections recorded participants’ feelings and perceptions and identified outcomes such as changes in their behaviour. The small-

group workshop enabled the sharing of experiences of primary pre-service teachers who have maths anxiety, in the form of self-selected sections of their responses to the readings. This is an important part of the interactive bibliotherapy process and may be different from other practices of reflection in pre-service education.

4.7 Research design and methods

The purpose of this section is to describe the research design and discuss the types of methods that were used. The description of the data collection instruments used in the research includes the techniques and procedures for gathering and analysing data.

The researcher used a mixed method approach including both quantitative (collection of survey data) and qualitative (semi-structured interviews, writing critical incidents and analysis of pre-service teacher reflections) methods. Two years of empirical studies are included in the survey data. The inclusion of the qualitative data accompanied by survey data and other quantitative methods, brought richness and depth to the study. The combination of methods addressed Greene et al.’s (2004) purposes for mixed-method design as Table 4.7 shows.

Table 4.7

Purposes of mixed-method design as addressed in this study

Purpose	Way addressed
Triangulation	In the critical incident reflections, triangulation with the survey will increase chances to test the consistency of findings obtained through different instruments.
Complementarity	Interviews will clarify the results from written reflections. Both will provide information about the process and will qualify the survey results.
Development	In this research, results from previous studies guided the choice of readings. The results from the written reflections were used to modify subsequent questions in the final interviews. Interviews were related to the outcomes of previous research using the bibliotherapy framework.

4.7.1 Data collection phases and techniques

In this section, the procedures for each of the phases of this research will be listed and explained. The following instruments were used in the collection of data from the research samples, as primary sources of data.

Phase 1:

- Survey – Participants were surveyed at the start of their first year with an instrument the RMARS (Alexander & Martray, 1989) to collect data on levels and range of maths anxiety. They were asked to rank the extent to which they feel anxiety about activities involving mathematics and to score the level of their anxiety about mathematics.
- CIT (Flanagan, 1954) – pre-service teachers' reflections on a past experience that contributed to their self-perceptions as a learner and teacher of mathematics were collected in tutorials.

Phase 2:

- Cognitive Bibliotherapy – pre-service teachers' reflections, stimulated by selected readings on maths anxiety, were collected in tutorials.

Phase 3:

- CIT – pre-service teachers' reflections, on a past experience that contributed to their self-perceptions as a learner and teacher of mathematics were collected in small-group workshops.
- Interactive Bibliotherapy – pre-service teachers' reflections, stimulated by selected readings on maths anxiety, were collected in small-group workshops. Reflections and discussions were shared with the group.
- CBT reflections collected in the workshops.
- The PANAS (Watson et al., 1988) was used in the small-group workshops to collect quantitative data. This is a scale that consists of words that describe feelings (for example, interested, excited, nervous, afraid). Participants are asked to rate the extent to which the word describes the way that they are feeling at the moment, from 1 *Very slightly or not at all* to 5 *Extremely*.
- Workshop feedback was collected from all participants at the end of the workshop.
- Semi-structured interviews after the workshops focussed on the insights that the pre-service teachers developed as part of the bibliotherapy process.

Table 4.8 provides a summary of these instruments, the participants providing the data, the function of the instrument, and the timing of its administration.

Table 4.8

Administration of instruments in chronological order showing participants and function of instruments.

Instrument	Participants	Function	Timing
RMARS	PST who are not part of the research population	Test and validate survey questions	Semester 2, 2011 Campus 1
RMARS	Research groups A and B	Identification of initial levels of maths anxiety in PST	Semester 1, 2012 First year PST Campus 1 & 2
Tutorial 1 Critical Incident Analysis	Research group B Campus 2	Confirmation of issue and identification of sources of maths anxiety	Semester 2, 2012 First year PST Campus 2
Tutorial 2, 4, 12 Cognitive bibliotherapy	Research group B Campus 2	Responses of PST to bibliotherapy readings	Semester 2, 2012 First year PST Campus 2
RMARS	Research groups C and D	Identification of initial levels of maths anxiety in PST	Semester 1, 2013 First year PST Campus 1 & 2
Workshop PANAS, Critical Incident Analysis and Interactive bibliotherapy discussions	Year 2 PST from Research group A	Identification of sources of maths anxiety. Share selected reflections with peers. Response to bibliotherapy readings. Share selected reflections on readings with peers.	Semester 1, 2013 Second year PST Campus 1
Semi-structured interview	PST who are not part of the research population	Test questions in advance	Semester 1, 2013 Campus 1 (continued)

Instrument	Participants	Function	Timing
Semi-structured interview	Year 2 PST who attended workshop Research group A	The data collected in the interviews will be segregated into key themes. The data collected in the interviews will be analysed for evidence of changes.	Semester 2, 2013 Campus 1
Workshop PANAS, CIT and Interactive bibliotherapy group discussions	Year 2 PST and Year 4 PST Research groups A and E	Share selected reflections on readings with peers.	Semester 1, 2015 Campus 1
Semi-structured interview	Level 4 PST who attended workshops Research group A	The data collected in the interviews will be segregated into key themes. The data collected in the interviews will be analysed for evidence of changes.	Semester 2, 2015 Campus 1

Note: PST refers to pre-service teacher.

Table 4.9 aligns the use of the various data collection instruments and subsequent analysis of resultant data with the research questions. Details of the analysis of the data will be given in Section 4.8.

Table 4.9

Alignment between research questions, sub-questions, data collection and analysis

Research Phase	Research questions	Data collection instruments	Data analyses
Phase 1	1. With what range and extent of maths anxiety do PST present?	Mathematics anxiety survey Critical incident reflection (tutorials)	Descriptive statistics Factor analysis Critical incident analysis
	1a. What are the indications for influences that have stimulated this anxiety?	Critical incident reflection (tutorials)	Critical incident analysis
Phase 2	2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?		
	2a. For the pre-service teachers who participated in cognitive bibliotherapy what were the responses?	Written bibliotherapy reflections (tutorials)	Bibliotherapy analysis
Phase 3	2b. For the pre-service teachers who participated in an interactive bibliotherapy workshop, what were their responses?	Critical incident reflection Interactive bibliotherapy reflection and workshop group discussions	Thematic analysis
	2c. What was the immediate and detectable change in their affect upon completion of the workshop?	PANAS Workshop feedback sheet	Change in mean PANAS scores Workshop feedback
	2d. What was the more lasting impact of the interactive bibliotherapy on the pre-service teachers' maths anxiety?		

4.8 Data analysis

The data were collected, compiled and analysed. The aim was to identify phenomenological themes for the cohorts and to enrich these with themes identified by individual participants. The underlying assumptions for the interpretation of the results were that the factor analysis of the surveys and perspectives and data collected by the qualitative methods made it possible to extend beyond the standard comparisons of levels of maths anxiety and provide a more nuanced view of the nature and causes of pre-service teachers' maths anxiety.

4.8.1 Data compilation and preparation

The data collected via the surveys were used to identify the level of maths anxiety in the pre-service teachers who volunteered for the project. Data from the RMARS surveys were entered into an Excel spreadsheet, checked for accuracy, and arranged for analysis. Data collected through CIT and written bibliotherapy reflections were compiled into tables by matching participants' codes. The data from the workshops were transcribed. Interviews were summarised as written notes or recorded with selected sections transcribed. The data collected in the interviews was compiled and grouped to segregate it into key themes.

4.8.2 Data analysis

The data analysis for each research method is described below.

Survey. Data for surveys at the two campuses for two years are analysed in this thesis. The data analysis for this survey utilised descriptive statistics and inferential statistics. The descriptive statistics used were mean and standard deviation. Inferential statistics involved *t*-tests which were conducted to compare the means, for example, between males and females. Confirmatory and exploratory factor analyses were performed to investigate the factor structure of the maths anxiety construct.

Data were analysed with the Statistical Package for Social Sciences (SPSS) 20.0. Means and standard deviations for the total scale scores on the RMARS were computed. Gender and age differences were examined for the total scale scores on the RMARS and the three subscales using *t*-tests. Concurrent validity of the instrument was investigated by examining the relationships between the RMARS scores and pre-

service teachers' self-perceptions of their general and current maths anxiety levels, using paired t-tests.

The analysis of the survey data also distinguished patterns in levels of maths anxiety, using analyses of:

- females versus males
- pre-service teachers from rural versus metropolitan schools
- mature age (25 years and over) versus school leavers (under 25 years)
- differences between the two campuses

The number of participants who had attended rural high schools was smaller than anticipated. Analysis of the survey for these participants was discontinued after the first year. There were insufficient numbers of participants who identified as Aboriginal and Torres Strait Islander people for analysis.

Confirmatory factor analysis on Alexander and Martray's (1989) RMARS and Baloglu and Zeldhart's (2007) 20 R-MARS compared the factor structure to the findings from both those studies. Exploratory factor analysis was completed in order to identify the factor structure.

Critical Incident Technique. The researcher encouraged the participants to write detailed reflections of the incidents. Written pre-service teacher descriptions of what they experienced were used to identify the bases of the critical incident experiences. As well as the traditional binary analysis of positive or negative experiences, the researcher undertook a thematic analysis. The writing recorded participants' feelings and the analysis sought to identify outcomes such as changes in behaviour, particularly from those reflections which demonstrated higher levels of Hatten and Smith's (1995) hierarchical framework for types of reflection:

- descriptive writing – description of event, not reflective
- descriptive reflection – reflective, including some reasons or justification for actions
- dialogic reflection – exploring event, using judgement, explaining, look at possible rationale or alternatives

- critical reflection – multiple perspectives, showing awareness of historical or socio-cultural context.

The analysis sought to examine how identities of pre-service teachers as learners of mathematics were shaped by their experiences. The author therefore used Sfard and Prusak's (2005) proposal to "equate identities with stories about persons" (p. 14), and in particular identified whether words such as be, have, can, always, never, or usually were used (reifying), and whether change to the story could affect their feelings about the person or community (significant). The accounts written by the participants about themselves were analysed by locating the verbs and adverbs that suggested reification and terms that related to their environment, showing significance.

The initial analysis used the traditional, binary analysis of critical incidents from Lazarus' (1991) model of emotion (shown in Table 3.1). It noted, for example, whether critical incidents were perceived as a threat, whether the participants reported feeling inadequate or blamed themselves, and, where consequences were negative, anxiety and avoidance. In addition, Alger (2006) indicated that what is identified as the locus of the problem is important, because it shows to what extent participants believed that they could impact on the event.

Participants who responded to at least two prompts were included. They were identified as those who gave positive responses to the prompts (POS), those who gave consistent negative responses (NEG), those who gave positive or negative responses, but then qualified them with a comment (PQ and NQ respectively). In addition, some participants gave responses that included positive and negative aspects (for instance, they had a negative view of themselves as a learner of mathematics but a positive view of themselves as a potential teacher of mathematics).

Then the data set, comprising the pre-service teacher reflections and CIT responses, was analysed using thematic analysis (Braun & Clarke, 2006). Van Manen (1997) discusses the nature of themes. He describes the concept of a theme in terms of sense-making by focusing on meaning and regards a theme as a summary or simplification of a notion which describes an aspect of the lived experience. He reiterates that a theme is an insightful, interpretive product of interrogation of the text by the researcher, that is, the sense that the researcher can make of something. Writing themes "tends to orient

us away from contextual particulars towards a more universal sphere” (van Manen, 1997, p. 128). This author’s interest in the themes is primarily pedagogical. Her motivation arises from her life as an educator, and her aim is to appraise the pedagogic significance of each theme for the pre-service teacher (or for teacher educators to be practically responsive to the issues identified).

Van Manen (1997) describes three approaches to thematic analysis. These are wholistic (analysing the whole), selective, or line-by-line. This researcher’s approach was wholistic, in that the entire account was examined. This was appropriate to CIT, as, in this technique, the participant had selected the appropriate incident. However, in viewing the responses, the author also used a selective approach to focus the analysis, in order to identify “what statement(s) or phrase(s) seem particularly essential or revealing about the phenomenon or experience being described?” (van Manen, 1997, p. 93). Hence, the author sought to capture in a statement the main thrust of the meaning of the episode. As van Manen indicates, this is “not a mechanical process. Rather it is a creative, hermeneutic process” (1997, p. 96). In the process of analysis, the themes are examined and re-examined and reformulated, in an attempt to explicate the theme while retaining the essence of the pre-service teachers’ experiences. The pre-service teachers may re-interpret who they were, but also who they might become. As van Manen (1997) states “through hopes and expectations, we have a perspective on life to come” (p. 104). This future perspective links to projective identity.

The analysis aimed to identify “essential themes” (van Manen, 1997). These are themes without which the phenomenon would lose its fundamental meaning. In addition, the analysis identified “incidental themes” (van Manen, 1997). These themes may not be unique to the phenomenon. Van Manen (1997) emphasises that: “even the themes that would appear to be essential meanings are often historically or culturally determined or shaped” (p. 106).

The thematic analysis enabled the researcher to explore the complexity of the data in order to identify major themes and to explore themes arising from theoretical considerations of the data. This was followed by a comparison of the data, in which the qualitative results explained and enriched the quantitative results. The coded responses were organised into themes and patterns. A combination of *a priori* themes, based on themes identified in the literature and inductive, post-defined themes was developed.

The researcher identified patterns and themes in the data that answered Research Questions 1a and 2c, using interpretation and personal judgement. Braun and Clarke (2006) consider that accounts in the literature of thematic analysis that use the language of themes *emerging* or *being discovered* do not recognise the active role of the researcher in identifying, selecting and reporting themes. The links described in the results were created by the researcher. She acknowledges her role in searching for, selecting and editing themes across the data set. Because her analysis was driven by the specific research questions, there is no claim that the analysis provides a thematic description of the contents of the whole data set.

An additional analysis of the pre-service teacher reflections was carried out with the use of Leximancer coding software (Leximancer, 2018) in order to identify concepts and how they were related and connected into themes, for a comparison with the themes identified by the researcher.

The data were also examined using a framework of contextual and personal factors provided by the literature. Contextual factors include resources and constraints of the environment (social, material, temporal and spatial), and personal factors are individual and motivational features that influence values, beliefs, goals, self-esteem, and self-efficacy. The review of data was informed by Hannula et al.'s (2005) components of Finnish pre-service teachers' VOM which included components obtained by factor analysis, such as beliefs about self, and about mathematics, and emotional relationship with mathematics.

- F1 I am not talented in mathematics
- F2 I am hard-working and conscientious
- F3 My family encouraged me
- F4 I had a poor teacher in mathematics
- F5 I am insecure as a mathematics teacher
- F6 I can do well in mathematics
- F7 I like mathematics
- F8 Mathematics is difficult
- F9 Mathematics is calculations
- F10 I am motivated

A grid based on Hannula et al.’s (2005) VOM components was produced. The factors used to inform the analysis of the responses are shown in Table 4.10.

Table 4.10

Factors used to analyse pre-service teachers’ responses

Date	Factor (Hannula et al., 2005)
View of self as learner of mathematics	F1, F2, F6, F10
View of self as potential teacher of mathematics	F5
View of mathematics	F7, F8, F9

Note: numbered factors refer to VOM construct Hannula et al. (2005)

Corden and Sainsbury (2006) investigated the use of quotations in reporting qualitative research. They identify the functions of quotations as providing evidence, explanation or illustration, or enabling participants’ own voices to be heard. In order to provide vividness and show the depth and strength of the participants’ feelings or, in contrast, to show their passivity and lack of engagement, direct quotations have been used in the analysis of the findings in Chapters 5, 6 and 7. These illustrate participants’ experiences in the way that they perceived them and offer greater depth of understanding than can the researcher’s interpretations alone.

The analysis was conducted using techniques similar to those used in grounded theory (Corbin & Strauss, 2008), to develop further data driven codes (DeCuir-Gunby, Marshall, & McCulloch, 2011). To test whether coding categories were being utilised consistently, the researcher re-coded the data. Data were reviewed to identify whether the analysis had caused the researcher to become sensitised to new issues and to enable her to look at the data through an altered lens. In this way, rigour was established by building up explanation through systematic interrogation of data.

Bibliotherapy. The pre-service teachers’ reflections on their views of mathematics, written before the bibliotherapy reading, were included as part of the data set for the thematic analysis. These reflections were compared to the reflections that the participants wrote about their views in response to the reading. Qualitative research allows the “capacity to illuminate through interrogating patterns in the data and paying

particular attention to exceptions” (Barbour, 2008, p. 221). As in the critical incident analysis, exceptions were acknowledged and included in the analysis.

The five stages of bibliotherapy identified in the literature guided the analysis of the interviews, searching for patterns and changes, to make sense of the notes and written reflections. The researcher identified themes and sought relationships between those identified from the critical incident reflections and bibliotherapy reflections.

The research sought to identify and explain experiences that impact on pre-service teachers’ views of themselves with respect to mathematics, and to identifying insights and changes in projective identity. These were compared to existing processes from the stages of bibliotherapy identified in the literature but seen through a different interpretive lens.

Interviews. In order to identify themes from the interview data, the process of pattern coding (Miles & Huberman, 1994) was adopted. This process aggregates data into more manageable sets (Miles & Huberman, 1994). Within the data, pattern coding identified two stages of education influencing the pre-service teachers’ formation of views: primary school and high (secondary) school. The identified themes enabled the collation of data into smaller and more meaningful units for analysis (Miles & Huberman, 1994). Within these stages of education, participants’ comments were further explored, using factors such as value, enjoyment, self-confidence, and motivation.

4.9 Limitations and quality of the research

Studies of the phenomenon of maths anxiety have some limitations. There is a number of validity threats associated with the use of survey methods. The most important of these are the inherent problems associated with self-reporting.

As Chapter 2 noted, maths anxiety is a complex construct. The survey does not evaluate the physiological and behavioural responses that are associated with feelings of anxiety.

This study focussed on the level of maths anxiety with which first year pre-service teachers come to their education studies. The findings may not be applicable to higher-year pre-service teachers.

In collecting and interpreting the data, it is important to take into account the highly personal nature of the reflections and the difficulties for participants in writing or verbalising their emotions and feelings (DeBellis & Goldin, 2006). Pre-service teachers who did not volunteer to take part in the tutorials or workshops may have some characteristics that were not researched. The results may be limited to those who took part in the study. Because of the small sample size and limited recruitment to the bibliotherapy workshops, the results may not be generalisable to other pre-service teachers.

Only a small number of male pre-service teachers participated in the study, especially in the workshops ($n = 1$). Although the numbers reflect the proportion of males enrolled in the course and are representative of the proportion of males enrolled in primary teacher education courses across Australia, the small number of males limits the male pre-service teacher perspective, and, therefore, the generalisability of the study to pre-service teachers.

4.9.1 Ensuring quality mathematics education research

Reliability is based on the assumption that the study can be repeated, and that a number of individuals can subsequently have the same experiences (Burns, 2000). Uusimäki, (2009) in her doctoral thesis, examined “critical incidents” and claimed that studies undertaken in natural settings in qualitative research situations are “particularly vulnerable and difficult to replicate ... because the exact event cannot be reproduced” (p. 132). However, this study did not seek to identify actual experiences, and, because the focus of the study was on pre-service teachers’ perceptions of the impacts of past events, the verification and replicability of those events was not relevant.

This mixed method study was carefully designed to ensure that principles underpinning quality mathematics education research were addressed. Table 4.11 presents the way that these were taken into consideration in the study.

Table 4.11

Alignment with Anderson's (1998) principles for educational research

Principle for research	How addressed in study
To solve a problem not yet addressed	Identifying issues around pre-service teacher maths anxiety
To involve collecting new data from first hand sources	RMARS survey and collection of CIT and bibliotherapy data from Australian pre-service teachers
Based on empirical evidence	Quantitative and qualitative data collected
Use carefully designed procedures and rigorous analysis	Careful choice of appropriate survey and procedures to ensure that voices of participants were heard, and participants were treated with respect
Emphasise outcomes of principles to aid understanding	Identification of critical factors in development of maths anxiety and evaluation of methods to address
Researcher should have necessary expertise	The researcher had performed preliminary studies in the area and completed research studies
Attempts to find an objective solution via validated procedures	Validated methods used and reviews by critical friends
A directional research process that may refine procedures or questions	Research process refined with development of bespoke workshop
Findings are carefully recorded and reported to others	During the research, findings were shared via proceedings of national and international conferences

Another concern was the consideration of the researcher's ethical responsibilities towards the participants. There was a potential impact from the engagement of a lecturer with the pre-service teachers. To overcome this, one cohort of participants was from a separate campus to the researcher, who was not involved in teaching any mathematics units undertaken by participants on the other campus. This aimed to eliminate any coercion for pre-service teachers to be involved in the study.

Gall, Borg, and Gall (2007) report validity threats involving instrumentation, rater bias, and differential selection. The participation of pre-service teachers from two campuses reduced differential selection threats, as the campuses have different characteristics. The survey was administered to the entire group, so differential selection was reduced. Internal validity would be compromised if the instruments that were reproduced on the

two campuses were not the same. Accordingly, the survey was reproduced for both campuses, and all interviews were done by the researcher. Participants for the interviews were volunteers (respondents who gave permission for the researcher to re-contact them); this self-selection was empowering. Methods used to minimise any participants' concerns included obtaining a mandate for the research through standard consent processes and assuring them of their anonymity through confidentiality of their responses.

The research design provided multiple perspectives and the potential for comparison. Mason (2006, p. 10) states: "social experience and lived realities are multi-dimensional and ... our understandings are impoverished and may be inadequate if we view these phenomena only along a single continuum." Trustworthiness in the study was developed through methodological triangulation – gathering data through surveys, CIT, bibliotherapy reflections, and interviews. In the research different methods are used for triangulation purposes, that is, to provide "multiple lenses on the same phenomena" (Schoenfeld, 2007, p. 87). For example, credibility was improved through the use of triangulation, whereby two sets of data, being the RMARS (Alexander & Martray, 1989) and the CIT, were used to investigate the levels of pre-service teacher maths anxiety. In addition, cross-validation of data helps to develop a more complete understanding. Greene et al. (2004) suggest that possible tensions and assumptions from different strategies may generate new insights and fresh perspectives. However, van Manen (1997) warns researchers to be careful not to abstract and fragment too much.

Trustworthiness was also shown by presenting the interpretive writing for regular consideration by supervisors and other researchers at national and international conference presentations and research seminars. As the research was completed over a number of years, the phenomenon of maths anxiety in pre-service teachers received sustained attention.

Researcher bias can be a challenge in qualitative research. Qualitative data offers different methods of coping with the constraints and opportunities afforded by the situation. This is reduced by having open and transparent coding, and re-coding. The researcher is aware of the danger that Burns (2000) raises, that the prejudices and dispositions of the researcher could bias the data. Additionally, Woolcott (1997)

identifies the threat of the researcher who already knows, (that is, the researcher who imposes predetermined interpretations on data rather than eliciting meaning) as an issue in ethnographic studies. In addition to this concern, Janesick (2003) cautions that it is possible to become too comfortable in a research setting and, as a result, to fail to recognise and to document important or significant events. This researcher has been transparent about her disciplinary standpoint, and explicit and reflexive throughout the process of analysis. She recognises that it is important to consider her attitudes, philosophy, and belief system. This is a way to ensure rigour as the researcher's interpretations are recognised as part of the research process. The researcher recognises that she is not detached from the research, but she has made no claims that she was able to identify with the participants, except as a supportive future colleague. Greater credibility is developed if researchers interpret their own experience, rather than implying that they are detached. The impact of the research on the researcher and a consideration of the influence of the researcher on the research have been considered.

In terms of external validity, although the findings were not generalised to all pre-service teachers, findings can be generalised to the research population and across settings.

Although the study was carefully designed to ensure its quality and trustworthiness, the researcher makes no claims that the research is reliable. The researcher recognises that her own perspectives and experiences as a lecturer and researcher (and indeed as a learner of mathematics) influenced the design of the study and the reporting and interpretation of the research results. Other researchers may have chosen another survey or framed alternative research questions. Based on different theoretical perspectives and linked to their previous experiences, they may have reported or emphasised other aspects of the results or interpreted the data differently.

4.10 Summary

Chapter 4 has outlined the study design and methods and justified how they align with the conceptual framework. The research methodology provided the rationale for the use of the mixed method design and explained how data were collected and analysed, in order to address the research questions. The chapter detailed processes by which the participants were identified in the study.

4.10.1 Summary of methods

The research methods examined the level and range of maths anxiety in pre-service primary teachers and how pre-service teachers perceived themselves as learners and teachers of mathematics. The study investigated how this perception develops during the bibliotherapy process.

4.10.2 Summary of data collection

The data gathering strategies were planned over different phases. The different phases are summarised in Table 4.12.

Table 4.12

The phases of data collection

Phase	Participants	Purpose/aim
Phase 1 RMARS survey,	First year pre-service teachers, 2012	A number of sources of information can be used but the voice of the individual is critical
Phase 2 Tutorial	First year pre-service teachers, 2012	Perceived experiences of individuals within the context of their environment.
Phase 3 Small-group workshop	Second and fourth-year pre-service teachers, 2013, 2015	A number of sources of information - the voice of the individual is critical
and Semi-structured one on one interviews	Pre-service teachers who had participated in the small-group workshops, 2013 and 2015	To obtain feedback on the impact of the workshops

4.10.3 Audit of data collection

The data collection for the study took place in three phases, as Table 4.12 showed. These extended over a number of years, as shown below in Table 4.13.

Table 4.13

Timeline for data collection

Campus	Year	PST year	Instrument
C1, C2	2012	1	Administration of RMARS survey
C2	2012	1	CIT, cognitive bibliotherapy in tutorials
C1, C2	2013	1	Administration of RMARS survey
C1	2013	2	CIT, interactive bibliotherapy in workshop
C1	2013	2	Interviews
C1	2015	2,4	CIT, interactive bibliotherapy in workshop
C1	2015	4	Interviews

Note: RMARS, Revised Mathematics Anxiety Rating Scale; CIT, Critical Incident Technique

4.10.4 Summary of analysis of the data

The multi-scope analysis (Grimm & Railsback, 2012) used of a range of analytical methods including ones adapted from other disciplines. The survey results were presented through descriptive and inferential statistics. Analysis of the narrative methods of CIT and bibliotherapy identified themes, guided by the main concerns of the participants. The stages of bibliotherapy also provided a framework for analysis.

4.11 Conclusions

In keeping with the pragmatist school of thought, mixed method was chosen as the most appropriate approach to addressing the research questions. Consequently, the study derived data from a range of methods. Their choice was guided by the conceptual framework and the need to consider the research methods which were appropriate to a study in the affective domain. In addition, the decisions regarding methods were informed by the issues raised in Chapter 3 regarding the need to align the methods chosen with the construct of maths anxiety developed in this thesis. The advantages and limitations of the methods were considered at each stage of the study. The analysis of the data drew on a range of analytic techniques, some of which were determined to be appropriate as the themes from the findings emerged.

4.12 Progression of the thesis

To this point, this thesis has presented the rationale, framework and literature, and methodology of the research study of pre-service teachers' experiences as they explore new ways of understanding their feelings about mathematics and try to reduce the detrimental impacts of maths anxiety. Chapter 1 described the global and educational

context, rationale, aim, and implications of the thesis. Chapter 2 presented a focussed review of the literature about pre-service teacher maths anxiety and previous research into means of addressing this anxiety. Chapter 3 presented the conceptual framework for the study

This chapter presented the justification and outline of the research methodology for this mixed method study, including the specific methods, and their limitations.

Chapter 5 will present the results of the RMARS survey (Alexander & Martray, 1989) and CIT (Flanagan, 1954) and analyses of these for levels and extent, and perceived causes, of the participants' maths anxiety.

Chapter 6 will explore the impact of the technique of bibliotherapy on the pre-service teachers, particularly on their anxiety towards mathematics, presenting the results for Research Question 2a.

Chapter 7 will analyse insights provided by pre-service teachers who took part in the interactive bibliotherapy in the small group workshops, thus addressing Research Questions 2b and 2c.

Chapter 8 will discuss the conclusions and implications for educational practice, contributions to the literature and will make recommendations for future research.

CHAPTER 5: DETERMINING THE RANGE AND EXTENT OF MATHS ANXIETY IN BEGINNING PRE-SERVICE TEACHERS

The main strength of this narrative approach that has clearly emerged is the possibility of collecting the aspects and details that respondents consider relevant in the development of their relationship with mathematics. The narrative approach differs from the use of traditional attitude scales—where respondents are requested to express agreement/disagreement on items chosen by others that are sometimes irrelevant for them—in that respondents can specify what they consider crucial and skip what they consider irrelevant. That is, the narrative approach brings out what is central for the respondents. (Di Martino, in Hannula et al. 2016, p. 5)

Overview

This chapter is the first of three chapters that present the findings of the study. Chapters 5, 6, and 7 present findings for Phases 1, 2, and 3, respectively (see phases of data collection in Section 4.7.1 and Table 4.9). This chapter reports on the range and extent of the pre-service teachers' maths anxiety at the beginning of their course; and the causes, perceived by them, of that anxiety. Quantitative data for both campuses were drawn from the RMARS survey (Alexander & Martray, 1989). These are presented in Section 5.2. In addition, pre-service teachers' written views of themselves as learners and potential teachers of mathematics, and their views of mathematics, were collected in tutorials from pre-service teachers on Campus 2 as qualitative data to supplement the quantitative data from the surveys. The pre-service teachers' anonymous responses were coded and examined for evidence of anxiety (Section 5.3). Reflections on critical incidents in their school mathematics classrooms were also collected in tutorials from pre-service teachers on Campus 2 for analysis for causes of maths anxiety (identified by participants). During analysis, the critical incidents were coded for themes emerging from the data, and those identified from the literature. Additional analysis of the critical incidents was conducted using Leximancer text analysis software (Leximancer, 2018), in order to confirm concepts and themes (Section 5.4). Section 5.5 draws the major points and conclusions from the foregoing sections.

5.1 Introduction

This study used a sequential exploratory mixed methods design (Yin, 2006) to investigate and address maths anxiety experiences of Australian pre-service teachers. This chapter presents the findings and analysis of data collected during Phase 1 of data collection. Justification for, and details of, the administration of the RMARS survey, and the rationale for the use of CIT and collection of reflections in tutorials were explained in Chapter 4, Section 4.6. The data comprised quantitative and qualitative data, which were analysed in order to address the following research questions:

1. With what range and extent of maths anxiety do pre-service teachers present?
 - 1a. What are the indications for influences that have stimulated this anxiety?

The RMARS survey (Alexander & Martray, 1989) was used to measure the range of maths anxiety in pre-service teachers starting a teacher education course on two campuses of an Australian university. The methods for analysis of these results were described in Section 4.8.2. Low response rates from participants are traditional issues in survey-based research (Saleh & Bista, 2017). To overcome potential recruitment issues, hard copy surveys were distributed in a lecture at the beginning of the semester. Comparisons with enrolment figures indicated response levels of approximately 90 percent to the survey. Participation numbers in the cognitive bibliotherapy over the three tutorials varied, and it was not possible to ascertain ongoing changes because of late enrolments during the semester. However, the author is confident that the response rate was more than 60 percent.

The quotation from Di Martino (in Hannula et al., 2016) which headed this chapter, explains the appropriateness of using the narrative approach to supplement the results of the survey in this mixed method study. In line with this thinking, CIT (Flanagan, 1954) was chosen as an appropriate method to elicit reflections written by participants to enrich the answers to research question 1. As Section 4.6.2 described, participants wrote in tutorials about how they felt about and saw themselves as learners and potential teachers of mathematics. Then they described a critical incident from their own school mathematics education that impacted on this image of themselves. In the next tutorial, participants described their views of mathematics.

The findings from the survey and CIT are presented below.

5.2 Range and extent of pre-service teacher maths anxiety – quantitative results

Pre-service teachers responded to the RMARS and a set of demographic questions. The data analysis for this survey utilised descriptive statistics and inferential statistics, as Section 4.8.2 described. The quantitative results of the RMARS surveys administered in two consecutive years are presented below.

Four different groups of pre-service teachers were surveyed (see Table 4.1). Surveys from 219 participants were collected at the beginning of Semester 1, 2012. Sample 1 (57 – 45 females: 12 males) from Group A came from Campus 1, located in a regional city and Sample 2 (162 – 140 females: 21 males: 1 not specified) from Group B was from Campus 2, located in a major metropolitan city. Participants rated each of the 25 questions from 1 to 5, so the minimum possible score was 25, and the maximum possible score was 125. Means and standard deviations for the total scale scores on the RMARS were computed and are shown in Table 5.1.

Table 5.1

Total anxiety scores of pre-service teacher sample in 2012 as measured by the RMARS.

PST samples	N	Range	Mean	SD
Total PST	219	31–116	63.32	16.74
Campus 1	57	31–104	66.02	19.19
Campus 2	162	34–116	62.78	17.86
Females	185	31–116	64.01	18.44
Males	33	35–108	62.24	17.90
Less than 25 years	192	31–116	62.44	17.73
25 years and over	26	35–112	73.58	19.75

This table of results was published in Wilson (2015).

The 2012 results show that the participants exhibited a broad range of anxiety levels. Scores ranged from 31 to 116, with a mean score of 63.32 and a standard deviation of 16.74. The results indicate that approximately 23 percent of participants had moderate or high levels of anxiety. Comparing participants from the two campuses, Campus 1 had a mean score of 66.02 and a standard deviation of 19.19, and Campus 2 had a mean score of 62.78 and a standard deviation of 17.86. No significant differences were found

between the cohorts from the two campuses on the total RMARS scores, $p > 0.05$. These results indicated that there was a wide range of maths anxiety within participants from both campuses, but that the cohorts on the whole were not significantly different.

Concurrent validity of the instrument was investigated using the 2012 results by examining the relationships between the RMARS scores and students' self-rating on a scale of 0–100 of their general and current maths anxiety levels, using paired t -tests. The analysis showed that there were no significant differences between the pre-service teachers' estimates of their general levels of maths anxiety and their current level of maths anxiety at the completion of the survey. However, relationships were found between the RMARS scores and students' self-rating of their maths anxiety levels. The RMARS scores were significantly different to the general maths anxiety level rating ($p < 0.01$), but not to their current level of maths anxiety. This indicates that the RMARS scores were a better indication of their perception of their current level of maths anxiety, than of their general level.

Surveys were collected from 208 participants from the same two campuses at the beginning of Semester 1, 2013. Sample 1 (63 – 50 females: 13 males) from Group C came from Campus 1, and Sample 2 (145 – 126 females: 18 males: 1 not specified) from Group D came from the Campus 2. Means and standard deviations for the 2013 total scale scores on the RMARS were computed and are summarised in Table 5.2.

Table 5.2

Total anxiety scores of pre-service teacher sample in 2013 as measured by the RMARS.

PST samples	N	Range	Mean	SD
Total PST	208	30–125	64.74	18.39
Campus 1	63	30–110	64.05	18.07
Campus 2	145	31–116	65.03	18.58
Females	176	30–125	65.97	18.52
Males	31	33–89	57.71	16.19
Less than 25 years	192	30–125	64.43	18.42
25 years and over	16	32–103	68.44	18.75

Note: These tables of results (Table 5.1 and 5.2) were published previously (Wilson, 2015); RMARS, Revised Mathematics Anxiety Scale; PST = pre-service teacher.

Total Anxiety scores ranged from 30 to 125, with a mean score of 64.74 and a standard deviation of 18.39. As in the previous year, the participants exhibited a broad range of anxiety levels, ranging from almost no maths anxiety to very high levels of anxiety. An independent-samples t-test was conducted to compare campus differences in maths anxiety. In both years, there was a wide range within the campus cohorts, ranging from very little maths anxiety to very high levels of anxiety, with almost half of the participants acknowledging at least a fair amount, and 2 percent high to very high levels, of anxiety. No significant differences in Total Anxiety were found between the cohorts from the two campuses in either year. They were statistically equivalent on the total RMARS scores.

Subsequently, the researcher investigated the structure of maths anxiety via factor analysis. Investigation of the scree plot and the eigenvalues indicated that a three-factor solution was most appropriate for these data. Rotation was performed, and the three-factor solution explained 63 percent of the variance. The structure of maths anxiety was assessed in terms of the three factors and is represented in Table 5.3.

Table 5.3

Three factor Structure of the RMARS. Semester 1, 2012

Item	Factor 1	Factor 2	Factor 3
1	X		
2	X		
3	X		
4	X		
5	X		
6	X		
7	X		
8	X		
9	X		
10	X		
11	X		
12	X		
13	X		
14	X		
15	X		
16		X	
17		X	
18		X	
19		X	
20		X	
21			X
22			X
23			X
24			X
25			X

Note: RMARS, Revised Mathematics Anxiety Scale

This structure replicated the three-factor solution reported by Alexander and Martray (1989), and Baloglu and Kocak (2006). Again, in 2013, a factor analysis (exploratory, principal component analysis) on the results of the survey indicated that the three factors explain 62 percent of the variability, and, using a varimax rotation, the three previously identified factors were acceptable.

After the three-factor structure was established, the factors were compared. No significant differences in the three factors were found between the cohorts from the two campuses in either year. Also, as on the total RMARS scores, Campus 1 and Campus 2 were statistically equivalent on the three subscales: Mathematics Test Anxiety (MTA), $p < 0.33$; Numerical Task Anxiety (NTA), $p < 0.09$; and Mathematics Course Anxiety (MCA), $p < .73$. Means and standard deviations are shown in Table 5.4.

Table 5.4

Means and standard deviations of the sub-scales of the revised mathematics rating scale.*

Factors	Mean (SD)	
	2012 (N=219)	2013 (N=208)
Mathematics Test Anxiety (MTA) /5	2.98 (0.82)	3.06 (0.83)
Numerical Task Anxiety (NTA)/5	1.77 (0.81)	1.85 (0.84)
Mathematics Course Anxiety (MCA)/5	1.80 (0.81)	1.90 (0.85)

* Standard deviations are reported within parentheses.

Note: this table of results was published in Wilson (2015).

Table 5.4 shows the factor analysis for the three contributing factors (MTA, NTA and MCA) for each of the two years. The score for each of the factors depends on the number of questions that contribute to that factor. In order to compare the levels of the anxiety components, each is presented as a score out of five. The analysis shows that for both years, the MTA factor was much higher than the other two factors. This indicates that the primary factor that arouses pre-service teachers' maths anxiety is testing or evaluation.

5.2.1 Age

Age differences were examined for the total scale scores on the RMARS as well as for the three subscales. For the purpose of this study, and in line with published research, mature-age pre-service teachers were defined as those 25 years and over. The 2012 results for age are shown in Table 5.5. Age differences in anxiety were found to be significant.

Table 5.5

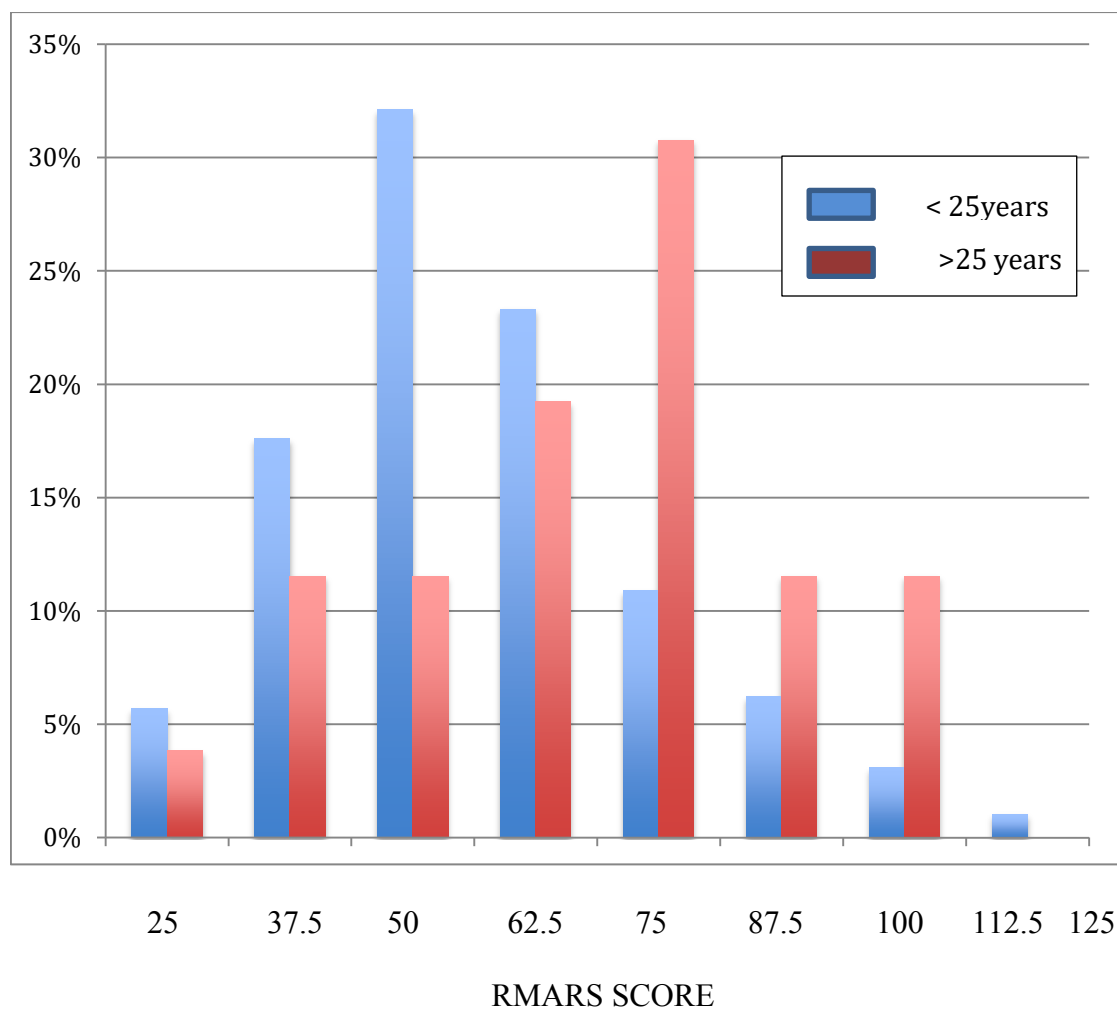
Means and Standard Deviations of maths anxiety by age group in 2012*

Factors	Mean (SD)	
	< 25 years (<i>n</i> =193)	≥ 25 years (<i>n</i> =26)
Mathematics Test Anxiety (MTA)	44.63 (12.26)	50.04 (11.78)
Numerical Task Anxiety (NTA)	8.80 (4.05)	11.81 (4.89)
Mathematics Course Anxiety (MCA)	9.01 (4.07)	11.73 (5.21)
Total anxiety	62.44 (17.73)	73.58 (19.75)

* Standard deviations are reported within parentheses.

The mature-age group demonstrated higher levels of maths anxiety with larger standard deviations. Table 5.5 shows relevant age-related results for the three subscales. Statistically significant differences were found between the scores of the younger and mature-age participants on the total RMARS scores, $t(217) = 2.97, p < 0.005$; and on the three subscales: MTA, $t(217) = 2.12, p < 0.05$; NTA, $t(217) = 3.47, p = 0.001$; and MCA, $t(217) = 3.09, p < 0.05$, with mature-age participants receiving higher scores.

Figure 5.1 shows the percentages of the younger than 25 years and mature-age, 25 years and over cohort's anxiety scores at each level of anxiety.



Increasing mathematics anxiety



Figure 5.1 Percentages of maths anxiety scores of younger (<25) or mature-age (25 and over) pre-service teachers.

The results of the analysis of age differences in total maths anxiety and the three subscales in 2013 are shown in Table 5.6. No significant differences were identified between age cohorts in 2013. This contrasts with the findings from 2012 (shown in Table 5.5). Although consistent trends are evident, and the mean scores of mature-age participants were higher than those of the younger cohort on all factors, no statistically significant differences were found, by using paired *t*-tests, in the second year of the survey.

Table 5.6

Means and standard deviations of maths anxiety by age group in 2013*

Factors	Mean (SD)	
	< 25 years (<i>n</i> =192)	≥ 25 years (<i>n</i> =16)
Mathematics Test Anxiety (MTA) /75	45.60 (12.30)	49.48 (13.05)
Numerical Task Anxiety (NTA)/25	9.30 (4.25)	8.78 (3.55)
Mathematics Course Anxiety (MCA) /25	9.01 (4.07)	10.18 (3.70)
Total anxiety /125	64.43 (18.38)	68.44 (18.75)

* Standard deviations are reported within parentheses.

The total scores on each sub-scale in the initial results from the survey reflect the different numbers of questions on each factor and thus are not comparable. In order to be able to compare the factors, the three results were expressed out of a total of five, in Table 5.7. This analysis shows that, for both age groups, the MTA factor is much higher than the other two factors. This supports the findings of the comparison of the two years' results shown in Table 5.4: the primary factor that arouses pre-service teachers' maths anxiety is testing or evaluation.

Table 5.7

Adjusted age means and standard deviations of the RMARS and its sub-scales for 2013 sample of pre-service teachers*

Factors	Mean (SD)	
	< 25 years (<i>n</i> =192)	≥ 25 years (<i>n</i> =16)
Mathematics Test Anxiety (MTA)	3.04 (0.82)	3.30 (0.87)
Numerical Task Anxiety (NTA)	1.86 (0.85)	1.76 (0.71)
Mathematics Course Anxiety (MCA)	1.88 (0.86)	2.04 (0.74)

* Standard deviations are reported within parentheses. Note: RMARS, Revised Mathematics Anxiety Scale

5.2.2 Gender

Gender differences were examined for the total scale scores as well as for the three subscales within the age groups. In 2012, no significant differences were found between females and males on the total RMARS scores, $p < 0.61$, nor on the three subscales (MTA, $p < 0.32$; NTA, $p < 0.71$; and MCA, $p < 0.30$). These results are shown in Table 5.8.

Table 5.8

Means and standard deviations of maths anxiety by age group and gender in 2012*

Factors	Mean (SD)			
	Younger (< 25 years)		Mature-age (≥ 25 years)	
	Females $n = 167$	Males $n = 25$	Females $n = 18$	Males $n = 8$
Mathematics Test Anxiety (MTA)	45.13(12.48)	41.04 (10.40)	49.94 (12.20)	50.25 (11.57)
Numerical Task Anxiety (NTA)	8.94(4.09)	7.92 (3.84)	11.72 (5.05)	12.00 (4.84)
Mathematics Course Anxiety (MCA)	9.01(4.16)	9.00 (3.62)	11.00 (5.30)	13.38 (4.93)
Total anxiety	63.08(18.08)	57.96 (15.16)	72.67 (20.09)	75.63 (20.13)

* Standard deviations are reported within parentheses.

However, in the 2013 cohort, female participants had significantly higher levels of maths anxiety ($p = 0.001$). In addition, they had a significantly higher MTA component of their maths anxiety ($p = 0.002$). The results for 2013 of analysis of gender differences in the three factors are shown in Table 5.9.

Table 5.9

Gender means and standard deviations of the RMARS and its sub-scales for 2013 sample of pre-service teachers*

Factors	Mean (SD)	
	female (<i>n</i> =177)	male (<i>n</i> =31)
Mathematics Test Anxiety (MTA)	46.95 (12.26)	39.60 (11.78)
Numerical Task Anxiety (NTA)	9.45 (4.05)	8.30 (4.89)
Mathematics Course Anxiety (MCA)	9.40 (4.07)	9.95 (5.21)
Total anxiety	65.97 (18.52)	57.71 (16.19)

* Standard deviations are reported within parentheses; Note: RMARS, Revised Mathematics Anxiety Scale

As with the age results, the total scores for each sub-scale in these results reflect the number of questions on each factor. In order to be able to compare the factors, the three results were expressed out of a total of five, in Table 5.10.

Table 5.10

Adjusted gender means and standard deviations of the RMARS and its sub-scales for 2013 sample of pre-service teachers*

Factors	Mean (SD)	
	female (<i>n</i> =177)	male (<i>n</i> =31)
Mathematics Test Anxiety (MTA)	3.13(0.82)	2.64(0.76)
Numerical Task Anxiety (NTA)	1.89 (0.83)	1.66 (0.89)
Mathematics Course Anxiety (MCA)	1.87 (0.85)	1.99 (0.83)

* Standard deviations are reported within parentheses. Note: RMARS, Revised Mathematics Anxiety Scale

This analysis shows that, as in the age comparisons shown in Table 5.7, the MTA factor is much higher than the other two factors in the gender comparison. This further supports the findings of the comparison of the two years' results shown in Table 5.4:

the primary factor that arouses pre-service teachers' maths anxiety is testing or evaluation.

5.2.3 Rurality

The maths anxiety levels of pre-service teachers who had attended rural schools were compared with those who had attended metropolitan schools. This division was based on participants providing the postcode or name of the town or suburb in which they attended high school. The 2012 results showed that participants who had attended rural high schools demonstrated a range of levels of maths anxiety, with no significant differences from those who had attended metropolitan high schools. There were smaller than expected numbers of rural students in the research population.

5.2.4 Discussion of quantitative results

The surveys provided information on the level and range of anxiety with which pre-service teachers start their teacher education course. On both campuses, and in both years, there was a range of maths anxiety displayed by the incoming pre-service teachers. However, there were no significant differences between the campuses in either year.

The research results show that primary pre-service teachers exhibit concerning levels of maths anxiety. This supports findings of previous researchers, who have identified that a noteworthy proportion of pre-service teachers have high levels of maths anxiety (Bursal & Paznokas, 2006; Gresham, 2007, 2008; Sloan et al., 2002; Vinson, 2001).

The inconsistencies in the results indicate that the level and distribution of maths anxiety in groups of incoming pre-service teachers may vary from year to year. It is evident from these results that beginning teacher education students are not uniform with respect to the level of their affective responses towards mathematics. Furthermore, these anxieties may present differently when taking a mathematics test, doing mathematical computations, or undertaking a mathematics course. This aligns with the conclusions of Cooke et al. (2011), based on their survey of different types of anxiety responses in a range of contexts.

The researcher sought to compare her findings with international findings of levels of maths anxiety in pre-service teachers, as measured by the RMARS. Researchers

commonly present average and standard deviation for the whole survey and do not publish the breakdown of the factors (see results listed in Table 5.11, for example.)

Table 5.11

Comparison of RMARS results from the literature

Author, year	Cohort	Mean (SD)
Ashcraft & Kirk, 2001	U.S. undergraduates <i>n</i> = 66	61 (16)
Bowd & Brady, 2002	U.S. final year B.Ed. <i>n</i> = 357	46.56 (15.74)
Haynes, 2003	U.S. undergraduates <i>n</i> = 75 <i>n</i> = 85	67.05 (21.25) 66.26 (16.89)
Johnson, 2003	U.S. community college students <i>n</i> = 57 <i>n</i> = 89	62.33 (20.34) 64.61 (19.56)
Baloglu & Kocak, 2006	U.S. elementary pre-service teachers <i>n</i> = 117	69.22 (20.38)

* Standard deviations are reported within parentheses; RMARS, Revised Mathematics Anxiety Rating Scale.

The studies in Table 5.11 have been completed with undergraduates from the USA. An additional issue that arises in attempting to compare research findings is that these results are sometimes quoted for cohorts that include both pre-service teachers and other undergraduates (e.g., Ashcraft & Kirk, 2001). This makes it difficult to perform comparisons, as the results for the different cohorts are not given separately. However, the mean maths anxiety levels from the current study (63.32 in 2012 and 64.74 in 2013) are comparable to those from other researchers. An exception to the findings from other researchers, is the results for the final year pre-service teachers (Bowd & Brady, 2002), which show lower levels of maths anxiety. This underlines the fact that a consistent pattern of results has not been reported in the literature.

The factor analysis supported the three-factor solution reported by Alexander and Martray (1989) and Baloglu and Kocak (2006). Although Bowd and Brady (2002) also reported the same three factors, they defined MTA by 11 items, Mathematics Course Anxiety (MCA) by eight items, and Numerical Task Anxiety (NTA) by four items. They concluded that the RMARS “gives measures of three meaningful constructs and

its factorial structure may vary somewhat with different populations” (p. 200). Baloglu and Zeldhart’s (2007) confirmatory factor analysis, also found the same three factors identified by Alexander and Martray. However, five of the MTA items did not map to that factor and were removed to produce a 20-item RMARS. They reported that, based on reliability investigations, the total scale and subscales were highly reliable, and they confirmed the three-factor structure.

Another difficulty in directly comparing results with other research directly, is that a number of different surveys has been used (see Table 3.2), although many of these surveys have been derived from the original MARS (Richardson & Suinn, 1972). Even when studies using the RMARS survey were identified as a basis on which to compare findings, the issue of what is reported as “high levels” of maths anxiety arose. Some researchers reported “high” levels of maths anxiety as a comparison with their sample. For example, Adeyemi (2015) followed the method of Ashcraft and Kirk (2001), categorising participants in her study into low, medium, and high anxiety using scores based on the sample mean and standard deviation, rather than levels of low, moderate or high anxiety that relate to the descriptors in the survey. This meant that RMARS results of 25 were reported as low anxiety, although that figure corresponds to the descriptor of “no maths anxiety”. This becomes an issue in comparing conclusions. Consequently, the author has been circumspect in making direct comparisons of quantitative results. However, it should be noted that, even when the results were based on different surveys, the conclusions are consistent with the findings from the current study.

The survey revealed that, in some instances, pre-service teachers came to their teacher education course with levels of maths anxiety already established. The survey identified that maths test anxiety was the biggest contributing factor to this anxiety. Flegg and Trimmer (2015) reported that they were informed by other students, on occasions, that students who knew they had maths challenges deliberately did not do the test so that they would not have confirmation of their problem. This may link to recruitment issues in the current study.

These cohorts had much smaller numbers of males than females, and of mature-age students than those younger than 25 years. This is a consistent pattern on both campuses and across Australian universities, although not necessarily of participants in all studies.

For example, Uusimaki and Nason (2004) worked with a class of predominantly mature-age pre-service teachers, which was unusual.

The findings in the 2013 cohort, that female participants had significantly higher levels of maths anxiety, were not consistent with the 2012 findings. In the 2012 results, female participants recorded higher, but not significantly higher, levels of maths anxiety. In terms of gender differences, the findings in the 2013 cohort, that female participants had significantly higher levels of maths anxiety, are consistent with previous findings of gender differences in the RMARS scores (Alexander & Martray, 1989; Baloglu & Kocak, 2006) and MARS scores (Brady & Bowd, 2005). Chapter 2 noted that the results for gender differences reported by researchers vary, with some researchers finding that female pre-service teachers have higher levels of maths anxiety, but others recording no significant difference. This underlines the complexity of this issue.

A similar situation arises from the results for age. In 2012, the mature-age group demonstrated significantly higher levels of maths anxiety in both the total maths anxiety score and the three subscales, suggesting that older participants show higher levels of maths anxiety than younger ones. However, although there was a pattern of higher levels of maths anxiety in the mature-age group in 2013, this was not statistically significant. The 2012 findings that the mature-age group demonstrated higher levels of maths anxiety in both the total maths anxiety score and the three subscales align with the findings of Baloglu and Kocak (2006) that older college students show higher levels of maths anxiety than younger ones. However, in their study, they reported that MTA and Mathematics Course Anxiety (MCA) were more instrumental in the anxiety of their older cohort than Numerical Task Anxiety (NTA) was, whereas, in the current study, the differences in the NTA results were more noteworthy. In the Australian context, Owens (2008) reported that mature-age first-year pre-service teachers approached their mathematics unit with more anxiety than younger ones. Other researchers (e.g., Beswick, 2006) have reported increased anxiety in pre-service teachers in the later years of their teacher education course.

In terms of rurality, analysis in the first year of the survey indicated that there were no significant differences identified between participants from rural and cosmopolitan high schools. Analyses were discontinued, as the number of participants who had attended rural high schools was much smaller than anticipated.

5.3 Elaborating the range and extent of pre-service teacher maths anxiety – qualitative findings

Descriptions and reflections of critical incidents were collected from Group B – Campus 2 pre-service teachers – during tutorials in Semester 2, 2012. The findings of the tutorial reflections and critical incident descriptions provided further data for the first research question. The research design incorporated the collection of qualitative data in order to investigate to what extent the results based on the quantitative data from the survey could be corroborated by examination of open-ended written responses. The data set that was analysed in order to investigate whether maths anxiety could be confirmed as an issue comprised the responses to the three reflective prompts from Tutorials 1 and 2. In addition, the responses to the Dossel (1993) reading in Tutorial 2, and further reflections on this reading from tutorials 4 and 12, were scrutinised for evidence of anxiety.

Qualitative elaboration is provided to supplement the findings for Research Question 1. In the RMARS survey, participants rated their emotional responses to certain mathematical experiences in their current lives, whereas, in writing the CIT, participants identified past incidents that still impact on their feelings about themselves. Thus, both research methods focus on relating aspects of emotional responses to lived experiences (Lazarus, 1991). Responding to the survey required rating anxiety as one of five levels. However, the CIT involved open-ended responses, allowing participants to express themselves in more detail.

In the responses to the three prompts in Tutorial 1, of the 268 respondents, 141 respondents (53 percent) used language that indicated feelings of anxiety (for example – anxious, insecure, nervous, not confident) in response to the reflection prompts and critical incident. Examples of these responses are provided below.

5.3.1 Initial analysis of responses to prompts

The answers to the prompts were analysed separately, and then in combination. Responses used in illustration are followed by participants' alphanumeric identification.

Views of selves as learners of mathematics. The reflections encouraged participants to think about themselves as learners of mathematics. This provided evidence of their

self-images and comparisons with their peers, and, for some, their fears that they could not achieve in mathematics:

My image of myself as a learner and teacher of maths started at a young age (year 4-5) when I couldn't keep up with the children in my class. This continued in high school therefore shaping my attitude negatively towards maths. (T772)

That I was not very good at it and therefore I had no interest, and it was too hard. Where I was able to, I would avoid it and only attempt it when necessary. (C054)

These comments contrast with those from participants who felt confident:

Positive I feel confident as a learner of maths. It's logical and it makes sense and easy to follow. (C528)

Still other participants qualified their responses:

I feel that if I get a deeper understanding of mathematical content that I will feel more confident teaching it. (R262)

Views of selves as potential teachers of mathematics. At the beginning of their teacher education course, many participants expressed optimistic views of themselves as future teachers of mathematics, based on their desire to provide positive experiences for students:

I feel I will be a good teacher because I struggled so much therefore will be happy to sympathise with students. (D614)

For some participants, their view as a mathematics learner: "I am not confident in studying maths and hope this unit doesn't get too complicated," directly impacted on their view of themselves as potential teachers: "Although I am not confident in my math skills at present I am looking forward to improving my understanding and becoming confident before I attempt to teach maths" (J701). These connections were very marked for other participants. For example, as a learner, J194 stated: "I feel nervous because I'm slow," and as a potential teacher "I feel stressed and nervous." Another respondent was "not interested" as a learner, and as a potential teacher, was "scared to teach maths as I wasn't any good" (D061).

As a marker of this lack of confidence, although participants presented positive views of themselves as potential teachers of mathematics, they were anxious that students might not understand the mathematical concepts they were explaining. Difficult experiences, for these participants, made them more determined to ensure that they helped their future students to learn mathematics.

Participants commented on their concerns about:

- the impact of their poor maths on teaching: “Eager but worried that I will not know the answers the child asks or does not learn from how/what I teach” (K901); and
- the need for explanations: “I do worry that I will have trouble explaining new concepts to students” (L062); and
- qualified their assessment of themselves: “If I learn it well then I will be able to teach it well to children” (M185a)

Views of mathematics. An important part of the pre-service teachers’ reflections involved the view of mathematics that had developed during their schooling. In their reflection on their feelings towards mathematics, the responses of 88 students out of 267 (33 percent) showed that they had had negative views of mathematics. These participants described mathematics as boring, difficult, and intimidating:

I hate maths – it bores me, it frustrates me, and I just don’t like it. (D519)

It’s hard and intimidating because if you get one thing wrong in your working out, the answer will be wrong. There are lots of rules and terminology I don’t understand. (Z570)

I was always an average student, could have done better but found it intimidating – was the one subject I had to work at. (C054)

Aggregated Views. In order to make sense of this, in further analysis, the participants were grouped on the basis of their responses to the three prompts. These results are summarised in Table 5.12.

Table 5.12

Definitions of codes

Coding	Number	Percentage	Definition
POS	67	25 %	Felt competent or talented in mathematics, positive view of themselves as future teachers of the subject, and enjoyed mathematics
PQ	67	25%	Positive statement, with qualification
INT	84	32%	Neutral or indeterminate response
NQ	25	9%	Negative statement, with qualification
NEG	25	9%	Did not feel competent in mathematics, nor view themselves positively as a teacher of mathematics, and did not enjoy it
Total	268		

Participants coded as POS saw themselves as competent or talented in mathematics, expressed a positive view of themselves as future teachers of the subject, and reported that they enjoyed mathematics. In comparison, those coded as NEG did not feel competent in mathematics, and did not enjoy it; nor did they view themselves positively as a teacher of mathematics. Of the 268 participants who responded to two or more of the prompts, there were 67 who were identified as POS (25 percent) and an equal number (67, 25 percent) who started their response with a positive statement, but then qualified their answer. Examples of qualification of answers included:

Generally comfortable, however begin to feel worried when a hard topic is being studied. (F820)

I feel confident and willing to learn if I have a teacher who is nice and helpful. (L108)

I feel confident in particular areas of mathematics. However, I am not confident in areas of measurement. (S411)

There were 25 participants (9 percent) who responded negatively to all of the prompts, and another 25 (9 percent) who qualified their negative responses:

Anxious, although eager to deepen my understanding and expand my knowledge of maths. (T424)

The remaining 84 participants provided neutral responses or a combination of positive and negative responses.

5.3.2 Findings from cognitive bibliotherapy

Although Phase 1 of the study was designed to provide data for Research Question 1, it was found that some data from Phase 2, cognitive bibliotherapy, also substantiated these findings.

Of the 238 participants who provided written responses to the reading (Dossel, 1993) in Tutorial 2, 80 participants identified their own maths anxiety in their responses. In addition to these, 19 more participants commented on their own maths anxiety when asked to reflect on the impact of this reading on them two weeks, later in Tutorial 4. An additional 6 commented in the final tutorial. In total 105 (44 percent) of participants wrote comments about their own anxiety in response to the reading. Examples of responses that demonstrated anxiety were:

I was the child crying over maths work. (D614)

I understand many of the effects of maths anxiety as I experienced them myself. (M633)

I need to overcome my anxiety. (A009)

I feel now that I understand why I have such high maths anxiety. (S409)

Some comments showed that their maths anxiety impacted on their engagement with their current course:

At first, I was still anxious about maths. I opened my workbook freaked out and closed it again and I wouldn't answer any questions in class. (D419)

5.3.3 Discussion of qualitative findings

These data confirmed previous findings that Australian primary pre-service teachers have concerning levels of maths anxiety, in common with those from other countries. Both the level and range of maths anxiety with which participants came to their course, as well as their views of themselves as learners of mathematics, provide evidence that historical difficulties with teaching and learning mathematics have continued into the 21st Century.

The pre-service teachers' views of themselves as learners and potential teachers of mathematics indicated that anxiety was an issue for noteworthy numbers of pre-service teachers. These findings provide further confirmation of the presence of maths anxiety in pre-service teachers, found by the RMARS survey. Analysis of the critical incidents provided further evidence of anxiety that affected pre-service teachers. Just over half the respondents used language that indicated feelings of anxiety (anxious, insecure, nervous, not confident). This proportion is consistent with the results indicated by the survey means in this study. However, it is higher than the frequencies of approximately 40 percent obtained by other researchers from surveys (Boyd et al., 2014; Di Martino & Sabena, 2011), or self-reporting (Perkins, 2016). In subsequent tutorials, responses continued to include additional evidence of anxiety. This demonstrates the difficulty of reconciling findings obtained by different methods.

At the beginning of their teacher education course, some participants expressed confidence in themselves as future teachers of mathematics linked to their desire to provide positive experiences for students. Researchers have suggested that this initial confidence may be misplaced. For instance, Swars et al. (2006) reported that pre-service teachers, irrespective of their level of mathematics anxiety, believed that they could teach mathematics effectively to their students.

In seeming contradiction to this, however, participants in this study were concerned about their explanations to future students. Participants' views of themselves as potential teachers of mathematics showed that they were anxious that students might not understand the mathematical concepts which they were explaining. Their desire to avoid mistakes with their students, and concern about passing their anxiety on to their students, also relates to previous research. These responses compared with Hannula et al.'s (2005) VOM factor F5 – insecure as a mathematics teacher – that included level of competence in maths and not being able to give explanations. Concerns were also expressed about passing their anxiety on to their students, as was seen in previous studies (Di Martino & Sabena, 2011; Jackson, 2008). Brown et al. (2012) found that pre-service teachers who had difficult personal experiences in learning mathematics used these difficulties as an impetus to employ a variety of instructional methods, so that they could help every child to learn mathematics (p. 379). It is possible that the

initial confidence expressed by participants related to their wish to provide the positive experiences for their future students that they themselves had lacked.

In reporting their views of mathematics, some participants described mathematics as boring. These findings relate to Kaasila's (2002) study of autobiographical narratives of primary pre-service teachers. He found that 36 percent identified that mathematics was boring, and they lost interest.

Researchers have reported that negative views persist during their course. For example, Itter and Meyers (2017) investigated 152 third year Australian pre-service teachers, using their written reflections about their categorisation of their attitudes towards mathematics. More than one-third, (52/152) described their attitude in negative terms. This is concerning in light of the importance of their future careers.

5.4 Causes of pre-service teachers' maths anxiety – qualitative findings

The findings of the tutorial reflections and critical incident description address the Sub-question 1a: What are the indications for influences that have stimulated this anxiety?

In order to address Sub-question 1a, the data set of the critical incident description was analysed in order to investigate the sources of anxiety that could be identified. Analysis of the critical incidents provided further evidence of anxiety that still affected pre-service teachers through the incidents that they identified as impacting on their views. In addition, the responses to the bibliotherapy readings were scrutinised for further evidence. There is evidence that memories of their prior experiences still influence them. This will be explored in greater depth in Chapter 6.

5.4.1 Analysis of responses to prompts

Although the initial prompts asking for their views were not aimed at identifying causes, some attributions of causes were obvious from the responses. For example, ongoing comparisons with their peers were stated:

My image of myself as a learner and teacher of maths started at a young age (year 4–5) when I couldn't keep up with the children in my class. This continued in high school therefore shaping my attitude negatively towards maths". (T772)

5.4.2 Critical incident responses

The data collection technique aligned with the narrative methodology and allowed the researcher to listen to the voices of the participants using narrative inquiry embedded in an interpretive framework in order to understand their past actions through their reflections on past experiences. Recalling and writing about critical incidents in their own school mathematics learning evoked intense emotions in many pre-service teachers. Analysis of the critical incidents provided further evidence of anxiety that still affected pre-service teachers through the incidents that they identified as impacting on their views. In addition, there is evidence that their memories of their prior experiences still influence them. These will be explored in greater depth in Chapter 6.

The analysis sought to identify factors that are recurrent, but the CIT also permitted unique factors to be identified. In order to take advantage of the opportunities for analysis, a multiple approach to the analysis was developed, including:

- quantitative data analysis
- thematic analysis (Braun & Clarke, 2006)
- leximancer analysis (Leximancer, 2018)

Quantitative data analysis. Of the 268 participants, 243 wrote responses to the critical incident prompt (a 91 percent response). Some described a positive and a negative incident or a change from one to the other, indicated by the (5) in Table 5.13, making 248 descriptions in total. Of these 248 responses, 87 (35 percent) were positive and 161 (65 percent) were negative. However, positive and negative prior experiences did not always match pre-service teachers' reflections on their anxiety responses, as shown by Table 5.13.

Table 5.13

Critical incidents compared with aggregated views of mathematics

		Critical incident	Positive CI	Negative CI
Aggregated view of mathematics				
POS	67	58	44	14
PQ	67	61	24	37
INT	84	77	12	65
NQ	25	24	5	19
NEG	25	23	2	21
		(5)		(5)
	268	248	87	161

Note: CI, Critical Incident; POS, positive; PQ, positive with qualification; INT, indeterminate; NQ, negative with qualification; NEG, negative.

Table 5.13 compares the proportions of positive and negative critical incident descriptions recalled by the participants to their aggregated views (see Table 5.12). Although the table shows that participants who have aggregated views that are negative have a much higher tendency to report negative critical incidents, those with more positive or intermediate aggregated views still report negative incidents; for the PQ and INT participants, these exceed positive incidents.

One advantage of the CIT is that it allows exceptional responses to be identified and discussed. It is not only looking for experiences that are common to many pre-service teachers. Even transitory or isolated incidents can have an impact:

I was in year 5 and I failed maths and since that day I hate maths. This experience makes me feel that I don't know anything about maths. (K611)

It was in year 10 and I failed the first test of the year; from this point on, I lost all of my confidence & still to this day I see it as a turning point in my maths education. (J210)

For this participant, this incident of failure and loss of perceived competence was described as a turning point. These impacts can be long-term:

I was in the highest maths class and it was so hard! I hated it immediately, became disinterested and knew the only downfall of me being a primary teacher would be my lack of interest in maths. (D519)

Although the prompt asked for a specific incident, many participants described events that took place over longer periods of time or happened a number of times. Of the participants 67 (28 percent) described a specific incident. Others described an ongoing situation, reflecting a more stable view of how they viewed themselves.

Of the responses, 226 specified the grade level of the incident. The 57 incidents that took place during primary school comprised 25 percent of these responses. The majority of the responses (169, or 75 percent) referred to incidents that occurred in high school.

Thematic analysis findings. In their accounts of the critical incidents, several themes predominated. These were *confidence*, *experiences of fear*, *failure*, and *avoidance*, *humiliation*, *the teacher*, *tests/examinations*, and *comparisons with their peers*. The themes are illustrated using quotations from the participants' responses; some quotations can easily be classified under more than one heading.

Confidence. Participants emphasised their lack of confidence. They described their mathematics classroom experiences in very emotional and personal ways when they wrote that they worried about being wrong and felt stupid if they made a mistake.

Year 4. Had to recite timetables. Hated it – seen as a joke. Couldn't succeed in the task. (D614)

Fear, failure and avoidance. Participants noted incidents that involved inability to complete activities in class. These incidents involved specific activities, such as completing times tables, fractions, and long division.

Explaining times tables, I didn't understand it. Teacher gave up, gave me 'colouring in' while other students learned maths. (M142)

I had to stand up in front of the class and say my times tables Feel – nervous & anxious, embarrassed. Still makes me feel nervous. (E540)

For some participants, this discomfort had led to avoidance:

I just hated maths so much in high school that I sat down the back of the school every class. My teacher would eventually come and find me! Year 11, I still feel butterflies in my belly when I think about it. (D052)

Humiliation. Their anxiety increased when being watched and feeling judged by others. They felt embarrassed by failure. This was often accompanied by feelings of humiliation because of the way that the teacher handled their failure:

Year 6 – I couldn't understand the concept of long division, so the teacher gave up on me and said don't worry about it. Looking back, it makes me feel like a failure. (J194)

The teacher. Of the 248 critical incidents, 140 (57 percent) were about the teacher. Of the 140 CI comments that concerned a teacher, 46 (33 percent) were positive and 94 (67 percent) were negative. To be coded as teacher, comments had to specifically mention the teacher. If a comment mentioned two teachers, in separate years, both were counted separately. Positive experiences emphasised personal attributes of the teachers. They related to the way that the participants felt as a result of interactions with teachers:

Year 8 – my teacher made me comfortable and helped me understand the task in a way that was not uncomfortable. (R962)

Year 11 to 12. Previously I had never been very good at maths. My teacher found ways to connect maths in ways I could relate to, making it fun. This developed my maths skills and attitude towards maths. (B781)

These participants identified the teacher's belief in them as very supportive for them. In contrast, other participants retained intense negative memories of their experiences with disabling teachers:

In year 9 the teacher wouldn't understand how we couldn't get the work. (K079)

Other comments that were associated with the contribution of teachers related to the teaching methods. Some of these related to the way that teachers introduced a new topic; others related to ability grouping and to embarrassment and feelings of exclusion. These facets of the environment of the classroom were identified as important. Although the themes of confidence; fear, failure and avoidance; and humiliation were described separately above, each can be related to the teacher. Participants particularly reported negative impacts from teachers' negative or insensitive comments. These

comments about teachers also related to the feelings of embarrassment and humiliation and showed the impact of teachers' comments made publicly:

In year 9, my teacher would make us answer questions on the board and if we got it wrong, he would say "Poor _____. What can we do with you?" (Z570)

Year 11 ... My teacher made it hard for me to learn and understand because he would give the class a time to finish answering a question and if I didn't know an answer, he would look at me and say: "You should know this." (B492)

Tests/examinations. Tests impacted on participants, in both positive and negative ways.

In year 7 I got 98% on my yearly exam & came first in the grade. This made me confident in maths for the rest of high school. (D887)

I think in year 11 when I was doing well in class but struggling in exams compared to the rest of the class that I thought I wasn't very good at maths. (S199)

I received a mark of 6 out of 60 and from then on, I gave up on maths, since then I have never studied any form of maths. (R836)

Comparisons with their peers. Incidents within the classroom predominantly involved a teacher, but peers were also identified as consequential:

In primary school I had one teacher who would always put you on the spot in front of a class and he would read out everyone's results in front of everyone too. This always made me anxious and from then on, I aimed to avoid maths. (C776)

When I entered an advanced maths class, was uncomfortable that I was behind others in the class & could not catch up. (V431)

Reflections on the influence of parents or family were not common, but an incident where a family member helped with homework showed powerful effects:

Nanna helped and pushed me in my maths. I am very grateful! (N345).

Another incident was also in the context of homework,

Parents always work, didn't get much help in math homework. (H346)

Parents also helped by organising tutors. Participants recalled:

my parents saying that I needed a tutor as I needed help in maths. (W291)

that was something that I struggled with until my parents put me in to tutoring that year. (J081)

Several participants looking back, re-evaluated the situation that they described and commented on a different view, or what they might have done.

When I think about this it makes me feel sad that I was unable to receive the help I need which has negatively impacted the way I feel about maths, (L435)

Now I see that by doing that the teacher was only trying to help me do better, (J225)

This provided evidence for some initial development of their projective identity.

Looking back, it makes me feel inspired because I see it in a new way, (M080)

I realised that I see myself as a learner that is willing to try and a teacher that is willing to make students understand what they have been taught. (C936)

Leximancer analysis. The vocabulary of the critical incident included many negative terms that demonstrated the level of emotion involved – “nervous and anxious, embarrassed,” “I felt lost,” “frustrated,” “feeling stupid,” “lot of stress.” Leximancer content analysis (Leximancer, 2018) includes both conceptual analysis and relational analysis: hence, there were two relevant outputs for the study. The output of the conceptual analysis, the ranked concept list, shows the presence and frequency of concepts. The output of the relational analysis, the concept map, shows the main relationship between concepts. The concepts are clustered into higher level themes based on their connectedness or commonality (Leximancer, 2018). The most common term identified by the ranked concept list was “confidence” with 89 comments referring to issues with confidence. The concept map showed the main relationship between concepts. The most important theme, shown by the number of concepts and colour-coded by a warm colour, was “teacher”. The major theme of teacher was centred on a cluster of concepts which were class, time, confidence, explain, understanding, teaching, learning, and exams. This supported and strengthened the findings from the previous thematic analysis of the important connection between teachers and the other themes identified.

5.4.3 Additional evidence from bibliotherapy responses

Although Phase 1 of the study was designed to provide data for Research Question 1a, data from Phase 2 also substantiated findings for this question. Of the 105 responses to the Dossel (1993) reading which made specific references to their own maths anxiety, some provided evidence of the source of their anxiety. Tests were emphasised:

The tests that were to see where we were up to, used to terrorise people. The slower you did it or the things you thought you didn't have to know stressed me out to the max. (S540)

The findings and analysis of the bibliotherapy responses to answer Research Question 2 will be presented in the next chapter.

5.4.4 Discussion of causes of pre-service teacher maths anxiety

In the current study, the participants identified the episode that was critical for them. This contrasts with other research methods, where the researchers themselves selected parts of participants' reflections for analysis. The reflections on the critical incidents that the participants had experienced as students provided evidence of how they felt in the first year of their teacher education course, whether positive or negative. This differs from other data collection techniques, for example, "worst experiences in mathematics" (Bekdemir, 2010; Jackson & Leffingwell, 1999) that directed participants to identify negative experiences. The use of CIT enabled the identification of positive experiences as well. This is also a feature of Coppola et al.'s (2015) investigation of "crucial events."

Recalling and writing about critical incidents in their school mathematics learning evoked intense emotions in some participants. This demonstrates the emotional investment of students in mathematics (Bibby, 2002; Hannula, 2002). Intense emotions were also reported by Coppola et al. (2015). The reported reasons for choosing the event were change of belief, change in relationship with mathematics, or recall of a significant or unexpected emotion.

Although the results from the RMARS survey indicated test anxiety as the largest contributor to participants' maths anxiety at the time of the survey, when asked about incidents in the past that gave rise to their anxiety, participants overwhelmingly

nominated incidents which involved teachers. Evaluation or testing also had important effects – especially for those participants who noted that one test result had a lasting impact. Hence, both the survey and the CIT contribute to understanding the perceptions of pre-service teachers.

The study identified the role of an individual teacher or teachers as a major theme. The finding that many participants attributed their maths anxiety to past negative mathematics classroom experiences with teachers is consistent with previous research reported (Arem, 1993; Bekdemir, 2010; Brady & Bowd, 2005; Jackson & Leffingwell, 1999; Sheila Tobias, 1978). It is also consistent with themes identified from mathematics autobiographies (Ellsworth & Buss, 2000; Sliva & Roddick, 2001). Grootenboer (2002) reported that, for New Zealand pre-service teachers ‘the most significant feature was the prominent place teachers had in the student-teachers’ recollections of their school experiences in mathematics’ (p. 14). Pre-service elementary teachers in Jackson and Leffingwell’s (1999) study of recollections of most challenging mathematical experiences reported that hostile behaviour, or insensitive and uncaring attitude of teachers at elementary, high school, and college levels produced or increased their anxiety towards mathematics. Sloan’s (2010) study reported that former teachers who appeared harsh, unapproachable, and intimidating, or used inadequate teaching methods, were to blame for the inception of pre-service teachers’ anxieties towards mathematics.

Importantly, participants in this study also identified the impact of individual comments from teachers. This links with van Manen’s (2008) idea of pedagogical tact:

To act tactfully as an educator may mean in a particular situation to be able to see what goes on with children, to understand the child's experience, to sense the pedagogical significance of this situation, to know how and what to do, and to actually do something right. Often tact involves a holding back, a passing over something, which is nevertheless experienced as influence by the student to whom the tactful action is directed. (p. 15)

Van Manen (2008) goes on to say that to:

act tactfully may imply all this, and yet, tactful action is instantaneous. The perceptiveness needed, the understanding or insight required, the feeling for the right action are not necessarily separate stages in a sequential process. Somehow,

perceptiveness, insight, and feeling are instantly realized in a mode of acting that is tensed with a certain thoughtfulness or thinking attentiveness; tact could be defined as a thinkingly acting. (p. 16)

Tact relates to the pathic dimensions of professional practice. Coppola et al. (2015) noted that one event such as a failure in a test, can provoke a positive or negative response from the student, depending on the teacher's handling of the event.

As well as teacher comments, participants reported negative impacts of teachers' rapid instructional practices. This is comparable with Brady and Bowd's (2005) study, where fast-paced instruction was reported as a cause by participants with high levels of maths anxiety. Chapter 1 noted that mathematics is still widely regarded as a discipline that focusses on instrumental knowledge and whose educators "usually emphasize teacher-directed methods such as lectures" (Cranton, 2011, p. 80).

The cycle of fear, failure and avoidance has implications for pre-service teachers' self-concept as learners of mathematics. Cramer (2000) cites denial as a defence mechanism against "an underlying sense of imperfection" (p. 640). She states that defence mechanisms protect against threats to identity and self-representation and can also ameliorate anxiety. Approximately two-thirds of the descriptions of critical incidents were negative. Participants perceived the incidents as a threat to their well-being, accepted blame, felt inadequate, and expected negative consequences. Some experienced anxiety and discomfort to the point where their response was to avoid the situation. These responses were emotion-focussed coping, such as a lack of action and strategies of minimisation (see Lazarus' model of emotion, discussed in Section 3.2.3).

The author reiterates that there is no claim that the critical incidents happened as the participants remembered them. The study is not examining whether that event happened as they remembered. Rather, it is helping them to reflect on themselves as learners of mathematics. Their views were developed because of their perception of an event and have been reinforced by the experiences that followed. What they experience now is filtered through their beliefs and colours their perceptions, reinforcing their attitudes. Past experiences leave traces. The pre-service teachers' views of a person or situation may be confirmed when they reflect on the past:

Unpleasant encounters with math in formative years can be ruinous to subsequent learning. Students who were made to feel bad about math become wary and prejudiced against it, mistrusting their own ability. New experiences in math, seen in light of the old, are tarnished by the troubled past, which only accentuates and reinforces long-entrenched negativity. (Arem, 1993, p. 19)

Participants internalised moments from their mathematics classroom experiences in very personal ways when they wrote that they felt “stupid” or “dumb” if they made a mistake. These findings are similar to those of Itter and Meyers (2017) who investigated 152 Australian third year pre-service teachers who wrote reflections about instances from primary school which included competitions based on speed and times tables, and social comparisons involving public failure. In high school their experiences were teacher-focussed and fast-paced, characterised by rote learning.

Of participants who indicated the class in which their critical incident occurred, 25 percent described critical events in their primary and 75 percent in their secondary schooling. In comparison, Coppola et al. (2015) reported from their study of Italian pre-service teachers that most incidents that involved emotions occurred in the primary school (57 percent), but there were more turning points in high school. Although 88 percent of participants identified the school level of their critical events, transitions between these were not commonly described. This contrasts with the findings of other researchers. Coppola et al. (2015) found that school transitions were the main perceived cause of a crucial event that impacted on pre-service teachers’ relationship with mathematics; and in Itter and Meyers’ (2017) study, 25 participants (17 percent) described negative impacts of their transition from primary to high school:

They lamented the shift from an interactive primary mathematics curriculum that involved games, investigations, and group work to a secondary mathematics curriculum that was teacher-centred, text-book focused, and procedurally oriented. (p. 129)

The study prompt asked for a specific incident, but 72 percent of participants described ongoing events. In contrast, Coppola et al. (2015) reported 39 percent of their participants did not describe a specific incident, but ongoing events.

Participants also compared themselves with their peers and thought that they could not see or understand what others could. Brown and McNamara (2005) also reported

this type of response from British students. Solomon (2009) noted the considerable impact of ability grouping on identity. This is relevant to the current study, because feelings of anxiety and exclusion were caused by this practice.

The CIT provided participants with an opportunity to start reconstructing their views of themselves. Grootenboer and Zevenbergen (2008) suggested that students' past experiences add dimensions to their mathematical identities. The exploration of critical incidents challenged participants' concepts of self. Understanding their past responses as students to the incidents shows that, for some, reflections on critical incidents can be an enlightening experience. This is vital, because studies have identified a link between maths anxiety in pre-service teachers and their effectiveness as teachers of mathematics to young children. In particular, Harper and Daane (1998), explain that "the elementary mathematics classroom might be considered as a beginning point for creating mathematics anxiety" (p. 29).

Previous researchers who used different data collection techniques, such as giving a list of statements for participants to rate, presented data on family influences (for example, Hannula et al.'s (2005, VOM). However, in the current study, where participants were not given such prompts, there were few comments on family.

While some experiences were out of the participants' control (external), other experiences relied on what the participant did in the situation (internal). Some participants looking back, re-evaluated a situation and commented on a different view, or what they might have done. Helping pre-service teachers to develop an understanding of the importance of recognising when outcomes are contingent upon their own actions may improve their sense of confidence for learning and teaching mathematics. The author noted the unexpected amount of data from responses in these short sessions at the beginning of tutorials, including evidence for the beginnings of transformations that impacted on projective identity.

There is evidence that these negative perceptions of school mathematics experiences and the nature of school mathematics persist and can still be identified in Australian pre-service teachers about to commence their teaching careers. Geeves (2014, p. 294) found that pre-service teachers at the end of their teacher education courses are more likely to remember their school experiences as being negative and school mathematics

as difficult and boring. The findings that many participants attribute their maths anxiety to past negative mathematics classroom experiences with teachers is also consistent with previous research reported about teachers (Adeyemi, 2015; McAnallen, 2010). This shows that these feelings, unaddressed, can persist beyond the initial teacher education course.

5.5 Conclusions

The major conclusions of this chapter are summarised below.

5.5.1 Pre-service teachers come to their course with a range of maths anxieties

The findings from the survey revealed that pre-service teachers come to their teacher education course with a range of levels of existing maths anxiety, and empirical evidence demonstrated that maths test anxiety was the biggest contributing factor to this anxiety. The quantitative findings showed that pre-service teachers' assessment of their maths anxiety aligns with the findings obtained by the survey. Consistent with Australian research, international researchers of primary pre-service teachers have consistently pointed to concerning levels of maths anxiety in pre-service teachers.

Demographic factors of age and gender were not found to have consistent impacts. In the case of rurality, no significant differences were found. Although the survey analysis examined for gender and age effects, their inconsistency meant that they were not examined in other findings.

5.5.2 Impact of maths anxiety on how pre-service teachers view their mathematical identity

As well as the survey, written responses were used to identify evidence of maths anxiety. The aim of this writing was to help participants to reflect on their perception of that event and its impact on their construction of themselves as a learner of mathematics. It is not important to establish whether the critical incident happened as the pre-service teachers remembered, as it is their memory of the incident that affects the pre-service teacher.

At the beginning of their teacher education course many participants lack confidence in themselves as learners of mathematics. This aligns with findings of low confidence

reported in international studies. Negative experiences of mathematics are reflected in views of self as a learner of mathematics, and positive teacher role models are reflected in positive views of self as a learner of mathematics. It was evident from participants' statements that they experienced increased anxiety during testing or evaluation.

These school classroom experiences impact on how pre-service teachers construct their mathematical identity.

5.5.3 Causes of maths anxiety identified by pre-service teachers in their critical incident reflections

Many participants described their mathematical classrooms as traditional environments in which teachers presented materials, and students learned procedures. They saw themselves as having had passive roles in classrooms. In Brady and Bowd's (2005) study, feelings of inadequacy in classroom mathematics were reported by pre-service teachers with high levels of maths anxiety.

The reflections on the critical incidents that participants had experienced as students provided a snapshot of how the participants felt in the first year of their teacher education course. Recalling and writing about critical incidents in their own school mathematics learning evoked intense emotions in some participants.

Themes were: the role of an individual teacher; tests/examinations; cycles of fear, failure, and avoidance; and the pre-service teachers' comparisons with their peers. These themes have also been identified in the research literature. The teacher was commonly the major factor in developing a relationship with mathematics – either positive or negative. The participants reported negative impacts of teachers' negative or insensitive comments, fast-paced instruction, hostile behaviour, or insensitive and uncaring attitude of teachers at school: these produced or increased their anxiety towards mathematics.

School classroom experiences impact on how pre-service teachers construct their mathematical identity. The CIT provided participants with an opportunity to begin to reconstruct their views of themselves, by understanding how their mathematical identity was affected by their past mathematical learning experiences. Many experiences were external. However, some participants looking back, could recognise

and re-evaluate the situation and they commented on what they might have done differently.

5.6 Progression of the thesis

The first four chapters of this thesis presented the rationale, framework and literature, and methodology of the research study.

Chapters 5,6, and 7 present the findings of the study. Chapter 5 presented the findings of the survey which identified the level and range of maths anxiety, and examined the factors that participants identified as impacting on their images of themselves as learners and potential teachers of mathematics, using CIT (Flanagan, 1954). These were analysed for their perceived causes of their maths anxiety (Research Questions 1 and 1a).

The findings and analysis for Research Question 2 will be presented in the next two chapters. Chapter 6 will explore the impact of cognitive bibliotherapy, on the pre-service teachers, particularly on their anxiety towards mathematics. In order to answer the extended research questions that drive this study, Chapter 7 will build on the analysis through insights from interactive bibliotherapy provided by pre-service teachers who took part in the small-group workshops; and will contrast findings with the broader literature.

Chapter 8 will present the implications for educational practice and contributions to the literature. It will also make recommendations for future research.

CHAPTER 6: EVALUATING THE EFFECTIVENESS OF COGNITIVE BIBLIOTHERAPY FOR ADDRESSING MATHS ANXIETY

In looking for solutions and potential interventions, a thorough investigation of teachers' and preservice teachers' perceived causes of their own mathematics anxiety could help to build a theory as to future prevention. Also, through exploration of their own backgrounds, preservice teachers may perhaps identify and confront their own personal levels of mathematics anxiety prior to entering the classroom as teachers. (Trujillo & Hadfield, 1999, p. 219)

Overview

The second and third phases of data collection sought to investigate the potential of bibliotherapy to address primary pre-service teachers' maths anxiety and images of themselves as learners of mathematics. These two phases are reported in Chapters 6 and 7 which build on the findings from critical incident reflections in tutorials, described in Chapter 5.

Phase 2 of the study, reported in this chapter, aimed to evaluate the effectiveness of cognitive bibliotherapy (Shechtman, 2009) to understand and address the antecedents of maths anxiety in pre-service teachers. It also explores the development of understanding and empathy for future students with negative affect towards mathematics, especially in pre-service teachers with no previous experience of maths anxiety.

This chapter presents the findings and analysis of qualitative data. It reports on the responses to the bibliotherapy reading by the first-year pre-service teachers. Data were drawn from the pre-service teachers' responses to the reading, collected on Campus 2 during three tutorials in weeks 2, 4, and 12 of Semester 2, 2012. Details of the method of collection of reflections in tutorials were explained in Chapter 4.

The findings from the tutorial reflections address the Research Question 2: What is the effectiveness of the bibliotherapy intervention to better understand and/or address maths anxiety in pre-service teachers?

and sub-question 2a: For the pre-service teachers who participated in the cognitive bibliotherapy, what were their responses?

The researcher sought to understand what impacts cognitive bibliotherapy has on pre-service teachers' maths anxiety, on their views concerning mathematics, and on their developing professional identity.

The five stages of bibliotherapy, identified from the literature, guided the analysis of the reflections. A modified version of the bibliotherapy stages was developed for the cognitive bibliotherapy in the tutorials (see Sections 6.2 and 6.3.1). The analysis searched for patterns and changes, to make sense of the written reflections. The results of the analysis of the pre-service teachers' responses were then used to develop a hierarchy of types (Section 6.3.2). The author identified a parallel progression of stages in the analysis of responses to the bibliotherapy reading from participants who had not experienced maths anxiety. These were described under the term biblioperception (Section 6.4). In tutorial 12, participants responded to prompts about their future teaching. These findings are presented in Section 6.5. The discussion of findings (Section 6.6) and conclusions drawn (Section 6.7) conclude the chapter.

6.1 Introduction

Bibliotherapy was used to investigate affective responses to mathematics: firstly, to ascertain how it might impact pre-service teachers' views of themselves as learners and doers of mathematics; secondly, to discover how it might help to address their maths anxiety and their identity as future teachers of mathematics. According to Shechtman (2009), "looking at life's circumstances at arm's length may help individuals to deal with the complexity of their situations with less defensiveness, allowing understanding and insight to grow" (p.27). Primarily, the research sought to analyse and interpret affective responses to the readings that impacted on pre-service teachers' anxiety towards mathematics and to identify insights developed and changes in projective identity. These were compared to existing processes from the stages of bibliotherapy identified in the literature (presented in Section 4.6.2), but seen through a different interpretive lens, constructed by the researcher to allow for the first context of the bibliotherapy process.

The research design incorporated the collection of qualitative data in order to investigate the pre-service teachers' responses to the bibliotherapy reading (Dossel, 1993) from their open-ended written responses. In addition, the pre-service teachers' reflections on their views of mathematics, reported in Chapter 5, written before the bibliotherapy reading, were included as part of the data set for comparison with the reflections that they wrote about their views in response to the reading.

The bibliotherapy was carried out in two contexts as Section 4.6.2 explained. Firstly, participants in tutorials wrote guided reflections during their usual mathematics content units of their degree programs each week for three weeks, in tutorials, 2, 4 and 12, (see Appendices D, E, and F respectively), which encouraged them to think about the reading and their own experience of school mathematics. As Chapter 4 noted, this process constitutes "cognitive bibliotherapy" (Shechtman, 2009). The analysis and findings are presented in this chapter.

The second context for the bibliotherapy intervention was the small group workshops. The analysis and findings of the interactive bibliotherapy in the small-group workshops will be presented in Chapter 7.

6.2 Rationale and considerations for developing the analysis

Repeated readings of the pre-service teachers' responses resulted in the identification of three different groups of respondents: those who identified their own maths anxiety, those who did not identify as personally maths-anxious, and those who did not accept that maths anxiety existed. These were dealt with in three ways.

6.2.1 Modified bibliotherapy

As Chapter 5 reported, 105 (43 percent) of the 246 responses to the Dossel (1993) reading made specific references to their own maths anxiety. These responses were analysed using the stages of bibliotherapy, modified for the situation as discussed in Section 6.3.

6.2.2 Biblioperception

Approximately half the participants did not indicate that the readings had invoked any anxiety. However, many of these participants who did not identify personally as anxious wrote comments about maths anxiety. These responses were analysed using a bespoke framework of biblioperception, developed by the researcher to illustrate the parallels between these responses and those of the maths-anxious respondents. These showed that they had developed valuable understandings and insights about others, evidenced by this reflection:

I didn't realise maths anxiety is as much of an issue as it appears to be. I was naïve to the fact that it is a subject that creates fear in people for many different reasons (D308).

This aligns with the philosophy and aims of the study and is an important outcome. In addition, some of these participants initially spoke of others, but then reflected on their own anxiety during later tutorials, when they were reflecting on the longer-term impact that the reading had had on them. This demonstrates the benefits of allowing time for ideas and responses to incubate. A feature of qualitative research is the “capacity to illuminate through interrogating patterns in the data and paying particular attention to exceptions” (Barbour, 2008, p. 221). As with the critical incident analysis, exceptions in the responses of these groups of respondents were acknowledged and included in the analysis.

6.2.3 Examples of deniers

The third group of respondents comprised a small number of participants who did not recognise maths anxiety or did not accept maths anxiety. These participants demonstrated denial of maths anxiety as an issue. For example, one pre-service teacher wrote:

maths anxiety seems a bit of an exaggeration. Some people just don't enjoy maths as a subject, but I wouldn't describe it as anxiety. (J701)

These are acknowledged here, with examples of their responses, but the small number, did not justify the development of an analytic framework. However, there is a need for further research into the reasons underlying these responses.

6.2.4 Other issues

A potential issue for the data reported in this chapter is the brevity of the responses. This was a consequence of the circumstances under which the data were collected. These data were collected during the weekly tutorials that were part of the normal mathematics unit, as a means of capturing responses from as many pre-service teachers as possible. In a busy tutorial schedule, there was little time available to allocate to it. Consequently, the excerpts were short. There was no opportunity for sharing and discussion following the written reflections.

In order to analyse this data set, the researcher developed a modified framework for analysing the responses that indicated anxiety. The decision to modify the existing framework, used by Wilson and Thornton (2007/2008), aimed to address the restricted nature of the cognitive bibliotherapy data collection procedure, and to give consideration to indicative or partial responses. This framework will be presented in Section 6.3.

In addition, the researcher developed a new analytical framework for analysing the responses of participants who showed no initial evidence of maths anxiety. Past studies of bibliotherapy have focussed on participants who were maths anxious. From them researchers have identified the stages of the bibliotherapy process, which will be summarised at the beginning of the analysis section. After studying the written reflections, in order to compare and contrast the responses of this second group of participants with these stages, this researcher developed an aligned framework of parallel stages that she termed “biblioperception.” This framework will be introduced and explained in Section 6.4.

6.3 Analysis

6.3.1 Bibliotherapy

The initial analysis was based on the stages of bibliotherapy. The following summary of the stages provides a précis of the description of the bibliotherapy stages in Chapter 4. The term “stage” is consistent with its usage in the literature; the use of these terms by the researcher does not imply that the stages are regarded as hierarchical or sequential or, indeed, have hard boundaries.

These stages of bibliotherapy are summarised in Figure 6.1.

Identification The reader identified with the protagonist or character in the story and the situation in which they found themselves.
Catharsis The reader became emotionally involved, shared thoughts and feelings, and shared and released pent-up emotion.
Universalisation The reader realised that the problem was shared by others and that their experience was common.
Insight The reader applied the situation to their own life, gained understanding, and became aware that their problems might also be addressed. The reader identified possible solutions to their problem or coping strategies.
Projection The reader's added insight into his/her own circumstances was followed by a consideration and reflection of what this could mean for the future.

Figure 6.1 Summary of stages of bibliotherapy.

To take cognisance of the limited time at the beginning of a normal class tutorial, allowing only for short answers, Table 6.1 was developed. It provides a reinterpretation and redefinition of the stages from the literature (Figure 6.1) to accord with what might reasonably be expected to happen for pre-service teachers in the specific context. The descriptors have been re-envisioned for the specific case in this particular context where participants had only a short time to write their cognitive bibliotherapy responses and did not have the opportunity to share their reflections with their peers. Because the participants had approximately 10 minutes to read the article and write responses, curtailing the descriptions of the stages is appropriate and allows the stages to be considered and applied in a functional way.

Table 6.1

Pre-service teacher cognitive bibliotherapy stages

Bibliotherapy stage	Pre-service teachers' reflections on reading
Identification	Showed that they identified with the character/subject in the article (in this case the student or child in the article) or situation in the article
Catharsis	Indicated feelings, and/or expressed an emotional response
Universalisation	Related to their own experiences and found that they were not alone in their feelings and experiences
Insight	Gained understanding and became aware of the causes of their anxiety and that their issues might also be addressed
Projection	Considered what their new understandings could mean for themselves as future teachers

In the initial analysis, the pre-service teachers' responses were read carefully, and the researcher worked through a number of examples with her two supervisors and came to an agreed position, following discussion about how the responses might be interpreted.

All the reflections were read repeatedly in conjunction with the bibliotherapy article, to attempt to ascertain whether the pre-service teacher was simply repeating the language of the article or whether the terms they used had come from their own thinking. Even if the participants used specific language from the article, it might not mean that they were just repeating the article. It could be that the article gave the respondent a language with which to express their ideas, or stimulated insights into the nature and causes of their anxiety. As there was no sharing and discussion of the writings, it was not possible to differentiate between these options. Table 6.2 gives examples of the initial analysis.

Table 6.2

Initial analysis of pre-service teacher responses codes for bibliotherapy

Pre-service teacher response	Code	Interpretation
“I found it interesting as I can relate to most of the things said about people who have maths anxiety.” (Z570)	Acceptance of maths anxiety Understanding of how others feel	The pre-service teacher identified with the situation in the article. There was no indication that the reading had produced an emotional response. IDENTIFICATION
“People are aware of maths anxiety yet struggle to overcome it. There are many ways that this maths anxiety can be resolved in the class, through different methods of teaching. New to me – the maths anxiety problem can spread and is manifested from an early age and grows through schooling.” (L980)	Acceptance of maths anxiety. Initial cognitive response to the reading.	The reflection related to other people. There was no indication that the reading had produced an emotional response in the pre-service teacher. The article was reviewed carefully to see whether the pre-service teacher was merely writing a description and repeating the words of the article. The first two sentences summarised a section of the article. The “new to me” comment shows that the pre-service teacher is engaging with the reading but still at a knowledge level, not at an insight level. NO STAGE CODED
“I faced a similar problem as a child, as described in the article, maybe it was a lack of self-confidence and fear that made me think maths a difficult subject. If the research can lead to a proper educating environment, the new generation might not face the same problem and take maths as an interesting subject.” (S497)	Acceptance of maths anxiety. Related to own emotions.	The pre-service teacher identified with the problems of the children in the article. The reflection related to her own feelings and self-perceptions as a child. IDENTIFICATION (self as child)
“I feel now that I understand why I have such high anxiety as I am afraid of public failure, time pressure and competitive classrooms.” (S409)	Acknowledgement of maths anxiety. Understanding of reasons.	The response used the language of the reading but was not just summarising the article, because the pre-service teacher made strong connections from the reading to her own emotions in the present. Showed understanding and developing self-perception and insight. CATHARSIS, INSIGHT

(continued)

Pre-service teacher response	Code	Interpretation
“I need to overcome my anxiety. However, a sense of relief that I am not the only person feeling this way and surprise that many current teachers feel this way.” (A009)	Acknowledgement of maths anxiety. Normalising anxiety. Connects reading with own emotions.	The pre-service teacher demonstrated emotional responses to the understanding gained from the reading that others feel as she does. CATHARSIS, IDENTIFICATION
“Still anxious but some comfort that I am not the only one feeling anxious towards maths.” (M441)	Acknowledgement of maths anxiety. Emotional response Normalising anxiety.	The pre-service teacher demonstrated an emotional response to the understanding gained from the reading that others feel as she does. CATHARSIS, IDENTIFICATION
“Understanding that many people have maths anxiety, but that is why it is most important as pre-service teachers to gain a sound understanding of mathematics to break this cycle with children from a young age.” (L683)	Acceptance of maths anxiety. Did not relate personally.	Related to understandings about others. Understanding of implications for teaching. NO STAGE CODED
“That I had developed coping strategies in primary school to avoid maths (pretending to be sick to go to sickbay) which I believe I developed as I had a fear of failing and that I felt I should be able to understand all the content which made me anxious.” (L435)	Acceptance of maths anxiety. Fear, failure and avoidance.	Understanding of reasons for actions. Insight into motivation for avoidance. Avoidance of mathematics classes. INSIGHT (self as child)

There was some indication that there were two levels of response. Some pre-service teachers' reflections summarised points from the article. This was interpreted as a cognitive response, not imbued with affect and emotion, and thus not engaging the whole person. After extended consideration and discussions of the possible interpretations of the pre-service teachers' reflections, it was determined that those that accorded with the descriptions would be coded using the stages of bibliotherapy. Table 6.3 lists examples of responses that were coded into the stages, as well as those that were problematic or those that definitely did not fit any of the stages (null coding).

Table 6.3

Exemplars of responses coded using stages of bibliotherapy

Pre-service teacher response	Rationale	Bibliotherapy stage
“Very true was related to my own personal experiences.” (I873)	Related to the situation in the article.	Identification
“This had all my feelings of maths throughout school. I feel like I wasn’t the only one struggling, but this is quite a common problem.” (R503)	Reading caused pre-service teacher to remember own feelings during school.	Catharsis
“Now that I have read the article, I can see that I’m not the only one that feels this way about maths. A lot of students struggle and find it hard to cope in this subject.” (R820)	Acknowledgement that others share feelings.	Universalisation
“My feelings are similar however I understand more thoroughly why most individuals hate or dislike maths – it seems competitive. I will be more positive and encouraging after reading this.” (C455)	Developed understanding of reasons for anxiety.	Insight
“It has helped me take a new perspective on maths and the different ways I can teach it to avoid students having maths anxiety.” (H908)	Thought about the implications for their future teaching.	Projection
“After reading the article, I will face maths with a more positive attitude to the one I originally had because that is how I would one day like my students to be.” (C455)	Considered how their attitudes might affect future students.	Projection
“I am trying to have an open mind about maths. Still learning new strategies.” (C054)	Debatable	Null coding
“I will try to understand all concepts taught instead of just surface learning to pass exams.” (H432)	Debatable	Null coding

Tables 6.2 and 6.3 illustrate the author's tendency to be conservative in assigning the bibliotherapy stages. Unless there was a strong indication that the response should be classified as one of the stages, the response was regarded as debatable and was left unclassified along with those responses that were definitely designated null coding.

Further analysis aimed to collect responses into groups and to identify and summarise common experiences. Table 6.4 summarises the bibliotherapy stages, in conjunction with a summary of the typical experiences from that category, and an example of an excerpt from a pre-service teacher's response that typifies that stage.

Table 6.4

Cognitive bibliotherapy stages

Cognitive Bibliotherapy stage	Summary of typical experiences in category	Excerpt example from pre-service teacher reflection
Identification	Identified with the feelings described	"I agree. I've had those feelings in maths before." (J105)
Catharsis	Expressed resulting emotional feelings	"I was the child crying over maths work." (D614)
Universalisation	Realised that others share common feelings	"That I was not alone in my feelings of helplessness." (S993)
Insight	Understanding of causes of anxiety	"The way a teacher teaches a class can have a big effect as well." (D163)
Projection	Implications for future teaching	"I realised that I need to change my attitude in order to not transfer it [maths anxiety] on to students." (M501)

An extended description of each stage follows. These descriptions are written under separate headings. However, the author recognises that the boundaries between stages are permeable, therefore each description attempted to capture the centrepiece or essence of a region of responses. The author accepts that, when dealing with people, there are rarely well-defined categories. Some participants responded emotionally to the reading itself whereas others often accompanied a recognition that there were others

who felt the same (universalisation) with an expression of the emotion that this realisation generated. Both these cases constituted an emotional response or catharsis. Further amplification for each of the categories is given in the following paragraphs, building on the succinct summaries in the Table 6.4.

Identification. The pre-service teachers' reflections showed that they identified with the character (in this case, the children referred to in the article) and the situation that caused them maths anxiety. Participants identified closely with the analysis in the article by Dossel (1993) that described the possible causes of maths anxiety among school students. The responses illustrate a developing self-awareness: for example:

I can relate to most of the things said about people who have maths anxiety. (S220)

Additionally, the identification stage of bibliotherapy began an enhanced meta-affective awareness:

I was able to see triggers for my anxiety. (D17).

Catharsis. Through their reading of the article some participants became emotionally involved. Several reflected on, and expressed feelings about, their own maths anxiety after reading about children's maths anxiety in Dossel (1993):

Nervous, anxious, unsure, afraid. (D892)

I did not find it enjoyable – just when I thought I understood they told me I was wrong, leaving me highly confused, frustrated & then finding myself dreading maths. (S993)

Insight. Reading the article about maths anxiety and the reasons school students struggle with mathematics heightened the pre-service teachers' awareness of the causes of their own maths anxiety. Some expressed the realisation that their problems were not necessarily of their own making and could be addressed:

That I had developed coping strategies in primary school to avoid maths (pretending to be sick to go to sick bay) which I believe I developed as I had a fear of failing and that I felt I should be able to understand all the content which made me anxious. (L435)

In some cases, they recognised that this was related to the nature of the mathematics studied and the type of understanding that, they felt, was valued in their schooling:

Maths anxiety is a result of pressure and expectation to know the answer rather than an inability to perform the task. (J473)

Universalisation. Common in their reflections on the readings was an expression of the comfort that participants felt in finding that they were not alone in their feelings and experiences. The recognition that others had the same issues normalised their experience and re-shaped their sense of identity:

I am able to thoroughly understand that I am not the only one who has a “panic attack” when the word mathematics is mentioned. (R257)

Projection. Reflecting on the nature of the teaching that they received led to an awareness of the alternatives to the approaches that they had experienced. The participants considered what their new understandings could mean for the future. They envisaged themselves as future teachers. In some cases, they rejected the way they had been taught and described the type of teacher they wanted to be. Some of the comments addressed specific issues such as the need to ensure that their students make connections in their mathematics learning, and have sufficient time, and that they, as teachers, should model positive attitudes in the classroom:

It has helped me take a new perspective on maths and the different ways I can teach it to avoid students having maths anxiety. (H908)

The author examined the initial responses of the participants to the bibliotherapy reading at its first sighting in week 2 that indicated anxiety and coded them as stages of bibliotherapy. As foreshadowed, not all of these 105 reflections were able to be allocated in this way. However, all the categories could be identified in the responses. Table 6.5 gives the numbers for the coding for each set of responses.

Table 6.5

Bibliotherapy coding of initial anxiety responses of pre-service teacher sample 2012,
(n =246)

Bibliotherapy stage	Tutorial 2
Identification	37
Catharsis	13
Universalisation	18
Insight – self	16
Projection	9
Total	93

The participants reflected on the reading in the next tutorial of the study (tutorial 4) two weeks later. Some expressed different responses, in some cases displaying stages of bibliotherapy that had not been evident in their original response to the article extracts. These demonstrate the value of extended time for deliberation. Table 6.6 gives the accumulated totals for these weeks of tutorials.

Table 6.6

Cumulative bibliotherapy responses of pre-service teacher sample in 2012

Bibliotherapy stage	Tutorial 2	Tutorial 4	Tutorial 12
Identification	37	38	38
Catharsis	13	37	37
Universalisation	18	24	31
Insight – self	16	26	27
Projection	9	19	22
Cumulative totals	93	146	155

These tables demonstrate that the evidence that the stages of bibliotherapy were detected across the shared perspectives of many pre-service teachers; they do not represent multiple comments from just a few individuals.

6.3.2 Ideal types

Analysing the responses of the participants, the author developed representative “ideal types” to illustrate different responses. In order to do this, the author selected the pre-service teachers’ tutorial responses from tutorial sessions 2, 4, and 12 that could be matched by the identification codes. This list comprised 71 sets of responses. From these, the 36 that included comments in response to the question about changes to their

maths anxiety from Tutorial 12 were selected as cases for analysis. The initial level of analysis of the sample of 36 cases segregated the responses of those who indicated that they did not have maths anxiety or whose answers gave no indication of anxiety (Type I) from those of the pre-service teachers who mentioned their anxiety towards mathematics. These responses were further divided into responses that indicated that maths anxiety had not decreased, (Type II), and those that agreed that the bibliotherapy reading and reflection had helped decrease their maths anxiety. This final set of responses was separated on the basis of comments that focussed on the individuals themselves in their present situation (Type III) and those that demonstrated a focus outward to others or a future focus to their teaching (Type IV). The genesis of four ideal types is summarised in Figure 6.2. As explained, it was not possible to obtain a complete data set for every individual in the tutorials, so this typology is based on responses from approximately 15% of the respondents. Hence, provision of proportions for each type was not warranted.

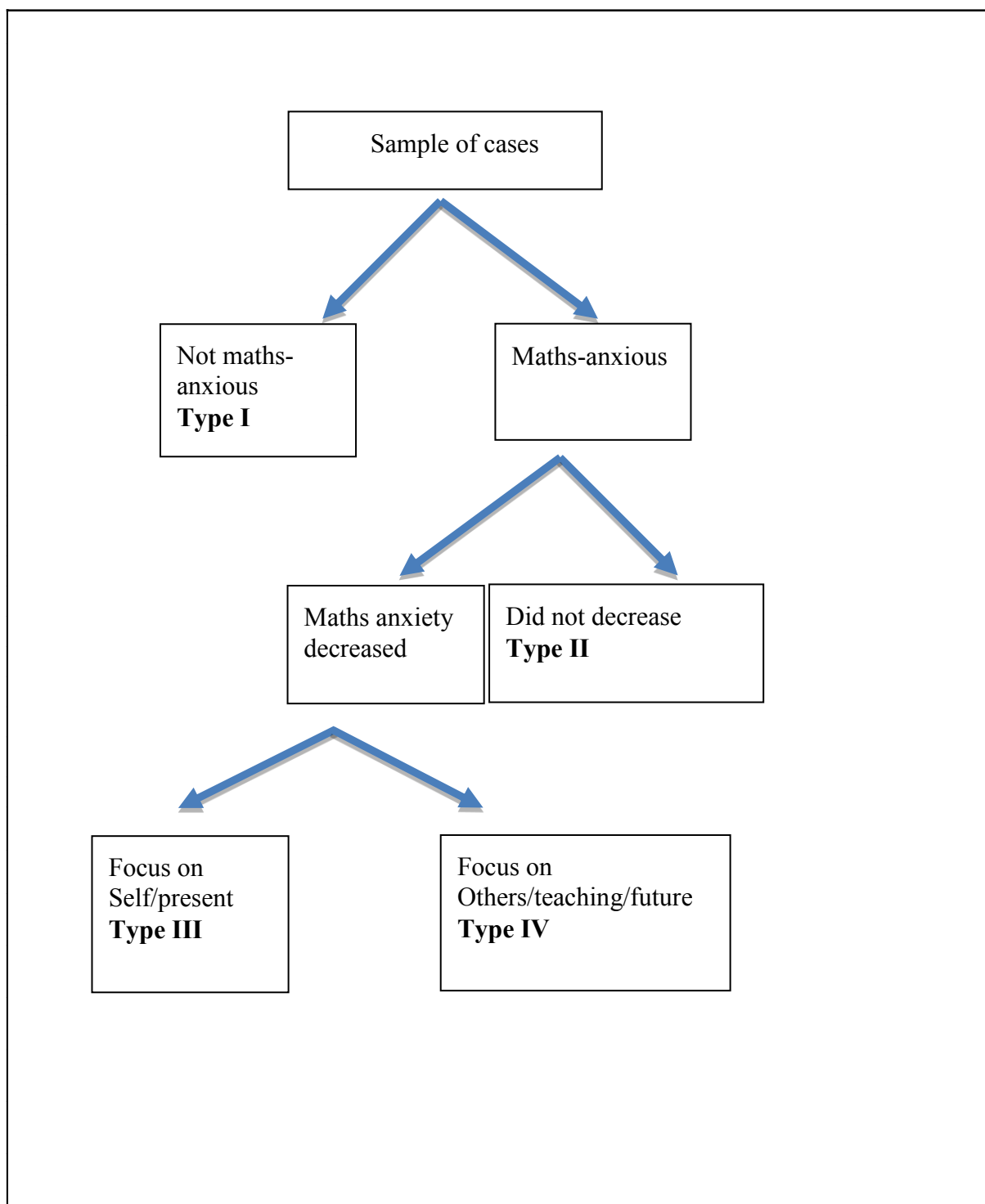


Figure 6.2 Emergent key of ideal types of acceptors/acknowledgers of maths anxiety.

The descriptions of the types were developed by examining the characteristics of the individuals in each type, and their reflections. Some illustrative examples of these are included with the type descriptions.

Type I. Type I pre-service teachers did not express any anxiety towards mathematics. This type of student is young and has only recently completed their high school education. They had not realised previously that maths anxiety was such an issue or that so many people had maths anxiety. This type included participants who expressed their indifference to, or dislike of, mathematics, as well as those who were confident in their mathematics. The bibliotherapy readings helped these participants to understand more about maths anxiety, some of the reasons that caused this anxiety, and some possible ways to approach this issue:

It made me realise there are people out there who do suffer from maths anxiety problems. (E655)

Type II. Other pre-service teachers acknowledged that they had a level of maths anxiety, and this was the aspect on which they were separated from Type I. Within this group were participants who stated in tutorial 12 that their anxiety had not been alleviated by the reflection on the reading. These participants were designated as Type II.

The Type II participants were also young recent school leavers. Although this type said that there had been no reduction in their maths anxiety as a result of the bibliotherapy reading, they agreed that they now understood more about maths anxiety. The comments of the Type II participants focussed inwardly on themselves, and their comments expressed the emotional feelings that resulted from understanding that they were not the only one who felt such anxiety. Despite the lack of change in their anxiety, these participants found comfort and reassurance in knowing that they were not the only ones feeling anxious; other people had the same worries and fears and felt a similar anxiety. Knowing that others experienced the same fears helped these Type II participants to be less fearful and to feel that they could achieve more in mathematics. Typically, they expressed a

sense of comfort that others feel the same way. (L980)

and noted:

it reassured me many people experience this. (J194)

Although these participants said that there was no change in their anxiety, they also said that the bibliotherapy reading and reflection had helped them to engage more with their mathematics, for example, the reading:

made me realise that other people experience the same things I do and not feel so scared. (R167)

This showed that, although fear, which is an aspect of anxiety, was reduced, the participant did not identify this as a reduction in maths anxiety. This attests to the complexity of the situation.

Separated out from the Type II pre-service teachers were those who agreed that the readings and reflections had helped their maths anxiety, and for whom the outcome had been an alleviation of their maths anxiety, making it less intense. This reduction in anxiety is particularly important for individuals whose anxiety makes them unable to engage successfully with their mathematics units during their teacher education studies.

Type III. The Type III pre-service teacher acknowledged their maths anxiety at the start of the unit but reported that by the final tutorial their maths anxiety had decreased as a result of the bibliotherapy reading. They also reported that their understanding of maths anxiety had increased as a result of their reading and reflection. Their comments also focussed on their own feelings. Like the Type II group, they felt comforted that they were not the only ones who had felt anxious. They now saw that this anxiety could be overcome. However, these participants elaborated more fully on the insights and understandings that had developed about the causes for their anxiety:

Yes, it allowed me to understand the reasons why I was anxious. (A191)

Knowing that it was something that lots of people felt was comforting. Made me feel like it can be acknowledged and overcome. (M636)

Type IV. The last type of pre-service teacher identified, Type IV, demonstrated a future focus, which prefigured the Projection stage of bibliotherapy, and so were allotted a distinctive type. They reported that their anxiety had decreased since they had completed the bibliotherapy readings and reflections, which had increased their understanding about maths anxiety. However, this smaller group of Type IV participants had seemingly moved beyond a focus on the self and were more outward-

looking in their comments. Their reflections illustrated the understandings that they had developed about other people. This included empathising with others and understanding what they go through and displaying insights into why others are anxious about mathematics. It seemed that having decreased levels of anxiety allowed this type of pre-service teacher to extend their reflections beyond the self to develop insights about the impacts on others. This was demonstrated by one participant who said:

by understanding what other people go through, I can assist. (S199)

The defining feature of this Type was a future focus. Other comments included:

Yes, Ways to approach it correctly so when I begin to teach, I can take an appropriate approach. (K459)

Yes, realise that I'm not the only one anxious about teaching maths ... feel more comfortable with maths as a learner and teacher. (K359)

It is acknowledged that these distinctions may need further confirmation, because they are based on the author's interpretation of short written comments and the participants did not have an opportunity to elaborate. For example, the initial part of the final comment was similar to that of Type II participants, illustrating the bibliotherapy stage of Universalisation, but the second part demonstrates the future focus. Hence this participant was classified as Type IV. These relationships between the Types can be seen graphically by referring back to Figure 6.2.

6.4 Extending the bibliotherapy analysis

As indicated in Section 6.2.2 more than half the respondents indicated that the reading did not initially invoke feelings of anxiety. The focus of the analysis then turned to those pre-service teachers who had not expressed feelings of anxiety towards mathematics, but who had nevertheless written reflections on the bibliotherapy reading. This subset of respondents comprises over a quarter of the group, so it is important that their voices be heard. These could have been participants who had overcome their anxiety and who were then moving on, or those who had not experienced anxiety. Alternatively, it is possible that these might have been participants who avoided writing about themselves, and instead wrote about others. Although it is important to recall that the process of bibliotherapy deliberately involves readings about a third person, in order

to be less confronting for those who are anxious, there is no guarantee that this strategy enabled all participants to respond in the context of the tutorials.

The numbers of responses about themselves and about others are shown in Table 6.7. These numbers give an indication of the relative proportion of the groupings.

Table 6.7

Bibliotherapy responses of pre-service teacher sample in 2012

Bibliotherapy stage	Tutorial 2	Tutorial 4	Tutorial 12	Total
Insight – self	16	10	1	27
Insight – others	12	14	0	26
Projection – self	9	10	3	22

The responses to the bibliotherapy readings from these participants who did not exhibit any maths anxiety themselves, focussed on their developing understanding about how others might feel. Interestingly, the researcher was able to identify that their responses exhibited corresponding stages to the bibliotherapy stages.

In order to analyse the responses of the participants for whom the bibliotherapy reading stimulated reflections about others, including their future students, the researcher now proposes a framework of parallel stages to those identified in bibliotherapy. To differentiate the responses of the non-anxious participants, the researcher labelled the process “Biblioperception.” Examples of the stages are presented in Table 6.8.

Table 6.8

Biblioperception stages applied to pre-service teachers' responses about others

Biblioperception stage	Corresponding bibliotherapy stage	Description	Excerpt from pre-service teacher reflection
Recognition	Identification	Identify the issue in others	"Yes, I learnt that others seem to have quite a bit of maths anxiety – never realised it was such an issue." (D308) "I still have a positive view of maths but now I realise why others struggle with it and why it isn't a well-liked subject." (J081)
Empathic emotion	Catharsis	Represent the emotion they imagine in another person	"I never understood how much people can be overwhelmed but I do now." (C754)
Normalisation	Universalisation	Realise that the problem is experienced by many	"I didn't realise that maths anxiety was such a common problem that people have." (missing identification code)
Illumination	Insight	Understand and perceive possible solutions to others' problems	"That having maths anxiety is both to do with the teacher and student. Has a lot to do with time pressure and has many contributing factors, which I didn't know of before reading this article." (N267)
Projection	Projection	Project to future teaching	"That most people have maths anxiety and it is our duty to prevent it for the future children and overcome it as teachers in learning." (N442) "That I want to create a classroom environment that encourages students in the hope that they will feel positive about maths." (C540)

The author foreshadowed in Chapter 1 that it is also important to raise awareness about maths anxiety in pre-service teachers who have not experienced it themselves in their own schooling, to develop in them empathy for students with negative affect towards mathematics, and hence enable them to be more effective teachers of mathematics in primary classrooms. These responses were interpreted as evidence of such empathy developing.

Table 6.8 demonstrates that the bibliotherapy readings were able to raise awareness. This is also illustrated in more detail by the extended responses of a non-anxious pre-service teacher (K459) who in her description of her feelings towards mathematics had indicated her positive feelings towards mathematics and enjoyable experiences of mathematics in the classroom:

I enjoyed mathematics. I feel confident when studying mathematics. ... Always been a positive experience.

Her responses to the reading and later reflections illustrate Illumination and Projection. Her initial response to the bibliotherapy reading showed that her thoughts were about how she might approach students with maths anxiety, and she listed a number of strategies:

that maths anxiety can be cured via positive learning/teaching environment, a lack of judgement, focus on success, work to develop failures/errors. Allow sufficient time depending on individual needs. Encourage confidence and student control of their own learning (tutorial 2).

Two weeks later, her thoughts continued to centre around her reflections on her future teaching:

It has made me more aware of how to teach maths in a rational manner that will benefit each individual student to decrease the possibility of maths anxiety (tutorial 4).

Again, in the last tutorial (tutorial 12), in which participants gave their series of reflections, her reflections reiterated her connection of the reading with her future teaching:

Yes, ways to approach it correctly so when I begin to teach, I can take an appropriate approach.

Clearly these interpretations of the participants' responses will need further research in order to provide evidence that they are well founded. Nevertheless, it is an important beginning and could open up a very fruitful line of exploration.

6.5 Intentions for future teaching

Pre-service teachers were asked about their intentions for their own teaching, specifically how they would help their future students to avoid maths anxiety. There were 123 responses addressing this question out of the total of 143 responses received in Tutorial 12. The responses were analysed and grouped under major themes. Table 6.9 shows the main foci of the responses.

Table 6.9

Pre-service teachers' future intentions for teaching

Focus	Description	Excerpt from pre-service teacher reflection
Classroom environment	Safe	“Providing a safe environment under no pressure” (H435) “Allow them to understand that making mistakes is okay and that it is part of the learning process.” (R262)
	Fun	“Make it fun” (H908) “Teach maths in a fun and carefree way so it takes away some of the anxiety” (D519)
	Time Pressure	“By not overloading them with it all at once.” (D480) “By giving them [children] the time they need and not pushing them.” (C776)
Self as teacher	Overcome own anxiety	“By overcoming any remaining maths anxiety that I have – I know children sense fear or uncertainty.” (M606)
	Share own experiences	“Share my story with them.” (R836) “Explain I had maths anxiety and teach them ways they can overcome it.” (M579)
	Attitude	“Be confident, clear and enthusiastic.” (F138)
Teaching strategies	Address affect	“Teach them that it’s ok to be nervous about maths at first but give them ways of overcoming anxiety & developing their understanding.” (K359)
	Teaching for understanding	“Ensure a thorough explanation is given to students with practical examples for them to remember and clarify their understanding.” (H592)
	Engagement Concrete materials Focus on students	“Making it more fun, practical, using a lot of games, interpreting maths with students’ interests.” (G250)
	Relax	“Relax and play games, make it interesting, no pressure.” (C754)

These participants' own difficulties experienced in learning mathematics provided an impetus for them to seek to avoid maths anxiety in their students by ensuring a classroom environment in which students feel secure and comfortable, and by using a variety of instructional methods.

Their responses related to three themes – the classroom environment they would create, themselves as teachers, and related teaching strategies. The idea of presenting mathematics as “fun” and making it “safe”, especially by removing time pressure, clearly related to their own negative classroom experiences. However, they determined to reassure their future students by sharing their own experiences.

6.6 Discussion

This section explores parallels with, and disjunctures between, the findings from the current study and the findings from other researchers. Previous research using affective strategies was reviewed and described in Section 2.6.2.

In this phase of the study, cognitive bibliotherapy based on reading and reflecting about children's difficulties with their mathematics learning provided a stimulus for pre-service primary teachers to identify with the children, re-examining their own experiences and reflecting on their perception of themselves as learners of mathematics. Some participants provided graphic descriptions of their own schooling (“I was the child crying...”). There were indications that some individuals were developing a more positive self-image as learners of mathematics. Gaining insight into how children's anxiety about mathematics can be minimised led them to extrapolate to their future teaching and consider their identity as teachers of mathematics. Sfard and Prusak (2005) explained; “identity talk *makes us able to cope with new situations in terms of our past experience and gives us tools to plan for the future* [emphasis in original]” (p. 16).

In the analysis, the five stages of bibliotherapy were modified to allow them to be applied in the short context. The modified version of the stages (described in Table 6.1) was identified in the responses of maths-anxious pre-service teachers and helped to explain how meta-affective change (DeBellis & Goldin, 1997) might begin to take

place. In particular, this was seen in the development of participants' awareness of, and feelings about, their emotional states, which supported participants to develop positive emotional feelings that were more productive of learning. Similar findings emerged from researchers who, using an application of bibliotherapy in which Finnish pre-service teachers read six mathematical biographies, concluded that pre-service teachers' identification with a peer with a similar background contributed to changes in their mathematical identity (Kaasila et al., 2008, p. 7).

The reflections on the bibliotherapy reading allowed participants to perceive their situation differently and helped them to re-evaluate their potential. Although cognitive bibliotherapy does not address all aspects of Ambrose's (2004) criteria for mechanisms that have potential for changing beliefs, the findings show that it can elicit emotional experiences, and connect beliefs and emotions. Pre-service teachers were able to modify their self-concepts and re-image themselves as future teachers. This supports the research of Lutovac and Kassila (2009) who reported using bibliotherapy with one Finnish and one Slovenian pre-service teacher who had reported negative school mathematics experiences. They concluded that insight frees pre-service teachers to review their mathematical past and develop new mathematical futures. In continuing studies, Lutovac and Kaasila (2011), developed a narrative form of rehabilitation and bibliotherapy in an effort to overcome mathematical anxiety (Lutovac & Kaasila, 2011). They investigated past and future mathematical identities (Lutovac & Kaasila, 2013) and future-oriented mathematical identity work (Lutovac & Kaasila, 2014).

Those participants who saw their future teaching in terms of making maths "fun" for students, were focussed on engaging their students affectively rather than cognitively. Schuck (1997), studying first year Australian pre-service teachers, found that they evaluated topics that they might teach based on whether they regarded them as highly accessible, or as highly enjoyable – both based on their own school experiences. This concentration and reliance on topics which were identified as familiar or fun to do showed a closed view of primary mathematics and a tendency towards reduction of cognitive load. Nearly 20 years later, the pre-service teacher reflections in this study provide evidence that these perceptions still need to be taken into account by teacher educators. There is a danger that these ideas might persist, as Geeves (2014) found in recent research. She reported: "beginning teachers had difficulty matching activities to

mathematical content so ‘fun’ rather than ‘content’ became the primary driver in their activity selection” (2014, p. 301). Geeves linked this back to their comments about fun when they were pre-service teachers.

6.7 Conclusions

The analysis of the data collected for Phase 2 of the study provides evidence that reading about the emotional and cognitive problems of school students associated with maths anxiety caused participants to reflect more deeply on their own experiences of mathematics. They realised that they were not the only ones with this anxiety. The changes in their views enabled the participants to approach their future teaching of mathematics with greater insights and empowered them to construct positive projective identities. The experience of cognitive bibliotherapy enhanced participants’ capacity to project themselves into their future role as teachers. The themes in the participants’ responses demonstrate that isolation and evaluation anxieties will not be allayed by merely arming pre-service teachers with content knowledge. According to Uusimaki (2004, p. 88), this could act to further problematise the individual and to dismiss the fundamental importance of having the individual feel part of an emerging mathematics community in which they perceive themselves to be supported.

Collecting data from the whole cohort of pre-service teachers and expanding the analysis beyond those individuals identified as maths-anxious enabled the development of a framework for the new concept of “Biblioperception.” This framework was developed in response to the finding that the reading raised awareness about maths anxiety for participants who had not experienced it themselves. They developed insights about others’ responses to mathematics which have the potential to increase their empathy and effectiveness in their future teaching of mathematics in primary classrooms.

Although several researchers (e.g. Cohen, 1994) emphasised the need for discussion with a mentor or leader, the responses to cognitive bibliotherapy illustrated an unexpected depth of reflection and insight in the participants’ responses over the three tutorials that comprised Phase 2 of the study.

6.8 Progression of the thesis

Chapters 1–4 presented the rationale, framework and literature, and methodology of the research study.

Chapter 5 presented results and analysis to address Research Question 1. Although the survey identified assessment as a major factor in pre-service teachers' current anxiety, the CIT responses identified the teacher as the dominant cause of their maths anxiety.

This chapter addressed Research Questions 2 and 2a. It used the construct of cognitive bibliotherapy to explore the impact on the pre-service teachers, particularly on their maths anxiety, of reading about maths anxiety in a classroom context. The chapter introduced an analysis of the responses, based on a modification of the stages of bibliotherapy, and a new concept of *Biblioperception*. A hierarchy of pre-service teacher types was developed.

In order to address Research Questions 2, 2b and 2c, Chapter 7 will build on the research methods and analysis in Chapters 5 and 6 through insights provided by pre-service teachers who took part in the small group interactive bibliotherapy workshops. Evidence will be presented that the way pre-service teachers feel about, and think about, themselves as learners and potential teachers of mathematics has developed and impacted on their identity.

Chapter 8 will describe the contribution of the thesis to new knowledge and to the range of analytical tools available, the implications of the findings, and recommendations for future research.

CHAPTER 7: EVALUATING THE EFFECTIVENESS OF THE SMALL GROUP INTERACTIVE BIBLIOTHERAPY WORKSHOP

Transformative learning involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. It is a shift of consciousness that dramatically and irreversibly alters our way of being in the world. Such a shift involves our understanding of ourselves and our self-locations; our relationships with other humans and with the natural world; our understanding of relations of power in interlocking structures of class, race and gender; our body awarenesses, our visions of alternative approaches to living; and our sense of possibilities for social justice and peace and personal joy. (O'Sullivan, 2003, p. 326)

Overview

This chapter completes the findings of the study, the first two parts of which were reported in Chapters 5 and 6. The final phase, Phase 3, continued the evaluation of the potential of bibliotherapy for the amelioration of pre-service teachers' maths anxiety, which began in Phase 2 of the study, and was reported in Chapter 6. This final phase investigated the effectiveness of interactive bibliotherapy incorporated into a small group workshop which was designed by the researcher in collaboration with the student counsellor (Section 7.2). The interactive bibliotherapy process in the workshop allowed participants to reflect on the reading and to write their responses within a longer timeframe, and then to choose how much of their written response they wished to share and discuss (Section 7.3). This workshop provided data for the analysis of critical incident and bibliotherapy reflections to further the identification of factors contributing to primary pre-service teachers' maths anxiety, together with the immediate effects of the interactive bibliotherapy intervention on this anxiety (Section 7.4). The findings from the workshops are discussed with respect to the literature in Section 7.4.7.

The findings from the workshop address Research Question 2:

2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?

and the sub-questions:

2b. For the pre-service teachers who participated in an interactive bibliotherapy workshop, what were their responses?

2c. What was the **immediate** and detectable change in their affect upon completion of the workshop?

To investigate the more lasting impact of the interactive bibliotherapy, follow-up semi-structured interviews were conducted with four participants. Individual cameos or vignettes were developed for each participant (Section 7.5).

The findings of the interviews address the sub-question:

2d. What was the **more lasting** impact of the interactive bibliotherapy on the pre-service teachers' maths anxiety?

The chapter continues with the analysis of the longer-term effects of the workshop. The findings from the interviews are discussed with respect to the literature in the discussion (Section 7.5.5). The conclusion evaluates the effectiveness of the interactive bibliotherapy intervention for addressing this anxiety and developing their mathematical identity (Section 7.6).

7.1 Introduction

One of the salient features of the study was the collaboration with the Campus 1 student counsellor in designing the workshop in Phase 3 of the study. The value of collaboration has been acknowledged and supported by researchers. Banta and Kuh (1998) claimed that "improvement efforts are much more likely to have intended effects when academic and student affairs faculty work together" (p. 42). Fifteen years later Graham (2013) concluded that her study:

indicates a need for university management to recognise the contributions of professional staff to the core business of learning and teaching and to explicitly value these contributions. This would allow both individuals and the institution to benefit from the capacity of these staff ... the work of all staff is essential to students achieving their learning outcomes, and that all staff need to work together, supportively, and valuing the work of their colleagues. (p. 12)

The workshop was briefly outlined in Section 4.6.3. Its rationale and design will be described in detail in Section 7.3. It comprised a series of activities that involved reflecting, writing and sharing narratives of personal maths critical incidents and responses to readings. During planning discussions, the counsellor suggested the incorporation of the PANAS (Watson et al., 1988) and the CBT activity into the workshop.

7.2 Nature of small group interactive bibliotherapy workshop

The small group workshop comprised an integrated series of activities designed specifically to engage participants both cognitively and emotionally, and to challenge pre-service teachers' experiences of their mathematical selves, thus preparing fertile ground for introducing new concepts and practical information. These activities are described in Section 7.3.

As Chapter 6 foreshadowed, the workshop was designed to provide a context for an extended version of bibliotherapy. This featured more time and the opportunity for exploration of feelings (*affective bibliotherapy*, Shechtman, 2009) combined with discussions with facilitators (*interactive bibliotherapy*, Cohen, 1994) and peers. Chapter 6 described how participants were given a short time at the beginning of three tutorials to describe a critical incident, and to write brief bibliotherapy reflections. In contrast, in the small-group workshop, participants were also asked to describe a critical incident, (see Appendix I), and write bibliotherapy reflections, (see Appendix J), but they were offered extended time to write, a key aspect of the interactive bibliotherapy in the workshop. In addition, participants had the opportunity to share, as much as they were comfortable, their experiences with facilitators and the other participants, and listen to the stories of their peers. This was an important step. Hackworth (1992) suggested that writing about and discussing feelings about mathematics would assist in reducing maths anxiety. The participants completed retrospective reflections "thinking about the experience and what it means after the fact" (Anderson, 1998, pp. 122–123). According to Webster and Mertova (2007, p. 14), narrative inquiry is used to reflect, the stories become "document[s] of critical life events ... [that] reflect the fact that experience is a matter of growth, and that understandings are continually developed,

reshaped and retold.” This allowed participants to interrogate their own perspectives and the validity of their stories.

Additionally, the participants had extended time to read the bibliotherapy article (Dossel, 1993) and write their reflections. Again, the significant feature of the interactive bibliotherapy in the workshop was the opportunity to share the reflections.

7.2.1 Data collection considerations

Pre-service teachers on Campus 1 were invited to the small-group maths anxiety workshop. As the researcher was aware of issues of recruitment, the invitation to the workshop was carefully worded and emphasised the potential contribution to pre-service teachers’ professional learning. Invitations to take part in individual follow-up interviews at the end the following semester were sent to all participants after the workshops.

Miles and Huberman (1994) assert that the circumstances of data collection may strengthen the quality of the data. Features of stronger data are that it is “collected later or after repeated contact,” “collected in informal setting,” and the “respondent is alone with field-worker” (p. 268). The first two are features of the workshop data collected, and all three were characteristic of the interview data collection. According to Miles and Huberman, weaker data are “collected in official or formal setting” and the “respondent is in the presence of others in group setting” (Miles & Huberman, 1994, p. 268). These were features of the data collection for the first context of the critical incidents and bibliotherapy data collection, the tutorial. Although the workshops were conducted in a group setting, the justification for this was that sharing reflections was an essential aspect of the interactive bibliotherapy process. The workshop context was designed very carefully to overcome any potentially negative aspects of data collection in a group setting.

7.3 Implementation of small group bibliotherapy workshop

A 2.5-hour workshop with two facilitators was carried out in a non-teaching space called a community room with informal furniture, and refreshments were provided. The workshop venue included comfortable armchairs, to encourage the use of extended time for writing.

The outline of the workshop activities and approximate timetable are shown in Figure 7.1. Data collection is indicated by (d). The methods used in this data collection are elaborated in Section 7.3.2 below.

Facilitator	Duration (mins)	Activity
Researcher	10	Introduction
Researcher and participants	10	Completion of PANAS scale & RMARS survey (d)
Researcher	10	Overview of Maths anxiety
Counsellor	10	Overview of anxiety and its function.
Researcher and participants	30	Critical Incident Technique (CIT). Writing and sharing of critical incident reflections (d)
Counsellor	10	Discussion of old stories vs new stories.
Researcher and participants	30	Bibliotherapy – Dossel (1993) reading. Writing and sharing of bibliotherapy reflections (d)
Counsellor and participants	20	Overview of Cognitive Behaviour Therapy. Completion of worksheet with mathematics example (d) Anxiety strategies
Researcher and participants	10	Completion of PANAS scale (d) and Workshop feedback sheet (d)

Figure 7.1 Design of the small-group workshop including data collection (d).

The researcher introduced the workshop. She welcomed those who had agreed to participate in this part of the study and offered them refreshments, in order to create a positive environment. The researcher sought permission to record the workshop (see Appendix G). She emphasised that comments made during the workshop were private and participants could reveal as much or as little of personal issues and experiences as they chose. This aimed to create a supportive atmosphere and build trust. Building trust within the group was important to encourage the sharing of stories and enable the expression of emotions in a safe environment. This was designed to provide support and encouragement of ongoing relationships within the group.

The participants then completed a PANAS (Watson et al., 1988, refer to Section 4.6.1); and RMARS survey (refer to Chapter 4, and see also Appendix H). The researcher gave a brief overview of maths anxiety explaining that it is a learned response and includes

cognitive, affective and physiological responses. She explained that recognising the antecedents of this anxiety and analysing them was important for addressing maths anxiety for themselves and others. She outlined that research has shown that teachers with maths anxiety have different teaching strategies and styles and may pass on maths anxiety to students. The researcher emphasised that their participation would make an important contribution because lecturers need to understand their students, and teachers need to understand how students feel about mathematics and what might cause or lessen their maths anxiety.

The counsellor then explained that anxiety is a natural physiological and behavioural response to a stress. She told participants that it is a natural functional response, and its manifestations can be identified. It is a normal protective reaction, and the brain is doing what it is meant to do but becomes over-responsive. The aim of this discussion was to normalise anxiety. The counsellor identified the effect that anxiety in general has on students, by explaining that markers for anxiety are either attempts to control one's environment and/or attempts to avoid any distressing stimuli. Students may be over-working or avoiding work. Other impacts are lack of motivation, lack of focus and concentration, avoidance of work, panic if the student feels incapable of doing the work, and chaotic and ineffective study practices. Participants were assured that there are ways of ameliorating these responses, such as controlling negative self-talk and replacing it with affirmative self-talk, and relaxation techniques.

In the next part of the workshop, the researcher introduced CIT. She asked participants to record their views of themselves as learners and potential teachers of mathematics, and then to write a description of a critical incident (positive or negative) from their own school mathematics education that was significant for them and that impacted on the way they thought about themselves as learners and future teachers of mathematics (see Appendix I). No limits were imposed. Participants were allowed to reflect and write without time pressure. This gave them more time to reflect on their perception of the critical event, its impact on their construction of what it meant to learn mathematics, on themselves as a learner of mathematics, and on how these perceptions had been reinforced by the experiences that followed the original incident. After participants had finished writing, they were invited to share their story if they felt comfortable doing so, and others were invited to respond. This created the opportunity for participants to

express their experiences as they perceived them, and to have their fears and experiences listened to and discussed in a reasoned way, and to see them from a different perspective. These responses related to the investigation of participants' storied identity.

After the participants had written and shared their stories, the counsellor discussed old stories and new stories. She explained that, as people grow up, old stories and ways of perceiving situations often do not serve them well. With maturity comes the need to develop a new story.

The researcher then distributed copies of the bibliotherapy reading, Dossel (1993), for the participants to read. Participants then wrote their responses to the reading (see Appendix J). They were then invited to share those reflections that they felt comfortable sharing with the other participants. Time was allowed for discussion as the other participants responded to their peers' reflections.

To increase participants' awareness that they have a cognitive response before they respond emotionally to a stimulus, the counsellor presented an overview of CBT. She used the example of how they might react emotionally when overtaken by a speeding car, explaining that when the incident occurs, there are automatic thoughts that we are able to become aware of and consciously change before the emotional response. Participants were then asked to complete a simple worksheet and apply the model to a situation involving anxiety about mathematics using the following questions: "What were your thoughts? What was your emotional response? How could you change your thoughts? What do you think your emotional response would be as a result?"

The implementation of the workshop plan, in general, followed the structure outlined in Figure 7.1.

7.3.1 Participants

Twelve pre-service teachers from Campus 1 took part in small-group maths anxiety workshops. Data were collected in Semester 1, 2013 and Semester 1, 2015. In 2013, the participants were six second-year primary pre-service teachers, (Alice, Debbie, Emma, Jane, John and Kathy). In 2015 data were collected from three second-year (Anne, Mary and Ruth) and three fourth-year (Chris, Julie and Sally) pre-service

teachers. Pseudonyms have been used to provide anonymity for participants and their data. Neither gender nor age was consistently identified as significant in the analysis of the survey results in Chapter 5, therefore, the gender of participants has been noted, but there is no intention to generalise based on gender or age from the workshop findings. Analyses of participants' responses have been reported using appropriate pronouns, but it must be emphasised that these are making no comment as to gender specific results.

These numbers of participants represent only a small percentage of the pre-service teachers who were invited to attend. Invitations were sent to the entire cohort in each case. In addition, invitations were sent to a cohort of first year students in 2014. Although four students accepted the invitation, they did not attend on the day and did not take up the offer of an alternate time (see Section 7.4.7 for a discussion of issues of recruitment, including speculation as to possible reasons for the low attendances).

Four participants volunteered to take part in individual follow-up interviews at the end of second semester about the impact of the workshops on their anxieties towards mathematics, particularly in the subsequent mathematics education units that they studied. The analysis and findings of the interview data are presented in Section 7.5.

7.3.2 *Data collection methods*

Data collection methods used in the workshop expanded the CIT and bibliotherapy reflections used in the tutorials. Additional data collection methods are explained below. These were indicated by (d) in Figure 7.1. Data included the RMARS survey (Alexander & Martray, 1989) data, the CIT data, the Bibliotherapy reading (Dossel, 1993), the CBT, the PANAS, and the participant evaluation of the workshop.

PANAS. Participants completed the PANAS (Watson et al., 1988) before and after the workshop to distinguish affect. The scale is a tool that gives a snapshot summary of positive and negative affect at a point in time.

Participants are asked to rate 20 words describing different feelings and emotions (10 positive and 10 negative). They are asked to rate each item from 1 to 5 (very slightly - extremely). The two scores can thus range from 10 to 50, and a higher score indicates higher levels of positive or negative affect. The difference in the results from the pre-

and post-workshop PANAS were used as an indication of the immediate impact of the workshop on positive and negative affect.

RMARS survey. The researcher asked participants to complete the RMARS survey (Alexander & Martray, 1989), described in Section 4.5.1 (see Appendix H), to identify their levels of maths anxiety.

CIT. Participants were asked to write descriptions of critical incidents that impacted on their views of themselves as learners and potential teachers of mathematics, in order to capture their self-perceptions. This aimed to provide insights into how they viewed themselves at this stage of their teacher education and the feelings that this evoked. Their written descriptions of critical incidents that impacted on these views were collected, and the researcher took notes on the ensuing discussion. The notes recorded participants' feelings and perceptions and identified outcomes such as changes in their behaviour. These critical incident reflections also helped to identify the causes of their maths anxiety.

Bibliotherapy. As with the tutorial participants from Campus 2, workshop participants were asked to read and reflect on the reading (Dossel, 1993). Participants' written responses to, and reflections on, the bibliotherapy reading (Dossel, 1993) were collected and notes were taken on the discussion that followed. Transcriptions and notes of subsequent discussions were used to identify indicators of their developing mathematical identities.

CBT. Workshop participants were asked to complete a worksheet (see Figure 7.2) with an example pertaining to a mathematical situation that caused them to feel anxious. They were asked to write their thoughts and the accompanying feelings during that situation. Then they were asked to think of alternative, more positive, thoughts to replace the negative thoughts and to consider how this would change their emotional response. They reflected on the positive impact of changing the way they talk to themselves.

Name	Describe situation	Thoughts	Emotional response	Change thoughts	Resulting emotional response

Figure 7.2 Cognitive Behaviour Therapy worksheet.

Workshop feedback. Participants were asked to rate the workshop and provide comments (see evaluation form, Figure 7.3).

Response	SA	A	N	D	SD
The workshop was relevant to my needs.					
The workshop made me feel supported.					
The venue was comfortable and conducive to learning and reflecting.					
I learned from other participants who shared in the workshop today.					
I feel confident I can apply what I learned in the workshop.					
I would recommend the workshop to other students.					

Key: (SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree).

Figure 7.3 Workshop evaluation form for participants.

7.4 Analysis of responses to interactive bibliotherapy workshop and immediate changes

The analysis of the data was driven by the researcher's understanding that critical incidents are produced by the way we look at a situation; a critical incident is an interpretation of the significance of an event (Tripp, 2012). It is important to emphasise that the aim of the interpretation of the written reflections was not to comment on the accuracy and veracity of the memory of the incident but to reflect on participants' perception of their experiences and its impact.

The analysis is structured as follows:

1. The RMARS survey (Alexander & Martray, 1989) data (Section 7.4.1)

2. The CIT data: The workshop results are compared to the themes identified by the analysis of results from the tutorials (Section 7.4.2)
3. The Bibliotherapy reading (Dossel, 1993): The five stages of bibliotherapy, identified from the literature, guided the analysis of the written reflections (Section 7.4.3).
4. The CBT (Section 7.4.4)
5. The PANAS (Watson et al., 1988) (Section 7.4.5)
6. Participant evaluation of workshop (Section 7.4.6)

The analysis of the lasting effects of the bibliotherapy workshop will be presented in Section 7.5.

7.4.1 RMARS data analysis

The RMARS survey (Alexander & Martray, 1989) data indicated that participants presented at the workshop with a range of levels of maths anxiety. Their RMARS scores ranged from 57 to 99 in 2013 and 39 to 82 in 2015, which indicated fair to high levels of maths anxiety. There was only one participant with a low level of maths anxiety, even though the workshop had been offered to all pre-service teachers. There were no very high RMARS scores; for example, the range of the 2013 workshop participants' scores was less extreme, in comparison with the range of RMARS scores of 31 to 104 for the whole cohort at the beginning of the previous year, (shown as the 2012 campus 1 results presented in Section 5.2, Table 5.1). This may be because anxiety levels had fallen during the year, but it could be a potential concern if the reason was that there were pre-service teachers with higher levels of maths anxiety who were reluctant to attend and avoided the workshop.

7.4.2 Critical incident data analysis

The participants were asked to record their image of themselves as learners of mathematics and future teachers of mathematics, and then to describe a critical incident in their mathematics classes that impacted on their views.

Images as learners of mathematics. Most participants who were at the start of their second year had negative views of themselves as learners of mathematics. Anne wrote:

“I see myself as a very confused learner of maths” and Debbie lamented, “Even if I grasp one aspect or concept, or think that I have it, it never seems to last long before I find myself back where I began. This process is frustrating and has eaten away at my confidence as a learner of mathematics for many years”. In these excerpts both Anne and Debbie described the effects of their lack of understanding over an extended length of time. They described their views in terms of anxiety, frustration and lack of confidence.

John saw himself as a struggling learner of mathematics:

I was a very obedient shy mild-mannered student and I do not know why the teacher made no attempt to help me as I struggled with this subject. My year 8 maths class was a very negative experience, I believe it made me lose a great deal of confidence in maths. I was an average student in all other subjects and maths I struggled with and was below average. I believe that negative experience has made me hate maths and be scared of maths as a subject.

In this reflection, John’s view of himself as a learner of mathematics was strongly connected to his school experiences and these have impacted on his current view of mathematics as a subject: “I find it difficult to understand, challenging, confusing, and hard”. John demonstrated traditional views of mathematics. For example, he associated “maths with being smart and successful and having advantages.” However, he added: “I am enjoying it now at university. I am working hard to try my best in maths.”

Evaluation caused issues with identifying as a competent learner for Chris:

Maths tests and exams in both primary school and high school have always made me extremely anxious. I always had a fear of failure and put a great deal of pressure on myself to do well (making myself physically ill). My need for constant reassurance that I am always doing a maths problem correct I think is the major issue (I would always want my work checked).

Some views were connected with topics participants perceived as harder or more complex. For instance, for Debbie her view “depends on topic, fractions and decimals—red rash, freak out, like a rollercoaster”. For others, the demands of the level of mathematics are a factor. Although Kathy viewed herself as “enthusiastic, excited,

engaged & very willing to learn”, she admitted: “I need to dig deep to pass maths.” These comments demonstrate the impact of high stakes situations such as evaluation.

In contrast, Mary, the participant with the low level of maths anxiety had memories of her mathematics classrooms that boosted her mathematics self-concept. “I enjoyed maths at school and tried hard – [this was] reflected in my results. In year 11 and 12 other students would come and see me for help over the teacher.” This reflection shows that she saw herself as a confident, successful learner of mathematics, resulting from interactions with her peers in the classroom context that affirmed her view of herself.

Two of the fourth-year participants indicated that they had changed their views of themselves during their studies:

(Chris)

Since beginning a teaching degree, I feel that I am a more confident learner of maths. I am more willing to take risks and feel as though current teaching approaches and strategies are helping my learning. I feel confident when learning maths however very anxious when using my maths knowledge in a test situation.

(Sally)

Four years ago, I would have said not a very good one (maths learner). I still see myself as someone who struggles with learning maths. I am not 100% confident in my ability yet but I think this is only because I am still trying to let go of past negative experiences. I have found at uni through doing maths units I am more equipped in maths than I thought, so this is helping me build my confidence a great deal.

These reflections describe an increase in confidence over the time of their teacher education course. These participants expanded on this in their interviews, and this will be discussed in Section 7.5 of the chapter.

When considering their image of themselves as future teachers of mathematics, participants expressed concerns about their future teaching. Kathy aired her concerns: “I am concerned that I won’t be as good as I would like to be and concerned about the impact this may have on my students. Presently, I feel I will do too much talking to my students to prevent them asking me questions I won’t be able to answer”. Debbie expressed her fears, questioning her readiness to teach: “I am frightened to think about

this. I often feel that if I failed to understand maths through primary school, how will I possibly teach it?”

These comments illustrate the fears that are caused by lack of confidence in their mathematical understanding. It is worth noting that, at the same time as expressing concerns, participants emphasised their desire to be effective teachers. Anne commented: “I hope that I am a good maths teacher although I am a bit nervous that I will pass my maths anxieties and poor math skills on to my students, which I don’t want to do.” For these participants, the desire to be effective teachers was intimately connected with their own experiences in classrooms. The strength of their commitment was demonstrated repeatedly and reinforced by the discussions. John’s comments emphasised the lasting impact of his school mathematical experiences and indicated his desire to avoid a repetition of them for his future students:

When I am a teacher, I am going to approach maths as best I can. When I am a teacher I [will] endeavour to help all my students and explain maths in a way that helps my students feel confident with mathematics. I will help all my students learn maths and not see it as a scary subject, the way I was led to see it. I would not want my negative experience to happen to anyone.

He reiterated his goal of becoming a supportive teacher during the sharing and discussion of the critical incidents:

I will be an engaging and supportive maths teacher. I will provide my future students with a number of strategies to help them feel confident and engaged to learn maths. I will do everything I can to help all students understand maths. I will use concrete materials not just textbooks.

His comments showed that he is anticipating the impact of his future mathematics teaching on his students, both in terms of supporting and developing positive feelings towards mathematics and supporting understanding and development of skills.

Thus, for these pre-service teachers their own difficulties experienced in learning mathematics provided an impetus for them to seek to avoid maths anxiety in their students by ensuring a classroom environment in which students feel secure and comfortable, and by using a variety of instructional methods.

CIT. Incidents in mathematics classrooms had had profound effects. In contrast to the mix of positive and negative experiences reported in the tutorial data in Chapter 6, all except one of the appraisals were predominantly negative. This reflects the characteristics of this particular group of participants. Mary described her positive experience:

When I was 4 and 5 my parents used to go in to my brother's kinder and year 1 class to help with reading. I was given my own desk within the class and I would join in with the class. So, I would do maths at kinder and year 1 level from age 4 and 5. Then when I started school I was ahead, and this made it really easy for me to understand the subject and enjoy it.

As well as the traditional binary analysis of positive or negative experiences, the researcher related the critical incidents to the themes identified by the thematic analysis of the tutorial reflections presented in Chapter 5. Written critical incidents were examined for the dominant themes identified from the Campus 2 tutorial responses: environmental factors, including the effects of a teacher and the way in which mathematics was presented as a subject; the impact of peers, and parental influences. In addition, personal factors such as lack of confidence, and the cycle of fear, failure, and avoidance were noted. Transcriptions and notes of subsequent discussions were used to identify factors contributing to their anxiety towards mathematics.

Participants' negative recollections showed that they were thinking deeply about the implications of their mathematical experiences. Written reflections described feelings, expectations and concerns from their formative experiences with mathematics in their school years, in both primary school and high school. Events included both specific key events, and also continuous events over time. For example, Kathy recalled:

No particular incident, I just got left behind & the gap grew larger. I then developed poor self-esteem in relation to maths, and grew critical of my maths abilities, which encouraged others to then joke about my poor maths skills. This then impacted on my life where I didn't want to be treasurer of committees, wouldn't calculate restaurant bills, or football, cricket scores.

In contrast, some individual incidents were recalled in detail, for example, John recounted an incident with a teacher from primary school:

When I was in year 3, there was one simple question that I just couldn't understand. My teacher just repeated the same approach to how she arrived at the answer. After around 4 or 5 times of just saying word for word the same strategy, she walked away and said: "we don't have time any more, just ask a friend".

As well as the description of the incident in Year 3, he had been affected by another incident in Year 8, shown by this critical incident description. His comments demonstrate the impact of high stakes situations such as completing mathematics in public:

The teacher often explained a problem on the whiteboard and then instructed the class to work on various activities set from a textbook. I had absolutely no idea what I was doing and did work on the activities however, completely had no understanding of what I was doing...On one occasion the teacher made me complete [a] problem in front of the entire class on the whiteboard. I had absolutely no idea what I was doing and yet the teacher still made me complete the task. I tried to attempt the problem and it made me a joke in front of all the other students. It was a humiliating and degrading experience.

As John described this experience, the emotional toll of the shame of the experience was clear from the extreme language of his description of the shame of not knowing the answer, and the feeling of being mocked by his peers. These experiences were critical junctures for John.

Emotion-focussed responses also demonstrated the ongoing impact of time pressure. Sally described an incident from her primary school. "One day I had a relief teacher and I was asked to recite my times tables in front of the class! It was horrible! [*emphasis in original*] She made me cry and I wasn't allowed to sit down till I got it right." Kathy identified experiences with time pressure that continued over longer periods of time rather than recounting a specific instance. These included repeated teaching strategies that had a negative impact. She recalled from Year 4:

Every morning we had an A4 sheet of multiplications. That just wrecked me. We were timed to do it. I couldn't do it and everyone else could. I still get anxious when papers are handed out in class and with multiplication.

During the following discussions, the feedback from peers and facilitators encouraged participants to challenge their existing perceptions of themselves as learners of

mathematics. For example, during the discussion, Alice recalled: “I never had a teacher that taught. The teacher used the textbook and board and when students asked questions, said ‘I’ve taught you that’”.

In the discussion, Debbie also indicated the embarrassment that resulted from a teacher’s comment about her in front of the class. She remembered “quick drill things, being asked to do maths in front of the class. Teacher asking class: ‘what has she done wrong?’” It was apparent that participants retained intense memories of their experiences with disabling teachers. In particular, they were affected by being singled out and by the public exposure of their struggles in front of the class.

Debbie shared comments about the way that she felt in response to the perceived lack of support from teachers:

Teachers not willing to work with me through it. Lost cause – they said: “We haven’t got time to work with you”. The emphasis was on the ability to produce things quickly and keep up. There was a lot of pressure – tests in the mornings, drill things. We were put under pressure all the time. There were constantly opportunities for embarrassment and humiliation in front of our peers. I thought “I am obviously the dumb one in class” – and I couldn’t see myself getting any better.

This reflection illustrated the fact that a combination of factors can have a cumulative effect on a student’s anxiety. For example, the dismissive comments from the teacher and the pressure-filled strategies reinforced her developing identity. The repeated humiliation reinforced the impact on her self-concept, and her conclusion that she was a “lost cause” and “the dumb one” and, worryingly, she could not see the situation improving.

From their memories, a theme of shame and humiliation was identified (exemplified by John characterising the incident in Year 8 as “humiliating and degrading”). He shared:

Throughout a whole year not understanding anything in maths, no support or help. My work or homework was never checked, and I performed badly on exams. I felt ashamed and could not feel I could get help or support. I feel angry that I fell through the cracks.

According to Torres and Bergner (2010) “humiliation has been subjected to relatively little conceptual or empirical scrutiny” (p. 195). In Table 7.1 their formulation of

humiliation has been applied to analyse responses from the critical incident reflections that indicated humiliation.

Table 7.1

Analysis of critical incidents using the Torres and Bergner model (2010) of humiliation

Humiliation element	Related to pre-service teachers' description of critical incidents.	Example
Person claims status	As students in the classroom, they presented themselves as a person able to do mathematics (part of their identity as a mathematics learner).	"engaged & very willing to learn" (Kathy)
Public failure	Their failures were held up in public	"Teacher asking class: 'what has she done wrong?'" (Debbie)
Status of the degrader to denounce	As students, they did not question their power relationship with the teacher, or the teacher's right to make a judgement of their mathematics ability or potential	"My work or homework was never checked, and I performed badly on exams. I felt ashamed and could not feel I could get help or support." (John)
Bid for status rejected	They were rejected as a person able to do mathematics successfully. They began or continued to reject their self-identity as a person who could do mathematics	"I thought: 'I am obviously the dumb one in class' – and I couldn't see myself getting any better." (Debbie)
Rejection of the individual to claim status	The teacher's interpretation or evaluation was accepted, and the student had little recourse to make a counterclaim against the teacher's academic judgement and what this could mean for themselves as learners of mathematics	"I never had a teacher that taught. The teacher used the textbook and board and when students asked questions, said 'I've taught you that.'" (Alice)

An earlier version of this table relating to other examples was presented at the annual conference of the Mathematics Education Research Group of Australasia and published in the conference proceedings (Wilson, 2015).

The model of humiliation can be applied to analysing and understanding individual statements, as Table 7.1 showed. In addition, it can provide an insight into the process by which participants are humiliated. John, for example, was a shy student who struggled, but persisted in trying. He had already described an incident of failing in front of the class, at the blackboard, and being publicly shamed (Section 7.4.2). John's reflection in Table 7.1 showed that he did not challenge the position of the teacher and showed acceptance of the status of the teacher to denigrate his efforts, despite the failure of the teacher to support his learning. Although he did not get help from the teacher, he did not challenge this, but felt ashamed. As a result, he saw himself as "below average" in mathematics. Thus, he was not able to make a counterclaim against the teacher's academic judgement.

As well as interactions with the teacher, participants recalled the impact of teaching strategies that took place over periods of time in the classroom. For example, Alice wrote: "I cannot pinpoint a particular incident, but I remember having a bad maths experience in primary school. We were always taught out of a textbook and not given a variety of strategies to cater for all learners." In addition, Anne recalled mathematics lessons as "always got taught rules". These excerpts reflect their experiences with an instrumental way of teaching and the mismatch with their need to understand the mathematics.

Participants were willing to expose their vulnerability. Sally showed how secure and supported she felt in the workshop by her willingness to share a story about a recent comment from her past teacher:

I got tutoring from my maths teacher (grade 9) at lunch time but I only ever remember her being really stern and direct! Not encouraging! I was at the school recently and saw her after nine years and she still made a comment about my maths abilities. This frustrated me! But also made me feel a reassurance that I was doing the right degree!

These reflections illustrate the lasting impact that individual teachers can have on vulnerable students. The reflections highlighted how the right/wrong dichotomy in school mathematics, and the discomfort that comes from getting things wrong contribute to their development as mathematics-avoidant students. Although looking back they can see it as poor teaching now, their focus at the time was on themselves as

poor students and their own deficiencies, not on those of the teacher. This shows the importance of reflection in recognising the impact of “old stories” that they have carried with them, and the change in their mathematical identity that the development of “new stories” can stimulate.

In contrast to Debbie who accepted that she was “the dumb one in the class,” and John and Sally who felt that they were humiliated in front of their peers, Mary recalled positive experiences of helping her peers in class. This reinforced the positive mathematical identity that she had gained from high test scores.

In addition to the expected descriptions of the environment of the mathematics classroom, participants also described their own responses as part of their critical incidents. Lack of action or the strategy of minimisation were the coping mechanisms that some used in situations which they found extremely stressful – a cycle of fear, failure and avoidance (Sliva & Roddick, 2001). This was illustrated by comments such as: “I felt ashamed and could not feel I could get help or support” (John). Kathy reported: “I tend to block – as soon as a student talks to me about a concept I go deaf – can only hear the word ‘maths’”. These participants perceived the incidents as threats to their well-being, accepted blame, felt inadequate, and expected negative consequences. Anxiety dominated their emotions, increasing the level of discomfort to the point where their response was to avoid the situation. The cycle of fear, failure and avoidance has implications for their self-concept as learners of mathematics.

Although comments about the influence of parents and families were not identified as common themes in the tutorial responses reported in Chapter 6, two of the workshop participants identified incidents with their parents. For example, Anne recalled:

Dad was good at maths. Mum was not. I got blessed with Mum's background. Mum tried to help. Dad could do it straight away. He said why are you crying, this is the answer. Dad yelled the roof off. He couldn't see why I couldn't understand. I said I get it, to stop him. Then I wouldn't ask him. Now we are best friends, but when it comes to maths [pause, shakes head].

This graphic description of when parents helped with homework shows the powerful effect of such incidents.

7.4.3 *Bibliotherapy data analysis*

The process of writing and verbalisation allowed the participants to express and share their cognitive and emotional responses to the reading. During the sharing of reflections with their peers, their views were acknowledged and feelings validated.

The five stages of bibliotherapy, identified from the literature, (see descriptions in Chapter 4, section 4.6.2) guided the analysis of the written reflections.

Identification. Participants identified closely with the analysis of causes of maths anxiety in the article by Dossel (1993). For example, Kathy reflected: “when I read this article, I found that all the factors leading to the creation of maths anxiety are easily relatable.” Participants’ reflections showed that they identified with the students and the situations that caused the maths anxiety. John’s response was “I can relate to the personality factor that I feel helpless towards maths and have reinforced this thinking”, whereas Ruth wrote that she “can see a lot of her experience in primary school.” Both these responses demonstrate that they have recognised themselves in the situation, either in more personal terms or in their experiences.

Debbie identified with the students in the reading who had struggled in competitive classrooms. She described her own experiences:

so many other kids got it and were good at it. To fit in, you needed to have those basic skills to be seen as normal. Everyone else liked to sit down and drill – they were all good at it. I kept to myself and felt not a part of it all. There were 20 plus students. Not too many students who looked at maths in a scary light.

As a student, Debbie had felt herself an outsider in the classroom, and considered that her emotional response set her apart from the other students.

Catharsis. Through their reading of the articles some participants became emotionally involved, and they felt relief at having the opportunity to share their experiences with other participants. In the discussion Kathy admitted that her “biggest fear is year 6 maths. I need to work very hard at Maths” and that she was anxious because her first lesson on practicum was Year 6 mathematics and she was concerned she would talk too much to stop students asking questions. She related her feelings to school where she

felt embarrassed and under pressure as she “got left behind in upper primary school and lower high school.”

John’s later reflections also showed benefits from the collaborative workshop. Sharing the shame, humiliation and then anger and bitterness was cathartic. His writing describing his experience in the past and how he views it now in the present was an emotional release for the problems encountered – and enabled him to express his anger: “I feel angry that I fell through the cracks.”

Insight. Reading articles focussed on the reasons school students struggle with mathematics heightened the participants’ awareness that their problems were not necessarily of their own making and could thus be addressed. For Alice, “it highlighted some obvious concepts that tend to make people nervous or anxious as well as myself. It conveyed the importance that students aren’t stupid if they can’t answer straight away or in a competitive environment.” She recognised that this was related to the nature of the mathematics studied and the type of understanding that was valued in their schooling. Reflecting on the nature of the teaching that she received led to an awareness of alternative approaches. Anne shared her insights about competitive classrooms. She concluded that there is a “very fine line between ok and not ok”, particularly in terms of the impacts on students of public failure. This shows that the reading had stimulated her appreciation of the nuances involved in differentiating activities for students. John expressed further insights that problems in class related to:

the pressure of authority figures. All my teachers would model the work on the board and more reserved children like myself felt scared to ask questions. ...The effect of public failure, I could not answer as I feel dumb if I get it wrong. The right/wrong, I was not sure if I got questions right or wrong.

Chris agreed “with many points presented throughout the article including the coping strategies section where students who try hard and fail experience more shame than students who deliberately put in a lack of effort.” Chris provided evidence of further reflections about this in her interview (see Section 7.5.3).

Universalisation. Common in their reflections on the readings was an expression of the comfort that participants felt in finding that they were not alone in their feelings and experiences, and the recognition that others have the same issues. Chris reflected: “I

am not the only person that is anxious about maths.” Listening to others’ stories helped them feel reassured and encouraged. This normalised their experience and demonstrated their need to know that they are not the only ones who have gone through this – others have experienced similar difficulties. In addition, participants realised that they might not have realised how others felt. As Debbie stated: “Looking back from my perspective, I’m sure there were many kids who would have felt like me and I didn’t know.” This illustrated a developing empathy for others.

Projection. Participants considered what their new understandings could mean for the future. They imagined themselves as future teachers, in some cases, rejected the way they had been taught, and described the type of teacher they wanted to be. For example, Kathy identified and related to common causes from the bibliotherapy reading both personal feelings: “feeling apathetic towards maths because of failure” and coping strategies: “failure - deliberate lack of effort.” However, she clearly expressed her future vision as a teacher: “I want to have an engaging, fun, contextual maths learning environment.” Some of the comments addressed specific issues such as the need to ensure that their students make connections in their mathematics learning, have sufficient time and that they as teachers model positive attitudes in the classroom. Mary, for example, said: “It all comes back to self-confidence, promoting a healthy attitude towards one’s-self will have a huge impact on their learning.”

Both Sally and Chris shared reflections on time pressure and learned helplessness as factors that stood out for them in the reading. Chris also shared her frustration with students’ reluctance to take risks in the classroom, and spoke of how she saw herself working to overcome this as a teacher in her future classroom:

I think this is an area that needs to be concentrated on by teachers. Why is there that students feel ashamed of having a go? We need to draw attention to successes & trial and improvement. We need to make failure not so daunting. Safe environment and ample time need to be given to place students in a good frame of mind to complete maths. Learned helplessness! Need to make this a positive thing. Getting a question wrong should not be a shameful thing! Competitive classrooms I feel contribute to the time pressure.

In the sharing and discussion after their written responses to the bibliotherapy reading, John reflected on his behaviour when he found it difficult to understand new concepts,

stating: “[The] ... teacher modelled on the board. I sat playing around, pretending I was doing maths ... I just don't get it, so I didn't do it.” As a result, the ... “gap got bigger and bigger. I just thought, I just don't get it, so I didn't do it.” This showed how his avoidance developed. In the discussion John shared: “I realise it affected me at the time. I feel bitter because it is still affecting my ability to do maths.” When trying to do a maths problem he still gets anxious because he thinks everyone else is finished and “I should be able to do it faster. I wouldn't be like this in another subject”. This showed that critically reflecting on his own mathematics narrative and on the reading and listening to others had allowed John to recognise that his mathematics learning had been compromised by the lack of teacher support. His emotional response had changed from shame to feelings of anger as he described his critical incident. Sharing the shame and humiliation, then anger and now bitterness was cathartic, as he could focus on the impact of the teaching strategies rather than feeling he was at fault. This stimulated his aim for his future as a teacher of mathematics: “my students will associate maths with pleasurable experiences and won't see it as a tense scary experience.”

Reflections on the bibliotherapy reading (Dossel, 1993) that followed the sharing of the critical incident stories, led participants to increased understanding of their own mathematical identity and how this might change.

7.4.4 CBT analysis

Workshop participants were asked to write about experiences related to mathematics that caused them to feel anxiety, their thoughts during that situation and the consequent feelings. Then they were asked to write positive thoughts instead and reflect on how these changed their emotional response. In every case, the participants recorded that writing more positive thoughts had engendered more positive feelings. Two examples that characterised their responses are provided in Table 7.2.

Table 7.2

Examples of Cognitive Behaviour Therapy results.

Name	Describe situation	Thoughts	Emotional response	Change thoughts	Resulting emotional response
Debbie 2013	Recently, sitting in a class (lecture/tute) and being given a sheet and being asked to calculate the answers to particular problems.	Instantly: "I can't do this". I was worrying about whether I would be singled out in front of the lecture and that my incorrect answers just reminded myself that I'm not great at maths.	Freeze up, almost wanting to leave the class due to the fear of facing my lack of ability. Ashamed and upset.	Not see yourself as the only one who feels this way. Rethink and challenge those initial thoughts.	Anxiety would still be present. However, I would feel more relieved at the fact that I can manage the situation.
Ruth 2015	Answering a difficult maths question or starting a difficult topic	Why do I need to know this? When will I ever use this? I can't do it. It's too hard. I'm not doing it. I'll try but fail.	Anxiety	This is a chance for me to expand my knowledge/try something new. I can do this. What's the worst that can happen? Let's give it a go. How could I break it down?	Empowered Calm

These findings illustrate that these participants were able to change their anxiety responses by deliberately changing their thoughts. They recognised the need to interrogate negative, distressing or frightening thoughts, and to question how realistic they are and what other viewpoints there might be. Recognising that distorted thoughts can undermine self-confidence and make them feel anxious, they realised that when they think more realistically their symptoms subside. For example, Anne changed her thoughts to: "Remain calm. Ask questions. Be positive" and, as a result, felt "calmer, happier, clear head, ok". When Kathy deliberately thought: "I can ask for help. I can do

this. Refocussing, listening more intently. Saying to myself ‘this feeling is not part of my life any more’ – I am a different person on a different journey now’,” she commented that she “would feel liberated and relieved.” These are examples of the turnaround.

7.4.5 PANAS results and analysis

The PANAS results in both years indicated a shift towards positive affect at the end of the workshop. Table 7.3 shows the individual and average results of the PANAS at the beginning and end of the 2013 workshop.

Table 7.3

Results of the Positive and Negative Affect Schedule (PANAS) before and after the workshop, 2013

Participant	Affect scores			
	Positive		Negative	
	before	after	before	after
John	41	50	18	14
Kathy	23	41	14	13
Jane	15	17	23	15
Emma	34	34	14	10
Alice	18	27	11	10
Debbie	23	32	27	24
Mean	25.7	33.5	17.8	14.3

The results show that, at the end of the workshop, positive affect had remained constant in one case and increased for the others, and negative affect had decreased in all cases. This indicates that there was a reduction in participants’ negative feelings during the workshop. Overall, the increase in positive affect was greater than the decrease in negative affect. In some cases, quite large increases in positive affect were accompanied by much smaller decreases in negative affect, for example, Kathy’s rating of her positive feelings rose by 18 points, but at the same time her negative affect rating only fell by one point.

Table 7.4 shows the results of the PANAS at the beginning and end of the 2015 workshop. The mean results show that at the end of the workshop positive affect had increased, and negative affect had decreased for the participants.

Table 7.4

Results of the Positive and Negative Affect Schedule (PANAS) before and after the workshops, 2015

Participant	Affect scores			
	Positive		Negative	
	before	after	before	after
Julie	35	41	15	16
Anne	32	40	38	10
Sally	31	36	14	14
Chris	25	43	20	10
Ruth	21	24	14	13
Mary	18	27	14	11
Mean	27.0	35.2	19.2	12.3

The 2015 results indicate that there was an increase in positive feelings for all participants, and a reduction in participants' negative feelings for four participants, with staying the same and one increasing marginally during the workshop. These results confirm the results from the 2013 workshop shown in Table 7.3, that the immediate result of the workshop was a shift to more positive affect. The reduction in Anne's negative affect score is very marked, and much larger than the increase in her positive affect. This contrasts with Kathy's results from 2013. Both results demonstrate the strong shifts in feelings that were an immediate result of the workshop.

7.4.6 Participant evaluation of workshop

All participants were asked for feedback at the end of the workshops. The workshop evaluations were similar in 2013 and 2015, with participants agreeing or strongly agreeing with the statements. As an illustration, Table 7.5 presents the responses of the participants from the 2015 workshop.

Table 7.5

Workshop evaluation of pre-service teachers (n = 6) in 2015

Response	SA	A	N	D	SD
The workshop was relevant to my needs.	4	2			
The workshop made me feel supported	5	1			
The venue was comfortable and conducive to learning and reflecting.	5	1			
I learned from other participants who shared in the workshop today.	4	2			
I feel confident I can apply what I learned in the workshop.	6				
I would recommend the workshop to other students	5	1			

Key: (SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree).

Participants were also asked to add written comments after the survey that outlined what they had gained most from the workshop. Sally said, “It was helpful to talk to others about my experiences. I am feeling more comfortable about maths and I have a deeper understanding of anxiety.” Chris gained most from

talking and sharing my experiences with maths about others. It was great to learn how others feel in similar situations. The session was really interesting, and I enjoyed learning some actual info & mental health strategies about changing my thinking towards maths anxiety. It was really good to have open discussions with [the facilitators’ names] and relate these to why we feel this way and how we can overcome it.

The participants stated the insights that they had developed from the workshop. Chris said: “I found it very interesting to find out about anxiety and why we feel this. How we can cope with it,” and “realising that my maths anxiety was a thing of the past and I can change the way I feel.” This showed further evidence for the development of insight, which is part of the bibliotherapy process.

Participants reported that they appreciated the opportunity to have quiet time writing and reflecting as part of the workshop. Although the participants had been offered

unlimited time for writing, some of the written reflections were comparable in length with the shorter reflections written by participants in the tutorials who had limited time. However, on looking back at the end of the workshop, they requested “More time,” and “More quiet time to complete questionnaires.” Participants also requested additional workshops.

7.4.7 Discussion

The analysis provides evidence for the effectiveness of the workshop in addressing maths anxiety. It is noteworthy that the range of maths anxiety identified in the workshop participants was smaller than that of the larger cohort, even though the workshop had been offered to all pre-service teachers in the cohort. There were no participants with nil or very high RMARS scores. This could relate to issues of recruitment – if pre-service teachers with higher levels of maths anxiety avoided the workshop (akin to the avoidance of tests reported by Flegg and Trimmer, 2015) and those with no anxiety were not convinced of the value of the workshop for them. Alternatively, the time commitment required could be the issue. These causes are speculative and would repay further investigation.

The workshop was designed around reflective strategies. Past experiences affect pre-service teachers’ understanding and perception of themselves as learners and potential teachers of mathematics. Narratives were a way to highlight the identities of pre-service teachers as learners and potential teachers of mathematics by exploring the emotions that pre-service teachers associate with their experiences. Participants spoke more about their feelings than the content of mathematics, and several viewed themselves as failures, often as compared to their peers. This echoed the findings of Brown and McNamara (2005). Initially, self-blame and feelings of inadequacy were common. Increasing levels of discomfort had led to avoidance of situations. This is of concern if it persists, as pre-service teachers with low self-efficacy perception are less able to cope and reach their learning goals. Other international research has focussed on the value of investigating pre-service teachers’ prior experiences in mathematics (Coppola et al., 2015; Kaasila, 2007a; LoPresto & Drake, 2005) using mathematics autobiographies, narrative rehabilitation and bibliotherapy. According to Coppola et al. (2015), reflections by Italian pre-service teachers “represented a sort of math-therapy” (p. 207).

John's traditional view of mathematics echoes the misconception that an above-average brain is required for success in mathematics and the school mathematics curriculum is not designed for students with average ability. Similarly, Muis (2004) identified a common belief that mathematics understanding requires a higher ability than other subjects and requires innate ability.

The identification of teachers as a major influence, concurred with previous research (e.g., Cady & Rearden, 2007; Ellsworth & Buss, 2000; Sliva & Roddick, 2001; Sloan, 2010; Steve Tobias et al., 2010; Trujillo & Hadfield, 1999). For more details, see discussion of the literature on past mathematics classroom experiences in Section 2.5.2. In particular, Steve Tobias et al. (2010) identified teachers as the major factor in turning points (marked changes in participants' feelings) and similar abrupt changes were described by participants in response to comments by teachers. This demonstrates the vital part which pedagogical tact (van Manen, 2008) can play in classroom interactions (see discussion in Section 5.4.).

In particular, embarrassment and humiliation by teachers were regarded by participants as crucial issues. Torres and Bergner (2010) view this as an ethical issue, suggesting that it may be a human right not to be subjected to public humiliation. Participants identified feelings of shame. These feelings have been discussed in reference to mathematics learning by Bibby (2002), and, in terms of their broader impacts, by Beilock (2011) and Brown (2008). There is a need for a debate raising awareness of humiliation and shame as consequences of teaching or assessment strategies in the classroom, particularly those relating to evaluation and time pressure.

One of the issues raised by Angelides' (2001) study of teachers is that individuals may be emotionally charged, try to give reasons, and "try to present themselves as not being at fault in the incident" (p. 440). Although participants in this study were emotionally charged, the data shows that, looking back at their role as students in the incident, many saw that they originally deferred to the teachers' interpretations that as students they were at fault. This is a feature of the Torres and Bergner (2010) framework (see Table 7.1). However, their subsequent reflections enabled a more nuanced and balanced view.

The process of writing and verbalisation as part of reflecting on their actions and decisions gave participants an opportunity to analyse their past actions and emotions

and understand how significant experiences had shaped their identity. Critical incidents included one-off events and longer-term descriptions such as Anne's powerful recollections of her homework experiences. Adverbs such as "every" and "still" (Kathy) and the language of "all the time" and "constantly" (Debbie) indicated reification of their ideas over time (Sfard & Prusak, 2005). However, reflections on the critical incidents allowed participants to describe, explore, and better understand how their mathematical identities had developed and could continue to evolve through their reflections on the classroom interactions.

Critically reflecting on their mathematics narratives showed the value of taking the time to think and explore their own perspectives. Listening to others' stories and hearing others' perspectives was an important part of the workshop. The participants made associations between their stories and other pre-service teachers' stories of mathematics experiences. Others' experiences with maths anxiety were not identical, but the fact that someone else had gone through a similar experience enabled listeners to identify with them. They showed respect for others' perspectives. They built trust, enabling their emotional expression in a safe environment. Sharing vulnerability in the workshop encouraged productive conversations and working together towards positive solutions.

While some experiences had been out of the participants' control (external), other experiences relied on what they had done in the situation (internal). Reflecting on, and confronting, their perceptions of their critical incident experiences allowed a release, similar to the catharsis stage of bibliotherapy. Some participants changed their perception of the incident or could now see what they might have done differently. They began to perceive value in these experiences. This both extends and contrasts with research findings by Brown et al. (2012) who reported that "pre-service teachers who described negative previous experiences with mathematics were able to recognize this deficit and take internal control over their preparation and their commitment to children's understanding of mathematics" (p. 382). In this study the CIT provided the participant with an opportunity to reconstruct their view of the experience, not as a deficit to be eliminated, but as beneficial and affirming. They could reconstruct their views of themselves in a more positive light. The participants could re-interpret who they were, but also who they might become, that is, their projective identity.

One outcome that was unexpected was that the participants did not write for as long as the planning of the workshop had allowed. The extra time provided in the workshop did not seem to result in more writing. This was inconsistent with comments by several participants in their evaluation at the end of the workshop that they would have liked more time to write. This discrepancy may have been caused by participants feeling some pressure to finish writing when they saw that others in the group had stopped. Of course, this explanation is only speculation. However, length was not a measure of the depth of their reflections. Although some of the reflections did not seem much longer than those from the tutorials considering the extra amount of time allowed for writing, participants shared more personal and detailed reflections with their peers in the small-group workshop. The critical incident reflections provided stories that were complemented by the bibliotherapy reading. The bibliotherapy process was expanded in the workshop as participants listened to and discussed stories of critical incidents from the other participants and then explored further through reflecting on the reading and sharing their reflections. This indicates that encouraging participants to share their reflections on a reading extended the insights from their written reflections. For participants with low levels of maths anxiety, sharing reflections opened the way to new understandings of others' classroom experiences. Hadfield and McNeil (1994) advise that teachers should address students' negative feeling towards mathematics rather than letting them persist. The implication is that all pre-service teachers should be aware of maths anxiety and its potential impacts on their future students, hence the need for all to learn about it in their courses.

For the cognitive bibliotherapy in the tutorials (described in Chapter 6) participants read about others in order to identify with those who have similar experiences and gain insights into their own motivations or actions (Lenkowsky, 1987). Lutovac and Kaasila (2011) extended cognitive bibliotherapy by using extracts of peers' mathematical autobiographies, describing their work as "narrative rehabilitation". In the current study, the participants shared their own accounts of critical incidents in the workshop. The process of writing followed by verbalisation allowed further reflection on their actions and decisions. This was reinforced by the counsellor's explanation of the need to revise old stories using a different perspective. The inclusion of sharing of critical incident experiences and interactive bibliotherapy in the workshop was transformational, giving the participants the opportunity to re-perceive the situations

from their current perspective as adults. High stakes situations can generate unwanted thoughts and feelings. Controlling anxiety and emotional responses requires resources (Richards & Gross, 2000). The CBT exercise allowed the participants to develop cognitive tools to transform a situation by changing their thinking.

The immediate result of the workshop, evidenced by the PANAS results, was a shift to more positive affect. These results were consistent with the findings of Uusimäki (2004) that positive feelings increased, and negative feelings decreased in self-identified pre-service teachers doing collaborative tasks and discourse.

In the very positive evaluations of the workshops, the requests for more workshops showed that this was, for participants, a one-off experience and they would value ongoing support and encouragement, and ongoing relationships, within a group. Although the responses to the first workshop demonstrated positive outcomes for the participants, recruitment remained an issue for in planning further workshops.

7.5 Lasting effects of bibliotherapy workshop

As follow-up from the workshop and to provide data for Research Sub-question 2d, interviews were used to investigate long-term effects on participants' maths anxiety and their subsequent studies of mathematics units in their courses and practicums (see Appendix K). Data excerpts are presented to illustrate how different pre-service teachers reconstructed their mathematical identity during and after the workshop activities. There is no intention to generalise from these examples.

The interviews sought to identify participants' perceptions of whether and how their views have shifted, as a result of the workshop and whether their maths anxiety had been ameliorated. While the PANAS data, reported in Section 7.2.5 sought to ascertain the immediate effects of the workshop (Sub-question 2b), the interview data, collected six months after the workshops, provided evidence for lasting effects of the workshop (Sub-question 2d). The results and interpretations of the participants' responses to the interview questions are presented in this section.

Two second-year pre-service teachers volunteered to be interviewed at the end of the year after the workshops in 2013, and two fourth-year pre-service teachers volunteered after the 2015 workshops. Although a number of other participants had indicated at the

time of the workshops, their willingness to be interviewed, they did not respond to subsequent invitations and reminders after they had completed their next mathematics education unit. This impacted on the way in which data were analysed and presented. Consequently, these four participants have been employed as vignettes, for this discussion.

The analysis of the survey results did not identify gender or age as significant in the findings, and the workshop data have not been reported based on gender or age. Consequently, those factors have not been highlighted in the analysis of the interviews. This is consistent with the qualitative analysis of a small sample. The researcher is not able to generalise from this sample but aims to use the deeper complexity of a small number of specific instances to explore relationships and processes, taking inferences and interpreting them in the context of her personal and professional knowledge.

In order to provide an authentic context for the analysis of the interviews, the researcher developed cameos or vignettes of the four interview participants from their responses to the data collection strategies in the workshop. The construction of these vignettes was informed by the factors identified by Hughes and Huby (2004) for constructing vignettes. These vignettes or cameos are presented first for each participant and are followed by summaries of the interviews. Finally, Tables 7.4 to 7.8, summarising the participants' development of mathematical identity, are guided by the conceptual framework (see Figure 3.6) and also draw on Lutovac and Kaasila's (2011) discussion of identity work and formulation of mathematical identity.

Participants 1 and 2. Participants 1 and 2 were second year pre-service teachers who were interviewed in 2013.

7.5.1 Participant 1 – John

John viewed himself as a shy and well-mannered student who struggled in mathematics and who was “below average” in this one subject. He had negative memories of his mathematics classroom and still sees himself as responding differently to issues with mathematics compared to other subjects. His initial views of himself as a teacher were centred around ensuring that these negative experiences were not repeated for his future students. John's response to the bibliotherapy reading was to identify strongly with the factors in the reading and list his personal experience with most of the common

causes of maths anxiety identified in the reading. His reflections on his experiences led to changes in his feelings from helplessness and fear of public failure, to expressions of anger and bitterness.

John's dysfunctional emotional reactions had been activated during his mathematics classroom experiences. The characteristics of this participant that made him stand out in the workshop were his change in emotion and his expression of anger and bitterness about the way that he had fared during school mathematics classes. However, in the interview he concentrated on the changes that he had instigated as a result of the workshop. Two themes were identified from the responses in the interview. These were positive changes in his approaches to his own learning and practicum, and further reflections on his identity as a future teacher.

Initially, John described how his perception of his maths learning changed after his engagement in the bibliotherapy workshop. He has learned to identify and respond to activities where anxiety may still be an issue:

Especially in exam or pressured situation, doing lectures and going through lecture maths problems can be tense and scary, when I can't get it. Fear of not being able to understand, feel scared, don't want to have gaps in my knowledge. I want to be able to understand it.

He has changed his views of himself as a learner. He said: "instead of thinking: 'It's maths, I won't understand anything,' I kept telling myself 'I will understand.' If I think 'Maths – I can't do it,' it takes over. Opening my mind, being positive, helps me to focus more on what the lecturer is doing."

John explained how he used the techniques from the workshop in his subsequent mathematics unit. He said, "with exams, I didn't feel as anxious. I concentrated on thinking: 'I have studied my best.'" I was thinking about cognitive behaviour and challenging my [negative] thought processes. I focussed on my breathing. I was more confident in class, doing assignments and preparing for exams, by using those strategies." He also applied this on practicum, "I didn't let the anxiety take over. I soldiered on. I think it helped a lot. It definitely helped. Going on the next couple of pracs, I will feel more confident."

He expanded on how he approaches his classes:

When there is a maths problem in the class – there are a couple every lesson – instead of [before I did the workshop] looking around “everyone else understands”, couldn’t even work on it because I think: “ I won’t understand,” now [after the workshop], go in and focus on the lecturer, listen carefully, focus on working it out, take time, focus on telling myself to take time and I can do it, would understand. I could just focus on me and the maths problem. Positive attitude – taking my own time. Instead of challenging thoughts – “you can’t do it. Everyone else can get it” – I think: “Yes, you can do this. Just focus on the problem and take your time” and this stopped the anxiety from occurring.

These comments described the positive benefits of the workshop on his studies in his subsequent mathematics education units. They showed how he used his own and others’ past experiences to re-image himself as a learner in the subsequent mathematics unit that he studied.

Secondly, John’s focus in the interview was also strongly on his future teaching, even though he was only in the second year of his course:

Make maths positive and engaging. I don’t want them to be uncomfortable and see it as a daunting subject. I want them to learn. I want to help them to feel more confident and give them strategies to help with anxiety – e.g., don’t say negative things to yourself. Be positive. Work with parents if child is anxious – “this is what I am doing with your child in class to try to overcome their anxiety problem.” Talk to colleagues as well – get their advice on how to provide effective strategies. Understanding how they feel will help me as a maths teacher.

It seems that reflecting on his recollections of his school mathematics classroom have both consolidated his determination to turn his maths anxiety to a positive and produced a strengthened, transformative effect on his projective identity as a future teacher (see Figure 7.4). He opined:

My anxiety will help me to recognise for students who are struggling that may be a problem, and to be able to cater for those students. It has made me more mindful because I don’t want any student to go through what I went through – need to understand how students feel because then I can develop strategies. If you don’t know how they feel, they will move on to the next class and fall through the gaps.

The comment about falling through the gaps reflects the experience that he went through at school and has fostered his determination to be more aware of students. This was a coherent theme throughout his reflections during the workshop.

Development of mathematical identity	Description
View of oneself as a learner of mathematics	Positioned self as outsider, victim. Extreme description
View of oneself as a potential teacher of mathematics	Desire to be engaging and supportive
View of mathematics	Difficult subject; needed for success
Critical incident	Humiliation by teacher
Bibliotherapy reflection	Recognition of factors that compromised his learning
Bibliotherapy projection	Focussed anger into determination to make his classes enjoyable
Interview: impact of workshop	Applied tools and strategies to class and practicum
Subsequent mathematics unit	Challenged maths-avoidant behaviour
Practicum	Persevered, didn't let the anxiety take over
Community – parents	Ask colleagues for advice, explain affective strategies to parents
View of self as future teacher – Projective identity	Student focussed. Turn own experiences into positive for students. Facilitator for students who struggle

Figure 7.4 Participant 1 – development of mathematical identity.

Figure 7.4 shows that John's mathematical identity developed as he challenged his previous assumptions and views. His critical incident description brought out the intensity of the experiences and their impacts on him as a passive recipient. However, he was open to the transformational experience afforded by the workshop to counteract these and reconstruct his desire to be an engaging teacher into his future identity as a supportive facilitator of learning.

7.5.2 Participant 2 – Kathy

Kathy had negative memories of her school mathematics experiences, where she felt put under pressure, and was profoundly aware of comments from others about her lack of skills. She now views herself as an engaged and willing learner, but one who has to try hard. She is concerned about the level of her ability compromising her future

teaching. This participant identified and had personal experience of a number of common causes identified in the bibliotherapy reading.

Kathy did not identify a specific incident but recounted her development of negative feelings towards mathematics over time and the impacts of this on her learning and everyday life, such as avoiding being treasurer of committees, or calculating restaurant bills, or sporting scores. This also included stigmatisation and labelling by family members.

From critically reflecting on her mathematics narrative and listening to others, Kathy identified changes in her mathematics learning. She was able to look at incidents from a different perspective and showed increased capacity to regulate her emotions.

During the interview Kathy said:

I feel more confident, slightly more confident in maths and I feel within the context of my life that I am looking [at] maths differently...I am more aware of that when I come across contextual maths. I am aware of the feelings that are rising up inside me – I'm more conscious of that and I try to suppress them or deal with them, whereas before it was "it's too hard, it was ... push them aside and think it's too hard.

She explained that, since the workshop, "I try to say to myself, come on you can do it, just slow down and think about it in a logical frame of mind and just deal with little sections at a time. Try and look at it from another angle." Before the workshop, "I just automatically would have walked away from it or tried to avoid it." This also changed her previous acceptance of her family's comments about her mathematics ability, and she now responds by challenging these comments.

Her reflections on her practicum after the workshop discussions also show that she implemented her new perspectives:

... something that you said to me last semester, when I was about to head into placement. You said, "don't think that you have to come up with the answers all the time," and in fact I took that advice and applied it when I went out on placement and I was teaching a year 6 maths class and it was really remarkable to me to see – there were two or three kids in the class that were quite exceptional and just being able to

approach a maths problem from a different perspective and demonstrate it to the rest of the class.

She also now recognised the impacts of maths anxiety on her other subjects, such as science:

I know they are two areas that are closely linked – and I had not identified that before in the past – it was always separate. I never saw maths and science as interlinked in the past, but now I do and now I now understand why I found maths and science equally as difficult. Somehow or other, they were very separate as I was growing up and I see them as linked now and now I understand why science was difficult for me. It's because maths was as well.

In summary, Kathy views her potential teaching as a challenge:

I think the importance of my place as a teacher, to be able to do this really, really well, and I know that it's going to be something that is going to challenge me in my first few years out – because I'm going to have to consciously make time to teach it and to give quality lessons. So, it is something that I am going to have to keep working hard at and I do realize the importance of maths and I don't want my students to be the adult I am around maths.

Figure 7.5 summarises the development of Kathy's mathematical identity.

Development of mathematical identity	Description
View of oneself as a learner of mathematics	Gaps in knowledge, left behind. Positioned self as outsider. Struggle with maths affecting her confidence and her perception of how others viewed her
View of oneself as a potential teacher of mathematics	Concerned that I won't be as good as I would like to be and concerned about the impact this may have on my students.
View of mathematics	There was always just one way to get to the answer
Critical incident	Ongoing experiences had built anxiety and avoidance
Bibliotherapy reflection	Identified strongly with the experiences in the reading
Bibliotherapy projection	Wants to have an engaging, fun, contextual maths learning environment.
Interview: impact of workshop	Positive self-talk and changes in perspective
Subsequent mathematics unit	Change in avoidance pattern
Link to other subjects	Understanding of impact of maths anxiety on science studies
Community lecturer/practicum associate teacher	Willing to take advice and apply it during practicum
View of self as future teacher – Projective identity	Will work hard to meet the challenge

Figure 7.5 Participant 2 – development of mathematical identity.

Figure 7.5 illustrates Kathy's renegotiation of her mathematical identity. She realised that her limitations were self-imposed, as a result of her previous experiences. Her proactivity in driving the process of her transformation is shown by the change in her responses to comments by her family, and her vision of herself as ready to meet future challenges in her profession.

Participants 3 and 4. Participants 3 and 4 were fourth-year pre-service teachers who were interviewed in 2015. In the workshop, describing their views of themselves as learners of mathematics, they had both reported increased confidence over the course of their teacher education studies.

7.5.3 Participant 3 – Chris

Reflecting on herself as a learner of mathematics at school, Chris identified her fear of failure and responses to time pressure, both in testing situations and in classwork, as

causes of her anxiety. She positioned herself as an outsider with a need for constant reassurance in her school mathematics classrooms. However, as a learner in her teacher education course, she feels that she has increased in confidence, although she still struggles in mathematics testing situations.

In the interview, Chris reflected on the increase in her confidence over her teacher education course:

I believe by learning the right strategies and talking openly about my feelings about maths I can be a confident & positive figure in maths for my future students. Modeling mistakes and learning from them is very important for both myself and my future students.

The researcher interpreted this as a substantial change in her attitude towards mistakes. In contrast to the way she viewed her mistakes when she was a student, she now sees them in terms of their potential contribution to students' learning.

She reflected further on the other classroom experiences that stimulated her anxiety towards mathematics:

In class when asked maths questions aloud and having to provide an answer immediately has impacted on how I feel about maths (I think I liked more time to think it through). I hated when the smartest kids in the class would shout out the answers, so you would never get a go because the answer would have already been said. This was mainly when reciting times tables and playing maths-based games.

This reflection showed her recognition of the impact of competitive classroom practices on her learning, causing feelings of not being able to make a contribution in her mathematics classes. These comments also demonstrate the impact of high stakes situations such as evaluation or completing mathematics in public. Chris emphasised that, reflecting on the bibliotherapy reading and also listening to the stories and reflections of others about their experiences impacted on her. The emotions it evoked included relief that she could share these experiences:

Talking about the maths anxiety in that little group in the workshop was really nice as well – to talk to different people in that small environment so that it wasn't scary or anything to hearing from other people about their anxiety in maths, I think that

makes you feel that you can talk about your own anxiety and then work through it together.

Reflecting, writing and sharing stories of personal mathematics critical incidents and responses to readings in the supportive context of the workshop reinforced the universalisation stage of the bibliotherapy process. She exhibited a sense of empathy with the other participants. She described the associations that she made between her story and other participants' stories of mathematics experiences, and how this impacted on her projective identity as a future teacher of mathematics:

I think it makes it something that is more open to talk about because I think everyone at some point has had some sort of maths anxiety, and it was nice to hear the different perspectives that you might not necessarily have – especially going in to teaching and knowing how different students might feel about different maths problems.

She related this back to her own school experience where feelings were not acknowledged:

I feel like when I was at school, we never discussed feeling anxious about a test or how we felt about the assignment. It was always something that you just had to do. You worked through it, but it was never discussed how you felt about doing it. I guess. That's what I mean about being open.

Looking back and summing up the impacts of the workshop she reiterated the importance of being able to express and share feelings:

I think becoming more open about talking about maths anxiety - allowing it to be something that isn't bad to have. And I think, making maths anxiety not that you have a problem but that it is something that everyone might face, even if it is only for one test in their life they have felt that anxiety I think at some point everyone has felt that feeling so I think that being open and talking in the group and not seeing maths anxiety as you having that problem or needing to see someone.

This reflection is notable because it addressed the embarrassment of admitting to maths anxiety and the way that the blame is shifted onto the individual. This led to a determination that maths anxiety isn't something that is "bad to have" that requires remediation or correction of something bad or defective, but that those feelings are

common to many. She found self-disclosure a positive experience and appreciated the choice of how much to share:

I think it was a lot more powerful having that small group, because you were comfortable enough to share your own experiences because you weren't talking to everyone, but you also had the ability to bounce off others where someone would say something and it would trigger, "Oh, yes, I have had that feeling before," but it might be buried inside and you haven't spoken to anyone about it. Because there were certain things that I guess I didn't realise that probably had an impact on me, but it did after talking to the girls about their experiences, and I thought, "I was in your shoes, but I didn't see it at the time.

Thus, she identified from the group discussions that others feel the same although the causes may be different.

She was able to re-evaluate how she viewed herself as a result of writing and sharing: "Writing about it was helpful but I felt talking to others helped you explain it better and also come to terms with what you were trying to say. I think sitting there and writing is well and good, but it is really good to hear from someone else." Participants revealed how they felt about themselves, were willing to disclose and were encouraging and supportive. Chris particularly valued the sharing. "It was good. I think a better feeling than if we had just written it and submitted something." She explained in more detail:

I think it gets a bit of weight off your shoulders – well look this has happened but all of these other people have had troubles too, and now we get to share them and work out ways to prevent it or ease it. I think talking about it was better than just writing because you are not only getting out what you want to, but then you are working out what to then do, rather than just sharing our ideas on paper.

Her feeling that it was a weight off her shoulders was evidence of catharsis, which is one of the stages of bibliotherapy. This showed that the effects stimulated by the workshop had continued.

Chris described the positive responses to her teaching that she saw during practicum:

So, for those students, they would come in after recess and they would be excited to do maths, they'd want to do it. It wouldn't be that anxious feeling and even the

students who struggle at maths, because every student was challenged but in a way that wasn't a test, made them feel more confident.

Attending the workshop had a positive effect on her understanding and perception of herself as a learner and potential teacher of mathematics. When asked if it made a difference in the way she saw herself as a teacher, she replied:

When you recognise the way that you learn and what prevents you from learning, it then allows you to then see you see students that might be in the same boat or realise that they may have a totally different issue and if my teachers just didn't see it – making me more aware to look deeply. It might not be the content; it might be how they feel about approaching it.

Figure 7.6 shows the development of Chris' mathematical identity.

Development of mathematical identity	Description
View of oneself as a learner of mathematics	Growing in confidence as a learner but still anxious in test situations
View of oneself as a potential teacher of mathematics	Believes by learning the right strategies and talking openly about her feelings about maths she can be a confident & positive figure in maths for her future students
View of mathematics	Emphasis on importance of mathematics
Critical incident	Positioned self as outsider
Bibliotherapy reflection	Gained most from talking and sharing my experiences with maths about others. It was great to learn how others feel in similar situations
Bibliotherapy projection	A confident & positive figure in maths for my future students by learning the right strategies and talking openly about my feelings about maths
Interview: impact of workshop	Not feeling alone
Subsequent mathematics unit	Support by sharing the class with another workshop participant
Practicum	Student-centred teaching strategies and empathy
Community – practicum associate teacher	Valued how teacher was modelling how to set up class so every student is challenged but not made anxious
View of self as future teacher – Projective identity	Self-development, anticipation of further change. Focus on student affect

Figure 7.6 Participant 3 – development of mathematical identity.

This summary shows the development of Chris’s mathematics identity and highlights the degree of her transformation. The collaborative nature of the workshop gave her the opportunity to test her belief in the value of sharing her feelings; and to develop understanding and empathy for students during her practicum. Her resolve to develop a focus on student affect in her future teaching is a logical outcome.

7.5.4 Participant 4 – Sally

Sally had an ambivalent view of herself as a learner of mathematics. She identified time pressure as something that she struggled with. She reflected on critical incidents with teachers in both primary and secondary school. These had resulted in continued failure that had led to learned helplessness and avoidance strategies. However, she had developed more confidence during her teacher education course.

In her evaluation at the end of the workshop, this participant strongly agreed that the workshop had helped her feel more comfortable talking about mathematics and increased her understanding of anxiety. Looking back on the workshop, she demonstrated further development of the universalisation stage of bibliotherapy:

We did some awesome stuff. It was really good talking about it in a small group. It was really good being there because I felt comfortable... It was positive hearing other people talk about their maths anxiety. You go, "Oh, I'm not the only one."

This response shows the comfort of hearing others' stories and knowing that others feel the same way. As a turning point, the peer support during the workshop performed an important function in helping her to cope with negative emotions.

This individual was in the last year of initial teacher education, and the focus throughout the interview shifted from her learning through reflections on her practicum placements and the actualisation of more positive interactions with students in her mathematics classes. This change in her projective identity impacted on her anticipation of her future teaching. Sally reflected that her increase in confidence from her current studies and the workshop was reinforced by her experiences during practicum:

After having first-hand experience in Maths through placement and working with people in the industry/profession, I am starting to build a stronger confidence and positive attitude towards maths and teaching it! I am slowly becoming more excited by maths!

In response to the question about how the workshop contributed to her future teaching, Sally showed that she had reconstructed her past experiences more positively and developed intentions for the future. She spoke about the collegial support from her associate teacher when she made errors, and the change in her approach to making mistakes in front of students:

I know I am probably going to get the wrong answer and probably make a fool of myself and I'll laugh, and the kids will laugh, and we'll move on, whereas before I was very (draws breath and whispers) "oh, what happens if I get the wrong answer?"

This response illustrates the shift in her perspective, which increased her capacity to manage her emotions in a more productive way.

Figure 7.7 shows the development of Sally's mathematical identity.

Development of mathematical identity	Description
View of oneself as a learner of mathematics	Struggled with time pressure and failure
View of oneself as a potential teacher of mathematics	Starting to build a stronger confidence and positive attitude towards maths and teaching it
View of mathematics	Understanding from parent and teachers that there is a right and wrong way to do mathematics
Critical incident	Negative incidents in both primary and secondary school
Bibliotherapy reflection	Humiliated in front of peers
Bibliotherapy projection	She can overcome learned helplessness, and not be discouraged by negative comments
Interview: impact of workshop	Positive effect of sharing feelings in a supportive environment
Subsequent mathematics unit	Peer support
Practicum	Change attitude towards making mistakes – acceptable to make mistakes
Community lecturer/practicum associate teacher	Supportive, helped her be comfortable making mistakes
View of self as future teacher – Projective identity	Self-development, betterment of teaching capacity

Figure 7.7 Participant 4 – development of mathematical identity.

Having shared her feelings in the workshop's supportive environment, the comfort that Sally felt about acknowledging her errors in front of her practicum class contrasted with the humiliation she had described in her critical incident. The analysis above highlights the degree of the transformation of Sally's mathematical identity to her goal for self-development as a teacher.

7.5.5 Discussion

The interviews with the participants reveal that there are commonalities found among them with respect to the nature of the benefits of the workshop. The interviewees all regarded the workshop as having facilitated change. Their responses indicated that the workshop was transformational and motivational and there is some indication that this had continued to have an impact beyond the day of the workshop. Participants' interview responses showed that they were thinking more deeply about the issues identified in the workshop for their mathematical experiences during subsequent units and their practicum. These perspectives arose in all four interviews.

The interviews allowed the researcher to investigate longer-term changes in some pre-service teachers' perceptions of their mathematics learning after they had engaged in the bibliotherapy workshop, and to discover whether the immediate changes persisted. There is evidence from all the participant interviews, to argue that these initial changes were sustained and extended. The participants demonstrated the capacity to manage their emotions in a productive way and regulate their emotions. Maths anxiety limits pre-service teacher skill in mathematics content areas (Gresham, 2007), and the interviewees showed benefits from the workshop in overcoming this.

The full process of interactive bibliotherapy involves sharing reflections with a facilitator. The workshop and, to a greater extent, the interview comments, show the additional benefits and impacts of that sharing with facilitators and peers. Having peers share their critical incident stories was very powerful and "primed" the participants for the bibliotherapy reading. The sharing of peer responses in the small group workshop played an important role for at least some of the participants because it supported the enactment of the early stages of bibliotherapy for them. On reflection, the researcher identified hints of this in the workshop. However, these came to full flower in the interviews. The interviewees emphasised the importance to them of hearing stories from their peers. The interviews provide insights into how pre-service teachers might use their own and others' past experiences to formulate and position themselves as learners in the present and envision their future reality as teachers of mathematics. There are differences in the way that the participants reacted to, and were impacted by, the workshop. The responses were individual, but they cluster. One of the clusters is that hearing other participants talk about their stories and experiences allows identity, catharsis, individualisation and the development of insights, leading to supportive collaboration in subsequent classes. For the participants who chose to go through the process of the workshop, it is not unexpected that friendships would grow and that they would feel more confident working with these peers in a classroom context. This illustrates the importance of peer support in coping with negative emotions.

Participants 1, 3, and 4 reflected on impacts on practicum. Kaasila and Lauriala (2010, 2012) also identified changes in pre-service teachers' identities, using bibliotherapy based on reading other pre-service teachers' reflections during preparation for practicum. These were evidenced by changes in their views of themselves as

mathematics learners and teachers as they approached and completed their practicum. For Chris, the modelling by her associate teacher was highlighted. Bandura (1997) identified one of the four main influences on self-efficacy beliefs as vicarious experiences. In this case, success was modelled by a person with whom Chris identified, and when her associate teacher was successful, Chris also grew to expect success. This relates to the projection stage of bibliotherapy.

The interviewees emphasised the importance of creating a positive and supportive atmosphere in mathematics lessons, and of strengthening students' self-confidence. Their focus was student-centred and showed empathy for struggling students. As Frankcom-Burgess (2017) concludes: "perhaps this is the other side of maths anxiety that, once faced and accepted, it is possible to mitigate the effects, to work diligently to improve one's mathematical knowledge for teaching" (p. 210).

The researcher analysed how individual participants narrated their stories in relation to their mathematical identities in different contexts over time and with respect to their wider experiences of life. They described experiences in the past and how they view them now in the present. They were able to make sense of the past perspective that they had had as a student and to explain it from their present perspective. Their identity changes related to social acceptance in the group and belonging to a community as opposed to the alienation which they had felt previously. They had felt a stigma through being labelled as having maths anxiety. This was reinforced by negative media stereotypes about teachers and mathematics. Maloney et al. (2013) argue that individuals who identify strongly with the stereotyped group are more likely to be affected by stereotype threat. In contrast to this, participants began to see the value gained from reviewing their past experience and re-storying it as a benefit for their development as teachers. Bringle and Hatcher (1999) argue: "Experience becomes educative when critical reflective thought creates new meaning and leads to growth and the ability to take informed action" (p. 180). The reflections that involved negative memories of a teacher's actions were able to transform a previously unfortunate situation into a critical learning experience for the participants, developing their future perspective and reshaping their identity and evaluation of their future effectiveness as teachers – their projective identity.

7.6 Conclusions

Phase 3 of the study extended the answers to the research questions that drive this study and deepened the investigation of bibliotherapy as a means to address maths anxiety in pre-service teachers. Interactive bibliotherapy addressed Ambrose's (2004) criteria for mechanisms for changing beliefs, more fully than the cognitive bibliotherapy in the tutorials reported in Chapter 6, as it encouraged pre-service teachers to become immersed in a reflective community. Bibliotherapy allows pre-service teachers to share and reconstruct their own experiences, and re-evaluate their identity as learners of, and teachers of, mathematics. Wade and Yarbrough (1996) explain, as "we reflect, we discover the links between different aspects of our life experience and where past experiences are reconsidered in light of new information. Reflection allows us to draw conclusions about our past experiences and develop new insights that we can apply to our future activities" (p. 64). These insights are a vital part of the bibliotherapy process.

The interactive bibliotherapy approach differed from cognitive approaches to addressing mathematics anxiety in pre-service teachers in that it simultaneously addressed affective and cognitive domains. It valued participants' experiences as they explored new ways of understanding their feelings about mathematics and reducing the detrimental impacts of maths anxiety. In the process, it provided participants with the opportunity to reconfigure their identity as future teachers of mathematics. The participants regarded the workshop as positive and empowering. This augurs well for promoting the use of workshops to address maths anxiety and identifying aspects that might be incorporated into teacher education courses.

The collaboration between the researcher and student counsellor enriched the workshop and allowed them to develop as professionals, greater understanding of the issues and obstacles in mathematics education faced by pre-service teachers. The CIT used in the workshop to review the participants' experiences, in combination with interactive bibliotherapy helped them to identify factors in their maths anxiety and perceive alternative conceptions. This enhanced their view of their maths anxiety as valuable experience in their growth as teachers.

The process of verbalisation and writing can be used to enable pre-service teachers to reflect on their own actions and decisions. It offers an opportunity for them to analyse

their past actions and emotions. Reflections on the bibliotherapy reading led participants to understanding and to develop insights. Phase 3 of the study extended previous indications of the importance that insight plays in the development of a projective identity as a teacher of mathematics. It examined how these pre-service teachers' perceptions of themselves as teachers of mathematics developed during the interactive bibliotherapy process. For these pre-service teachers, their developing understanding that their experience of anxiety about mathematics can positively influence their capacity to teach more effectively contributes to the development of a more robust projective identity. This plays to their strengths of empathy and support for struggling students.

The findings from this part of the study reinforce the importance of pre-service teachers gaining understanding and insight into their current thinking. In the quotation that introduced this chapter Trujillo and Hadfield (1999) explained the importance for preservice teachers of identifying their maths anxiety, understanding its causes, and confronting this anxiety before they begin teaching. The workshop provided one means for a safe and supportive environment for such a confrontation.

7.7 Progression of the thesis

Chapters 1–4 presented the rationale, framework and literature, and methodology of the research study.

Chapter 5 presented results and analysis to address Research Question 1, identifying the wide range of pre-service teachers' maths anxiety, and the factors impacting on pre-service teachers views of themselves as learners and potential teachers of mathematics.

Chapter 6 addressed Research Question 2 and 2a. It explored the potential of cognitive bibliotherapy for addressing maths anxiety.

This chapter addressed Research Question 2 (2b and 2c), analysing insights provided by participants who took part in the small-group interactive bibliotherapy workshops. It presented a blueprint for the workshop, which is a major contribution of the thesis.

Chapter 8 will describe the contribution of the thesis to new knowledge, and to the range of analytical tools available. The implications and limitations of the study are discussed, and recommendations made for practice, and further research.

CHAPTER 8: DELINEATING THE CONTRIBUTIONS, IMPLICATIONS, AND RECOMMENDATIONS

If future teachers are to produce mathematical literacy in their students, they must develop an understanding of the conceptual framework of mathematics anxiety as it relates to teaching mathematics. Teacher education programs must not only prepare pre-service teachers to develop a mathematics curriculum, which stimulates mathematical ideas and mathematical confidence, but must also acknowledge and address math anxiety. (Guillory Bryant, 2009, pp. 101-102)

Overview

This final chapter reflects on the contribution and implications of the study and concludes with recommendations for future research. Findings from the quantitative and qualitative methods used in the study were reported and discussed with respect to the literature in the previous three chapters. The findings and conclusions reported in Chapters 5, 6 and 7 addressed the three research questions presented in Chapter 1. This chapter synthesises the conclusions as they relate to the literature reviewed in Chapter 2 and the theoretical framework in Chapter 3. The distinctive approach in this thesis is explained (Section 8.1). The study is summarised (Section 8.2) followed by the strengths and limitations of the study (Section 8.3), its contributions to the field (Section 8.4), and implications for research (Section 8.5) and for practice (Section 8.6), including recommendations relating to preparation of pre-service teachers and addressing maths anxiety in pre-service teachers. The implications of the study for teacher educators and teachers of mathematics are also discussed. The implications of the study for policy makers are outlined (Section 8.7). Suggestions for future directions for research are then presented in Section 8.8. Concluding remarks (Section 8.9) complete the chapter.

8.1 Introduction

This study was located in the domain of mathematics teacher education (see Figure 1.1). Section 1.2.2 observed that teachers are charged with providing a foundation for life in the complex and diverse economic and social environments of the 21st Century. They need to help students develop skills and knowledge for lifelong learning (Mayer, 2003, p. 3). Primary teachers in particular are the basis for this foundation. Hence, teacher education is vital, especially in mathematics. It is worrying then, that primary pre-service teachers accept their

positioning as future teachers of mathematics as “deficient” (Klein, 2012, p. 29) as not being problematic. This is especially of concern for pre-service teachers with maths anxiety.

The core of the research problem for this study centres on maths anxiety in pre-service teachers. This thesis is set against a background of recent Australian research findings that three-quarters of pre-service teacher participants reported fear, loathing, and ambivalence towards mathematics (Itter & Meyers, 2017, p. 136). The study is timely because, as discussed in Section 1.2.1, the impact of maths anxiety on pre-service teachers and the students whom they ultimately teach is critical in the current technological age. High maths anxiety among pre-service teachers has been widely accepted as an impediment to their becoming effective teachers of mathematics (see Section 2.2), because maths-anxious teachers often transfer their fear and avoidance of mathematics to their students and thus high levels of teacher maths anxiety can be perpetuated in classrooms (Bekdemir, 2010; Furner & Berman, 2005; Hembree, 1990; Martinez, 1987; Sloan et al., 2002; Sheila Tobias, 1978; Vinson, 2001; Wood, 1988; Zettle & Raines, 2000). Addressing maths anxiety among pre-service teachers is important if they are to become effective teachers of mathematics. Specifically, for this study, the aim was not necessarily to eliminate anxiety. Rather, it aimed to change the way in which pre-service teachers experience, and respond to, the fear that comes with the anxiety.

The distinctive approach in this thesis can be summarised as:

1. The author sought to question the prevailing widely accepted assumption that maths anxiety in pre-service teachers is a bad or negative aspect that needs to be eliminated or cured. She recognises that, if this is not questioned, absence of protest may be taken as tacit legitimisation.
2. The author argues for addressing or ameliorating maths anxiety in pre-service teachers as opposed to eliminating it. The study examined the potential for overcoming debilitating maths anxiety through participants’ increased understanding and revision of the genesis of their maths anxiety, leading to an increase in their evaluations of their future effectiveness as teachers of mathematics and identification of potential benefits for their future teaching.
3. One of the foundational premises of this thesis was the need to remain open to the idea that all pre-service teachers, especially those who have not experienced it, should learn about, and understand, the causes and development of maths anxiety. As a result of the study, the author argues that all pre-service teachers need to develop awareness and understanding of maths anxiety and its impacts on their future students.

This study aimed to address pre-service teachers' images of themselves as learners of mathematics, through critical incident methodology and bibliotherapy. Section 3.1 explained that stories are the way in which individuals understand and know themselves and their experiences (Bruner, 1987; Clandinin & Connelly, 2000). This study adds to research on using narrative to understand pre-service teachers' maths anxiety, through their reflection on their prior experiences in mathematics classrooms.

The impetus for the research was the determination of previous small studies that identified that pre-service teachers reassessed their capacity to learn and teach mathematics as a result of guided reflections (Wilson, 2007). This led the researcher to question the status quo in terms of the impact of maths anxiety in pre-service teachers always being negative. These commonly expressed views are incorporated in the following quote:

Although it is only a conjecture, we believe that students surrounded by confident teachers who are excited and positive about their role in the students' learning process will exhibit fewer symptoms of math anxiety than students whose teachers are themselves anxious, uncomfortable, and negative about teaching mathematics. (Kelly & Tomhave, 1985, p. 53)

While it might seem that this quote is suggestive of potentially negative teaching outcomes for pre-service teachers with maths anxiety, the author would like to argue for a different interpretation and for the extension of this to recognising the potential to use pre-service teachers' experiences and understanding of maths anxiety to increase their effectiveness as teachers of mathematics. As explained in Section 1.4.2, Brown et al. (2012) questioned these underlying assumptions about pre-service teachers "that have high mathematics anxiety and will therefore be poor mathematics teachers vs. those that have low levels of mathematics anxiety and therefore have the potential to be effective mathematics teachers" (p. 383). This thesis argues that, when pre-service teachers understand and address their previous experiences of maths anxiety, rather than reverting to their memories of fear as a child, they can use them as valuable experiences. Hence, they can be regarded as an asset, not a negative attribute. Furthermore, this thesis argues that addressing maths anxiety in pre-service teachers includes refiguring the perception of their maths anxiety so that it is not seen as a deficit model but as an opportunity that gives them the potential to become more effective teachers of mathematics.

8.2 Summarising the study

This study focussed on the issue of maths anxiety in pre-service teachers. It has been established in the literature that this is pervasive and enduring. The study was a response to the need for further affective studies to illuminate this issue. For this reason, it explored mathematical identity.

8.2.1 The purpose, aims, and research process

The purpose of this research was to investigate how bibliotherapy might address maths anxiety and the mathematical identity of pre-service teachers in an Australian university. In consideration of the relevant literature concerning the theoretical work on maths anxiety (see Section 3.5), this study sought to investigate maths anxiety in pre-service teachers with a focus on affect. While there have been a range of attempts to lessen pre-service teachers' maths anxiety, as outlined in Section 2.6, the author has particularly noted studies (e.g., Di Martino & Sabena, 2011; Kaasila et al., 2012) that have focussed on affective strategies (Section 2.6.2).

The researcher firstly aimed to identify the levels of maths anxiety in pre-service teachers (Phase 1), then to examine the causes of maths anxiety identified by the participants (Phase 2) and then to evaluate the use of bibliotherapy to address their maths anxiety (Phase 3). Table 4.12 detailed the of phases of data collection.

The following specific research questions and sub-questions were investigated:

1. With what range and extent of maths anxiety do pre-service teachers present?
 - 1a. What are the indications for influences that have stimulated this anxiety? (see Chapter 5)
2. What is the effectiveness of bibliotherapy to better understand and/or address maths anxiety in pre-service teachers?
 - 2a. For the pre-service teachers who participated in cognitive bibliotherapy, what were their responses? (see Chapter 6)
 - 2b. For the pre-service teachers who participated in an interactive bibliotherapy workshop, what were their responses? (see Chapter 7)
 - 2c. What was the immediate and detectable change in their affect upon completion of the workshop? (see Chapter 7)

2d. What was the more lasting impact of the interactive bibliotherapy on the pre-service teachers' maths anxiety? (see Chapter 7)

The mixed methods (Yin, 2006) methodology chosen is appropriate for investigating these questions. The study used a sequential exploratory mixed methods design (Creswell & Plano Clark, 2011) to investigate and address maths anxiety experiences by Australian pre-service teachers. The research method centred on using bibliotherapy as a means to address maths anxiety in pre-service teachers. The major findings are summarised below in Section 8.2.3.

8.2.2 The conceptual framework

The conceptual framework of the study guided the methodological approach and provided a lens through which the data were examined. Research on relationships between concepts in the affective domain provided a foundation for the framework. The conceptual framework for this study is based on the affective concept of mathematical identity, which incorporates dispositions, orientations, and emotions. This study of how maths anxiety might be addressed in pre-service teachers has a specific focus on the development of projective identity. This has strong connections to the final stage of the bibliotherapy framework, projection.

8.2.3 The findings of the study

The study found that Australian primary pre-service teachers have concerning levels of maths anxiety in common with those from other countries. Both the level and range of maths anxiety with which pre-service teachers come to their course and their views of themselves as learners of mathematics, provide evidence that historical difficulties with teaching and learning mathematics have continued into the 21st Century. The survey results (see Section 5.2) found that participants come to their course with a range of levels of existing maths anxiety. The empirical evidence from the survey demonstrated that maths test anxiety was the biggest contributing factor to this anxiety. The frequency of maths anxiety identified was approximately 50 percent, which is higher than frequencies of approximately 40 percent obtained by other researchers (Boyd et al., 2014; Di Martino & Sabena, 2011; Perkins, 2016).

The quantitative findings showed that participants' assessment of their maths anxiety was consistent with their results obtained by the survey. Demographic factors of age and gender were investigated to determine aspects of their maths anxiety, but not found to have consistent impacts, and in the case of rurality, no significant differences were found. There are inconsistencies in findings particularly about gender and age that suggest a need for further

study of these factors and their impact. In addition to the survey, written responses identified evidence of maths anxiety, supporting and aligning with the quantitative results. The nature of pre-service teacher maths anxiety was also investigated qualitatively. The aggregated findings showed that maths anxiety in pre-service teachers is multilayered and multidimensional.

However, as this is an interpretive study, frequency does not automatically equate to priority, so CIT was the choice for a method that allows outliers to be considered. In line with the literature reported in Chapter 2, the major findings of the study reported in Section 5.4 also suggested that maths anxiety has its roots in negative experiences in school mathematics and negative stereotypes. Participants' responses to these negative experiences and situations were emotion-focussed (Lazarus, 1991, see Table 3.2), often resulting in avoidance. It was evident from pre-service teachers' statements that they experienced increased anxiety with testing or evaluation. Dweck (2016) discussed the different ways that people respond to failing a task, contrasting labelling oneself as a failure and not trying any more, with confronting challenges and persevering. Reflections from participants commonly demonstrated the first type of response. Participants recalled their mathematical classrooms as traditional environments in which teachers presented materials and students learned procedures. Their passive role in the classroom influenced their perception of what it took to be successful in mathematics.

Important findings of the study were the predominant role of the teacher in their experiences, (see Steve Tobias et al., 2010; Cady & Rearden, 2007) and the impacts of blame and humiliation felt by participants, predominantly emanating from their teachers. The participants reported negative impacts of teachers' insensitive comments, which showed the vital importance of pedagogical tact in the classroom, which "must always remain receptive to the social context ... [and] the good of the other (the child)" (van Manen, 2008, p. 15). In addition, time pressure, inflexible teaching methods, or insensitive and uncaring attitudes of teachers at primary and high school, were identified as problematic. These themes have been identified in the phenomenological mathematics education literature from other, mainly international, contexts. For example, Coppola et al. (2015) investigating "crucial events" impacting maths anxiety, found the same event such as a failure in a test, can draw a positive or negative response from the student depending on the teacher's handling of the event. For participants, the teacher was commonly the unique factor in developing their relationship with mathematics – either positive or negative. The findings reported in this study contribute to understanding the importance of the teacher and pedagogical tact (van Manen, 2008). The narratives

demonstrated that incidents which showed a lack of empathy from teachers were regarded as significant and endorsed by later experiences.

Although the participants were asked for a specific incident, many stated that experiences persisted over time. However, the findings also showed that transitory or isolated incidents can have a lasting impact.

This study employed the bibliotherapy approach to eliciting and understanding the affective responses of primary pre-service teachers. This approach simultaneously addresses affective and cognitive domains. The findings reported in Chapters 6 and 7 showed that this approach was a catalyst for change in participants' views of themselves, when their views of a person or situation were reformed as they reflected on the past. Their reflections illuminated factors in their maths anxiety and helped them to identify alternative conceptions. The responses highlighted the effect of participants' increasingly positive dispositions towards mathematics that were incorporated into their developing mathematical identity. Subsequently, participants re-interpreted their future teaching, showing the development of a more positive projective identity. These findings supported the stance that mathematical identity is not fixed.

The opportunity for an extended time for writing the critical incident and bibliotherapy reflections, and an opportunity to share those reflections, were vital features of the workshop design, reported in Section 7.3. However, one of the surprising outcomes of the study was the unexpected strength of the positive impact of CIT and cognitive bibliotherapy in the short time available in tutorials, reported in Chapter 6. Reflecting on and confronting their perceptions of their critical incident experiences allowed a release, similar to the catharsis stage of bibliotherapy. This suggested that, even within a relatively short time, it is possible to promote meaningful change. However, given the brief nature of the cognitive bibliotherapy intervention in the tutorials only the nucleus of the resulting transformations could be captured by the data collected at the time. In comparison, the interactive bibliotherapy in the workshop allowed deeper reflections. The interviews that followed-up the workshops collected data from a small number of participants and illustrated longer-term re-framing of their projective identity, although the researcher does not claim that the workshops led to permanent transformations. Even so, the data provides evidence that the tutorials and workshop were able to engender important short and medium-term changes in different cohorts of participants.

One of the more significant findings to emerge from this study is that participants with no, or low, levels of maths anxiety benefitted from the bibliotherapy readings or from hearing the experiences of their peers, as they were previously unaware of the issue of maths anxiety in their future teaching (Kaasila et al., 2014). It is important that these individuals have the opportunity to participate in workshops or other activities during their courses and are included in any future research studies.

Another subsidiary finding which merits further investigation was the recognition of the impact of maths anxiety on other disciplines, such as anxiety about science.

The findings of the study show that there are no easy remedies or solutions. However, they have demonstrated important changes in participants' emotions and dispositions.

8.2.4 Conclusions from the study

In light of the major findings and the research literature, the author concludes that maths anxiety is a substantial and persisting issue for pre-service teachers not only on these campuses, but, clearly evident in the literature, also for pre-service teachers at other institutions. As well as the survey, written responses identified evidence of maths anxiety, supporting and aligning with the quantitative results. There is evidence from the study that individuals can identify whether they have maths anxiety. This suggests that the use and value of long surveys is questionable, especially if the analyses are limited to comparing means and standard deviations. However, the identification of specific factors may be useful, making it important to identify the factors tested by any survey used, rather than presenting general conclusions.

The author contends that overcoming debilitating maths anxiety among pre-service teachers is important for them to become effective teachers of mathematics. For many, their maladaptations to mathematics developed early and are unconscious. These lead to difficulties in their studies because they have developed defences to avoid humiliation. They dissociate to protect themselves from the pain. However, as this thesis argues, addressing maths anxiety in pre-service teachers needs to go beyond minimising the pre-service teachers' own anxiety. Pre-service teachers need to understand and to address their anxiety or it may negatively impact their future teaching.

Participants were motivated and willing to expose their emotions. This was commendable especially in the light of their previous experiences of blame and humiliation. The workshop

enabled them to reveal painful memories, question their interpretations and representations of past incidents, work through them, and resolve them. Reflecting on and confronting their perceptions of their critical incident experiences allowed a release of emotions, which aligns with the catharsis stage of bibliotherapy. The interviews also showed the importance of affective support by peers in this process. They indicated that bibliotherapy also opened up the potential for more positive interactions with students in their mathematics classes. The workshop was transformative. While the data to substantiate this conclusion came from a small-group setting, the strength and sincerity of the responses were evident.

This study showed that it was challenging for participants with a background of enduring maths anxiety to overcome their feelings and to reconceptualise their experience of anxiety as worthwhile and as a valuable asset for a teacher. However, by sharing with other participants, they realised how others' experiences resonated with their own. Hence, they were enabled to confront and understand their anxieties and reassess their capacity to learn and teach mathematics. Developing insight is critically important, especially as pre-service teachers learn to acknowledge and harness their experiences of maths anxiety as a tool for positive change. This contributed to their professional learning, especially with respect to the antecedents of their maths anxiety and has important implications for their future teaching. For instance, understanding the impacts of blame and humiliation can inform the development of pedagogical tact, incorporated into the supportive learning environments that they envisage.

Despite (or perhaps spurred on by) their feelings about mathematics, the participants in the study aspired to take actions to support their own future students. They were looking forward to this aspect of their future teaching. The insights gained from understanding their own experiences of maths anxiety have the potential to help them understand that of their colleagues and students. The developing conceptions of maths anxiety in pre-service teachers elicited by the bibliotherapy experiences changed the assumption that it must be eliminated, to an appreciation of its potential to contribute to increased empathy and effectiveness as a teacher. The development of a positive and robust mathematical identity as a targeted outcome of teacher education courses, rather than a potential by-product left to chance, is vital. This was previously recognised in the literature by Beauchamp and Thomas (2009), Franzak (2002) and Walkington (2005) (see discussion in Section 3.4.4) and was confirmed again by this study.

Themes identified through the analysis of the study suggest the importance of insight as a major factor in bringing about a positive projective identity. Thus, participants were able to escape

the constraints of their episode of maths anxiety and transform their experiences into a powerful new legacy. In addition, those participants who do not have maths anxiety realised the valuable insights they can gain from the experiences of their peers. This will allow them to develop meaningful understandings and empathy towards their future students; and their awareness of the potential implications of their teaching strategies that will enable them to make conscious choices in their classrooms.

The researcher does not claim to generalise the findings to all pre-service teachers, or even to all Australian pre-service teachers. Although participants were from two different campuses, they were all drawn from one Australian university; therefore, the results might pertain to that educational institution. However, as discussed in Chapters 5, 6 and 7, conclusions were consistent with findings from other researchers that illuminate the causes of pre-service teachers' maths anxiety and potential ways to address it. Consequently, it is probable that the results are indicative for further action in other tertiary institutions that teach pre-service teachers.

Another positive outcome from this study that was more methodological in nature, but well worth noting, relates to collaboration. The collaboration between researcher and student counsellor in this study led to greater understanding of the issues and obstacles faced by pre-service teachers and illuminated factors in their maths anxiety. This type of collaboration has benefits for future research in this area.

8.3 Strengths and limitations of the study

8.3.1 Strengths

This study is based on the reflections and insights given by the study participants. The major strength of the study was the workshop participants' willingness to take risks by sharing their personal experiences and feelings with their presenters and peers. Their ability to identify with students who are struggling and empathise with them was commendable, as was their persistence in confronting their own experiences and anxieties.

The propensity of the researcher to question the status quo and not accept the current view, extended to examination of her own views. She questioned what, as a researcher, she was privileging. The researcher strove to remain aware of biases in interpreting pre-service teachers' reflections and the necessity to view findings in their context. To this end, she made extensive use of participants' own words in presenting the findings.

The researcher also pursued alternative explanations, following Angelides (2001) who suggested adopting strategies such as triangulation and peer debriefing to establish trustworthiness of the findings. Consequently, she exposed herself to questioning by other researchers. This included triangulating the interpretation of data in meetings with supervisors, and presentations of initial findings to research seminars at the Mathematics Education Research Group of Australasia (MERGA) and the International Group for the Psychology of Mathematics Education (PME) conferences. In addition, data was re-examined using the analyses developed by researchers in other countries (see Hannula et al., 2005).

The collaboration of the student counsellor with the researcher was a strength of the study. This meant that each was able to bring their various and differing insights to the design and implementation of the workshop. It also allowed for another perspective to be considered in the interpretation of the findings.

8.3.2 *Limitations*

The issue of recruitment of participants was a key limitation for this study. It was also identified by other researchers (e.g., Frankcom-Burgess, 2017). Although the researcher had cooperation from staff colleagues and was able to utilise lectures and tutorials to collect some data, recruitment to workshops outside of timetabled classes was an issue. Studies in researchers' own classes have the potential to overcome the issue of recruitment but may introduce other issues such as power imbalances, and issues raised in the interviews about the importance of sharing with supportive peers. Consequently, the researcher remained flexible and open to suggestions for varying the plan for her research, such as collection of data in the tutorials in order to cope with the issue of recruitment.

This study can be replicated because of the clear documentation of the methods. However, as with many educational studies of this type, findings from a different setting or the same setting at a different time would inevitably highlight different aspects of individuals' experiences. Although each pre-service teacher is a unique case, the potential exists for each different individual to relate this to their own lived experience, using the methods used in this study, and it would be anticipated that they would gain similar insights as the participants who participated in this study. Although it was not feasible to broaden the range of institutions studied, the researcher collected data from two campuses, located in different cities and states.

8.4 Contribution to the field

In the field of mathematics education, the findings of this research add to the current literature on pre-service teacher maths anxiety in five major ways:

- The alternative paradigm
- The future focus of the conceptual framework
- The research methods and analysis
- The workshop protocol
- The findings and conclusions

8.4.1 *An alternative paradigm*

The argument for a new paradigm in the way maths anxiety in pre-service teachers is regarded is a key contribution. The author proposes that maths anxiety in pre-service teachers can be an iatrogenic issue: that is, its features are ascribed to the issue, but inadvertently induced or affirmed by labelling maths anxiety in pre-service teachers as uncompromisingly negative, ignoring the value of their life experiences and blaming them for their anxiety and distress. The label creates more damage for them because their experiences are reframed into a construct that is negative and blaming. It is important to hear their stories and to accept their expressions of humiliation and anger. By sharing, they realise how other pre-service teachers' experiences resonate with theirs and are enabled to confront and understand their anxieties and reassess their capacity to learn and teach mathematics.

This thesis argues for a paradigm shift in the way teacher educators and policy makers view maths anxiety in pre-service teachers. Current negative views are anachronistic and fail to take advantage of the opportunity offered by pre-service teachers who articulate and reflect on their own experiences, and the contribution they can make to those who have not experienced anxiety to help them understand their future students. Thus, there is a need to identify and celebrate the positive influences that past experiences of maths anxiety can have on evolving more effective teachers in our classrooms, potentially enabling a wider range of students to develop more positive relationships with mathematics. Those pre-service teachers who don't have maths anxiety are able to gain valuable insights from the experiences of their peers. This will allow them to develop meaningful understandings and empathy towards their future students; and awareness of the potential implications of their teaching strategies that will enable them to make conscious choices in their classrooms.

8.4.2 The future focus of the conceptual framework

The conceptual framework used in this study foregrounds identity and includes the relevance of disposition. As was noted in Chapter 1, disposition is not included in the Australian Professional Teacher Standards. The author suggests that there is an urgent need to reconsider the Standards in the light of the AAMT Standards and U.S. and Singapore frameworks (see Section 1.2.2).

The conceptual framework guided the focus to interpreting pre-service teachers' reflections on their experiences in terms of the developmental understandings of identity. According to Wenger (1998), individuals have unique identities that are socially and culturally constituted. They are not fixed (Sfard & Prusak, 2005), but are dynamic and change or are reinforced by mathematical experiences (Boaler & Greeno, 2000). The conceptual framework demonstrates the future focus of the thesis by its emphasis on projective identity.

Although the study began with Phase 1 which elicited critical incidents in the participants' past experiences, the major emphasis of the study was forward-looking. The thesis focussed on the development of projective identity, based on the notion that mathematical identity is adaptable. As a result of the study, participants realised that they needed to no longer be defined by their past experiences with mathematics; as they discovered that when "the interpretations of events can be changed, it can free them to search for new perspectives on their mathematical past and future" (Kaasila et al., 2012, p. 991).

The participants' experiences were transformative, both in the interactive bibliotherapy workshop and, to a lesser extent, in the cognitive bibliotherapy in the tutorials. These types of transformations are endorsed by Morawski (1997), who states that "personal and professional transformation is a critical factor in teacher education, where intrapersonal awareness and growth need to become an integral part of the ongoing construction of knowledge and practice" (p. 255).

8.4.3 The research methods and analysis

The approach of this study makes important methodological contributions. The combination of CIT and bibliotherapy was a distinctive approach for addressing primary pre-service teachers' affective responses to mathematics that will add to existing frameworks and strategies for the study of affect in mathematics education (Hannula, Evans et al., 2004; Lutovac & Kaasila, 2011, 2013, 2014).

In response to the multi-faceted nature of maths anxiety, the research brought together a “multi-scope” analysis, a term introduced by Grimm and Railsback (2012) in their research in predictive ecology. It is characterised by the use of a range of methods, and in the case of this study, these included methods and analyses from overseas researchers, for example “Views of Mathematics” (VOM) (Hannula et al., 2005), and adapted from other disciplines, such as Torres and Bergner ‘s (2010) model of humiliation.

In addition, the author developed new methods of analysis, which make an original contribution. These included:

1. the modification of the bibliotherapy stage descriptions to develop pre-service teacher cognitive bibliotherapy stages (Table 6.1),
2. the development of the key of ideal types (see Figure 6.2) and their descriptors, and
3. the introduction of a new concept of *biblioperception* to investigate the responses of pre-service teachers who don’t identify as maths-anxious, but express insights about others, and the development of stages of *biblioperception* (Table 6.8)

8.4.4 The workshop protocol

The most practical contribution is the protocol, described in detail in Section 7.3, of the workshop that was rated highly by participants. The workshop design and plan make an important contribution to the field. The design of the workshop is new and original and provides a model that could be adopted and extended by teacher educators or other researchers.

The features of the workshop helped participants to identify and reframe the impact of key episodes and turning points in their classroom memories on their mathematical identity. The different perspectives of the researcher and student counsellor provided valuable insights. The design and implementation of the workshop was enhanced by the contribution of the student counsellor. Researchers (Banta & Kuh, 1998; Graham, 2013) have endorsed such collaborations, as discussed in Section 7.1.

8.4.5 The findings and conclusions

The results of the survey and findings of the tutorial and workshop are presented in Section 8.2.3, and the conclusions are discussed in Section 8.2.4. The findings, although from a restricted cohort of pre-service teachers, nevertheless inform and add to Australian (e.g. Boyd

et al., 2014) and international studies (such as Lutovac & Kaasila, 2019). The findings show that pre-service teachers come to their courses with existing levels of maths anxiety, strongly linked to testing (Chapter 5), and this anxiety persists during their course (Chapters 6 and 7).

The thesis contributes to the literature of affective ways to address maths anxiety. It adds to the literature on pre-service teacher mathematical identity, with a specific future focus of projective identity. The study extends and elucidates the previous identification of projection as an additional stage in bibliotherapy.

8.5 Implications for research

This thesis makes a contribution to recent research that resists and contests the widely accepted notion that pre-service teachers with maths anxiety need to be improved, be made accountable and be blamed as individuals. It strongly supports studies that no longer use deficit models of remediation or correction.

The recognition that maths anxiety is quite a nuanced notion has implications for the choice of surveys and reporting of research results. Although different factors have been identified that contribute to maths anxiety, studies continue to report maths anxiety by using just one number. Such a practice simply does not do justice to the identified factors, indicating the need for much more detail within studies. Researchers need to identify the factors being investigated and to choose the appropriate survey on the basis of these factors. The actual factors tested by the particular survey need to be named and the results of the component factors reported separately.

However, it is acknowledged that interpretation of survey results in this area of research is not always easy. In particular, issues relating to the interpretation of descriptors require closer examination. There is a need for increased awareness that analysis of the RMARS (Alexander & Martray, 1989) and other surveys imposes the same numerical value on responses that may not have been comparable, and the averages produced may not have been warranted. The RMARS has been used frequently, particularly in the USA, but the different contexts are hard to compare (see Table 5.11). The review of the literature was impeded by the different and overlapping abbreviations used for the surveys in the literature, which may have led to inconsistencies.

Further research is contingent on identifying the reasons for recruitment issues. These issues are not exclusive to studies of maths anxiety in pre-service teachers. Adeyemi (2015, p. 133)

reported that only four teacher participants were interviewed because “selected participants did not respond to the repeated invitations to participate in the interviews”. Despite the invitation to the workshop in this study being inclusive, and attendance was framed as a way to help participants and their future students, it was possibly still intimidating. As long as maths anxiety continues to be seen in a negative light, pre-service teachers may not be convinced of the value of participating in studies such as this. However, the findings reported in this study have the potential to alleviate some of their concerns.

The author recommends incorporating collaboration between researchers and student counsellors into studies investigating maths anxiety in pre-service teachers, as this can provide valuable insights. Features of this study such as the design and implementation of the workshop and interpretation of the findings, were enhanced by the sharing of different perspectives.

8.6 Implications for practice

The issue of maths anxiety demands complex solutions. The research literature increasingly acknowledges that emotions are important. Guillory Bryant, for example, in her studies of U.S. pre-service teachers emphasises two points: “One, it is recommended that pre-service teachers be made aware of their mathematics anxiety level and their attitudes about mathematics and two, it is recommended that teacher education programs acknowledge and address the importance of these affective variables and their role in pedagogy” (Guillory Bryant, 2009, p. ix).

The findings of this study have a number of important implications for future practice, and suggest several courses of action for pre-service teachers, teacher educators, teachers, and policy makers.

8.6.1 *Pre-service teachers*

Pre-service teachers need to be proactive in recognising their feelings and learning strategies to self-regulate their emotions. For those individuals who have maths anxiety, understanding their maths anxiety, identifying their reactions, and recognising that the outcomes depend on their own actions may improve their sense of confidence for learning and teaching mathematics.

This thesis emphasises the importance of these pre-service teachers giving voice to their stresses and anxieties. Their stories and the insights they gain from reflecting on their previous

experiences provide valuable resources: firstly, for themselves and their peers to consider how they might put into practice what they have learned from these reflections and secondly, for teacher educators because they can inform their understanding of what is needed in the design of teacher education programs.

For pre-service teachers who have never experienced maths anxiety, it is vital to increase their awareness of the issue proactively, in order to meet the needs of their future students. They must realise for their future teaching that there is a need for affective strategies, as well as instruction techniques, in order to help reduce the anxiety of their prospective students.

8.6.2 Teacher education programs

Addressing maths anxiety among pre-service teachers is vital in disrupting the cycle of maths anxiety outlined in Chapter 1. The findings from this research have significant implications for teacher education programs. The study showed that maths anxiety may impact differently when a pre-service teacher is taking a mathematics test, doing mathematical computations, or undertaking a mathematics course. Teacher educators should be aware of the extent, and the range, of anxiety with which pre-service teachers may present when they begin their teacher education course; the needs of students coming to their teacher education mathematics units may vary considerably.

As understanding of pre-service teachers who experience maths anxiety improves, intervention programs and workshops can be developed to help them ameliorate their anxiety. This thesis argues that all pre-service teachers need to develop awareness and understanding of maths anxiety and its impacts on their future students. It establishes the importance of speaking with pre-service teachers about the impacts of their mathematical experiences. Consequently, maths anxiety needs to be addressed in teacher education for all pre-service teachers. Therefore, the author recommends that affective issues be included as an essential element in all courses for all pre-service teachers, with extended outside workshops offered or recommended.

Teacher educators need to know about the experiences of pre-service teachers and the complexity of the interaction between personal and contextual factors. Critical incidents illustrate some aspects of this complexity. The findings go beyond the descriptive level in the CIT responses and contribute to teacher educators' understanding, revealing the worldview of the pre-service teachers who wrote them. The descriptive and indicative findings contribute to

teacher educators' understanding of the importance of verbalisation and sharing of emotions experienced by pre-service teachers.

There are important pedagogical implications and recommendations for practice for teacher education lecturers who are the key people who interact with pre-service teachers. Sloan et al. (2002) studied pre-service teachers and found that global learners, who approach problems in an intuitive manner, had higher levels of maths anxiety. Although pre-service teachers could reduce their anxiety by avoiding traditional instruction, this is not always possible. Thus, there is a need to increase the awareness of lecturers. "Whether our future teachers can teach mathematics effectively and empathetically depends on how teacher educators address entrenched negative beliefs and attitudes" (Itter & Meyers, 2017, p. 136).

The combination of demands on pre-service teachers' time and their reluctance to attend specific workshops indicates the need for selected aspects from the workshops to be incorporated as part of the pre-service course, because the author of this thesis recognises that it is not practical to run the small group workshop for all members of cohorts. This thesis suggests that primary pre-service teachers studying mathematics education would benefit from a targeted bibliotherapy process during their mathematics education units. The majority may benefit from doing a short survey and discussing their results, plus a process similar to the cognitive bibliotherapy that was completed in the tutorials and reported in Chapter 6. Some of the activities in the workshop could be incorporated into units, as participants suggested (reported in Chapter 7). Although pre-service teachers complete reflective exercises as part of some of the units in their courses they may not engage in reflection about the source of their feelings towards mathematics unless they are given some time and structure and the expectations that this is important. The process of reviewing feelings should be set up in a supportive way that allows concerns to be aired and includes views on the potential strengths that their experiences have engendered. The method from the study provides a model that could be adopted. It also provides a structure and language to assist teacher educators to analyse reflective writing in mathematics education. Hence it is practical in its potential application, even though teacher education mathematics units may vary considerably between institutions. It is essential that those pre-service teachers who lack personal experiences of maths anxiety be involved. For those not anxious about mathematics, it is crucial that they understand behaviours that their future students might exhibit and that they learn ways of teaching mathematics that meet the needs of those who are less confident.

However, workshops could still be offered for those who are interested. Small group workshops have their place for pre-service teachers with severe maths anxiety or those with particular interest who intend to specialise in mathematics in their primary course. The enactment of the bibliotherapy workshop may vary with, for example, the demands of time, with the move to online learning leading to the development of online group workshops. There is also the opportunity to transfer the process to other learning areas to address issues other than maths anxiety, such as anxiety about science.

Professional collaboration was vital for achieving the aims of the study. The thesis demonstrated the value of collaborating with counselling staff to set up workshops for pre-service teachers. This is about noticing and identifying student needs and tailoring responses to meet these needs of and adequately support students. Teacher educators may liaise with counsellors to raise awareness of the issue, address the issue in class, or, if necessary, encourage pre-service teachers to seek support from the appropriate professionals.

8.6.3 In-service teachers

Primary teachers play an important role in developing students' skills and confidence in mathematics and hence a vital role in students' mathematics learning. According to the literature, (e.g. Gresham, 2010) when teachers bring anxiety about mathematics to their teaching, they may teach in a traditional way avoid taking risks in their teaching and teach a minimal amount of mathematics. Their anxiety towards mathematics may extend to their students and impact on their potential to become successful learners of mathematics. Although the focus of this thesis has been on primary pre-service teachers, the workshop protocol could also provide a professional learning resource for practising teachers.

The identification from the study of the contribution of the teacher to maths anxiety has important implications for teachers' practice and relationships with students. Participants' views of the impacts of blame and humiliation can inform teachers' understanding of how pedagogical tact (see Section 5.4.4) can be incorporated into supportive learning environments. The findings from the CIT show that both primary and secondary mathematics teachers also need to understand the consequences of their comments and actions.

8.7 Implications for policy making

Policy makers can draw from this thesis to create informed policy that is sensitive to affective issues, for example, raising awareness of anxiety towards school and its extension into teacher

education, or considering emotional responses of pre-service teachers to mandatory numeracy assessments. This thesis argues for the importance of including affective factors as an aspect of the effective teaching of mathematics and recommends investigating the inclusion of dispositional attributes of teachers, which are not currently in the Australian Professional Standards for Teachers (AITSL, 2011b). These could be informed by the AAMT Standards (2006) and by the proficiencies developed in the United States by the National Research Council (2001a) and the affective strand of the mathematics framework from the Singapore mathematics curriculum (Ministry of Education, Singapore, 2012, p. 13).

The study can make a contribution to policy in light of the current emphasis on STEM (Lyons et al., 2012). Timms, Moyle, Weldon and Mitchell (2018) introduce their Policy Insights report about STEM learning in Australian schools by stating: “over twenty years of reports and articles from government, business, think tanks and the media have drawn attention to the science, technology, engineering and mathematics (STEM) learning problem,” (p. 1). However, there is no reference in the report to emotion, anxiety, disposition, identity, nor affective issues, as student engagement is interpreted simply as the numbers of students participating, rather than in terms of cognitive or emotional engagement. The findings of this study demonstrate the need for a more nuanced appreciation of the factors involved in the learning problem.

8.8 Directions for future research

There are opportunities for further research with a focus on mathematical identity from both methodological and theoretical perspectives.

The study highlighted many of the complexities in pre-service teacher maths anxiety, but further research, especially in affective studies in mathematics education, needs to build on research investigating affect and identities together (Andersson, 2011; Grootenboer et al., 2006; Hannula et al., 2016; Kaasila et al., 2012; Lutovac & Kaasila, 2014).

There is a need to strengthen the future focus in research on pre-service teacher mathematical identity and to explore how enhanced projective identities can be maintained.

Researchers into the nature and extent of maths anxiety in pre-service teachers should consider the multidimensional nature of maths anxiety and identify the contribution of the factors of

mathematics test anxiety, numerical task anxiety and mathematics course anxiety. If the use of surveys is to continue, it is important to present more analyses of the results.

The inability of research studies to definitively identify the consistent impact of gender or age suggests a need to switch the research focus to other factors such as culture or environment. Even so, the issue of mature-age students with maths anxiety undertaking tertiary studies has emerged, and it is recommended that further research should investigate whether this factor is a possible variable that should be incorporated into the current debate on attrition and retention described by Krause (2005). Because of the low numbers accessed in this study, the author recommends purposive sampling of pre-service teachers from Indigenous or rural backgrounds for initial investigations of impacts such as culture and environment.

There are a few but powerful comments in the data from participants about parents, (see Section 5.4.2) suggesting that the influence of parents and siblings as an area of needed research. Extending cross-cultural research on primary pre-service teacher maths anxiety (such as Lutovac & Kaasila, 2011) will allow further insights into factors that contribute to their maths anxiety, especially the impacts of social and cultural influences on students' experiences in mathematics classrooms.

The finding of this study, that maths anxiety has links to learning in science, relate to its correlation with low confidence to teach mathematics and science and low self-efficacy reported by previous researchers (e.g. Bursal & Paznokas, 2006). Future research could investigate how the research approach, modified as appropriate, could provide a useful and insightful way to deal with impacts of anxiety in other disciplines, such as the lack of self-efficacy in science in pre-service teachers (Bursal, 2010; Bursal & Paznokas, 2006; Utey, Moseley & Bryant, 2005). In addition, further investigations are needed to identify potential impacts on STEM learning.

It is essential that the focus remain on addressing maths anxiety during teacher education courses, because Frankcom-Burgess reported: "many pre-service student teachers left their initial teacher education establishment to become teachers with their maths anxiety unabated" (2017, p. 68). This finding was echoed by Geeves (2014) and is clearly a cause for concern.

In addition, the author recommends that future research should be extended to include beginning teachers. Beauchamp and Thomas (2009) concluded that:

a teacher education programme seems to be the ideal starting point for instilling not only an awareness of the need to develop an identity, but also a strong sense of the ongoing shifts that will occur in that identity. In order to anticipate the reshaping of professional identity that will come, we must continue to consider the situation of teachers in the early years of practice. (p. 186)

Even when maths anxiety has been addressed, Dunkle (2010) cautioned that further research is needed to examine whether the reduced level of maths anxiety in pre-service teachers persisted and translated into effective mathematics teaching in their future classrooms. In light of the findings of this study, further research is recommended with teachers in the early years of practice to ascertain the long-term impacts of bibliotherapy workshops on teaching and teacher retention. Studies such as the study by Gresham (2018) who revisited participants in a prior study and reviewed their maths anxiety after five years of teaching experience exemplify this recommendation.

In addition, mathematics teaching anxiety among pre-service teachers requires more research (Brown et al., 2012; Peker & Halat, 2008). Studies should be conducted to examine the relationship between pre-service teachers' levels of maths anxiety and their mathematics teaching anxiety as beginning teachers.

8.9 Concluding remarks

This thesis contributes to the understanding of an important ongoing issue in mathematics education, that of maths anxiety in pre-service teachers.

This thesis argues for a paradigm shift in the way in which maths anxiety in pre-service teachers is viewed. Labelling maths anxiety in pre-service teachers as uncompromisingly negative, ignores the value of their life experiences and blames them for their anxiety and distress. The label creates more damage for them, because their experiences are reframed into a construct that is negative and blaming. It is important to hear their stories and to accept their expressions of humiliation, shame and anger.

This thesis recommends that we recognise pre-service teachers' experiences as strengths and exploit their potential for addressing maths anxiety. The developing conceptions of maths anxiety elicited by the bibliotherapy experiences indicated the potential to change the underlying assumption that it is bad and must be eliminated to an appreciation of the potential for increased empathy and effectiveness as a teacher. This involves a recognition of the

importance of giving pre-service teachers a voice, because they can inform our understanding of what is needed in the design of teacher education programs. Additional investigations into how to support and sustain pre-service teachers in affirming these changes in their mathematical identity seem to be warranted. This means acknowledging that mathematical identity and projective identity are malleable, and that the development of a robust projective identity is a key element in addressing maths anxiety in pre-service teachers.

Finally, as the author identified (see Sections 1.3.2 and 3.1), this thesis is located against a background of issues of exclusion and non-participation in mathematics education. Pre-service teachers' perceptions of such exclusion in their mathematics learning were illustrated by CIT responses in Section 5.4.2 and their impacts reinforced by the participants' initial reflections in Chapter 7. However, their later responses to the interactive bibliotherapy in the workshop provide evidence for the potential for an identity of inclusion (Solomon, 2009) to be developed by such activities and become a vital aspect of their projective identity.

APPENDICES

Appendix A: Ethics Approval



Australian Catholic University
Human Research Ethics Committee
Project Approval Certificate

Chief Investigator/Supervisor:	Associate Professor Gloria Stillman
Co-Investigator:	Professor Philip Clarkson
Student Researcher (Doctoral):	Sue Wilson
Project title:	<i>Using Bibliotherapy to address mathematics anxiety in pre-service primary teachers. (Addressing mathematics anxiety in pre-service primary teachers)</i>
Project approval date:	06/02/2012
Project approval end date:	31/12/2019
Human Research Ethics Committee (HREC) Register Number:	N2011 76

This is to certify that the above application has been reviewed by the Australian Catholic University Human Research Ethics Committee (ACU HREC). The application has been approved for the period given above.

Continued approval of this research project is contingent upon the submission of an annual progress report which is due on/before each anniversary of the project approval. A final report is due upon completion of the project. A report proforma can be downloaded from the website (link below).

Researchers are responsible for ensuring that all conditions of approval are adhered to and that any modifications to the protocol, including changes to personnel, are approved prior to implementation. In addition, the ACU HREC must be notified of any reportable matters including, but not limited to, incidents, complaints and unexpected issues.

Researchers are also responsible for ensuring that they adhere to the requirements of the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research* and the University's *Research Code of Conduct*.

Any queries relating to this application should be directed to the Research Ethics and Integrity Office (Res.Ethics@acu.edu.au).

Kind regards,

A handwritten signature in blue ink, appearing to read 'N Robinson', is written over a horizontal line.

15/07/2019

Nina Robinson
Research Ethics & Integrity Officer
On behalf of the ACU HREC Chair, Associate Professor Michael Baker

Research Ethics and Integrity | Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
T: +61 2 9739 2646
E: Res.Ethics@acu.edu.au
W: [ACU Research Ethics and Integrity](#)

Appendix B: Participants' consent form and survey

Code

(Please enter a code made up of the first letter of your mother's first name + last three digits of your mobile phone number)

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Paul White

Dear student

You are invited to participate in research addressing maths anxiety in students in primary teacher education courses. The project aims to investigate the range of anxiety that level 1 students feel towards mathematics, and ways that students might change the way they approach their mathematics studies. This project is part of ongoing research investigating maths anxiety in pre-service teachers in education courses in Australian universities. A more detailed information sheet is available on request.

Participating in part 1 of the research involves completing a survey, taking approximately 15 minutes, on two occasions - at the start of the semester 1, 2012, and at the end of Semester 2. You will be asked to label your two surveys with a code so they can be matched, but you will not be identified.

- **Background information for the survey:** This will ask for background information including your age and gender.
- **Survey:** Students will be asked to rank the extent to which they feel anxiety about activities involving maths, and to score their anxiety about mathematics. Each survey will take approximately 15 minutes to complete. Surveys will be administered and analysed by the project's research team.

Participation in this research project is voluntary. Participants can withdraw from the study without giving a reason. Withdrawal from the research will not prejudice the participant's academic progress. Confidentiality will be maintained throughout the study and in any report of the study. All survey participants will select a code and names will not be collected with the data. Participants in the survey will not be able to be identified in any reports, as only the aggregated data will be reported.

Primary Pre-service teacher survey

By completing this survey, I acknowledge that I understand that this research is not related to the course I am studying and agree for this data to be used in a form that does not identify me.

Demographic questions

1. Age:
2. Gender ___F ___M
3. Aboriginal or TSI yes _____ no _____
4. Did you complete year 12 in the
ACT _____
NSW _____
other _____ (please tick one)
5. Please name the mathematics course you completed in year 12: -

OR tick: I did not complete a mathematics course in year 12

6. Indicate the number of months _____ or years _____ since you completed your last mathematics course.
7. Postcode (or location) of your home address in your last year of school

8. Postcode (or location) of the school you attended in your last year of school

Indicate your GENERAL level of mathematics anxiety by entering a percentage, where 0 is: "no maths anxiety at all" and 100 is: "the severest maths anxiety possible". _____

In GENERAL, how confident are you in your ability to do mathematics? Enter a percentage where 0 is: "no confidence at all" and 100 is: "the highest possible level of confidence". _____

Mathematics scale

Read each statement carefully and use the following scale to indicate the amount of anxiety that you would experience in each of the situations listed

	1 (none at all)	2	3	4	5 (very anxious)
	situation				Level of anxiety
1:	Studying for a maths test				1 2 3 4 5
2:	Taking the mathematics section of a scholarship exam				1 2 3 4 5
3:	Taking an in-class test in a maths course				1 2 3 4 5
4:	Taking an exam (final) in a maths course				1 2 3 4 5
5:	Picking up maths textbook to begin working on a homework assignment				1 2 3 4 5
6:	Being given homework assignments of many difficult problems that are due the next class				1 2 3 4 5
7:	Thinking about an upcoming maths test 1 week before				1 2 3 4 5
8:	Thinking about an upcoming maths test 1 day before				1 2 3 4 5
9:	Thinking about an upcoming maths test 1 hour before				1 2 3 4 5
10:	Realizing you have to take a certain number of maths units to fulfill requirements in your course				1 2 3 4 5
11:	Picking up a maths textbook to begin a difficult assignment				1 2 3 4 5
12:	Receiving your final maths grade in the mail				1 2 3 4 5
13:	Opening a maths book and seeing a page full of problems				1 2 3 4 5
14:	Getting ready to study for a maths test				1 2 3 4 5
15:	Being give a surprise test in a math class				1 2 3 4 5
16:	Reading a cash register receipt after your purchase				1 2 3 4 5
17:	Being given a set of numerical problems involving addition to solve on paper				1 2 3 4 5
18:	Being given a set of subtraction problems to solve				1 2 3 4 5
19:	Being given a set of multiplication problems to solve				1 2 3 4 5
20:	Being given a set of division problems to solve				1 2 3 4 5
21:	Buying a maths textbook				1 2 3 4 5
22:	Watching a teacher work on an algebraic equation on the blackboard				1 2 3 4 5
23:	Signing up for a maths course				1 2 3 4 5
24:	Listening to another student explain a maths formula				1 2 3 4 5
25:	Walking into a maths class				1 2 3 4 5

Indicate your CURRENT level of mathematics anxiety by entering a number between 0 and 100, where 0 is “no maths anxiety at all” and 100 is “the severest maths anxiety possible”. _____

End of Survey

Part 2

You are invited to participate in the second part of the research project, which will investigate ways that students might change the way they approach their mathematics studies.

Participation in Part 2 involves:

- (a) providing reflections about your previous experiences in mathematics, via email,
- (b) reading materials about learning mathematics and sharing your written reflections in an online discussion group of your peers, during semester 1; and
- (c) taking part in an interview which will last approximately 30 minutes, at the end of semester 2.

If you volunteer for Part 2, you are asked to provide your name and email in order for you to be contacted and included in the on-line community. Participants in the reflections, on-line discussions, and interviews will not be identified to any other person, and participants will be asked to keep discussions confidential.

- **Reflections:** Reflections involve sharing a short reflection on a situation that impacted on your view of your mathematics learning, with the student researcher
- **Discussions:** On-line discussions of readings will be facilitated by the student researcher.
- **Interviews:** Interviews will be held with the student researcher. Interviews will be face-to-face and will last approximately 30 minutes. They will be audio recorded so they can be transcribed, and then the audio files will be stored in a locked cupboard.

The potential benefits for participants are that they may gain a greater insight into their understanding of mathematics anxiety. Students come to their pre-service teacher education with a range of attitudes towards and feelings about maths that shape their study of maths units at university and influence the way they see themselves as future teachers of maths in the classroom. The project will provide opportunities for participants to review their experiences and learn from others. In addition, they will be contributing to worthwhile research which may be published and shared with other pre-service teachers and teacher educators to help address maths anxiety in teacher education.

Participation in this study is voluntary and for the purposes of data collection and this study will not contribute to the evaluation of unit outcomes. Participants can withdraw from the study at any stage without giving a reason. Withdrawal from the research will not prejudice the participant's academic progress. Confidentiality will be maintained throughout the study and in any report of the study. Individual participants will not be identified. Individual participants in the on-line reflections and interviews will be given a pseudonym in any reports. Interviews will be audio taped, to facilitate transcription, after which audio files will be stored securely.

If you have any questions about the project, before or after participating, please contact Sue Wilson on 02 6209 1141 in the School of Education, Signadou Campus at the Australian Catholic University, 223 Antill Street, Watson, ACT 2602. Before commencing, you will have the opportunity to ask any questions about the project. You will also have the opportunity to discuss your participation and the project in general after completing the project. The researcher will contact you about the results of the research project, if you so wish.

This study has been approved by the Human Research Ethics Committee at the Australian Catholic University. In the event that you have any complaint or concern about the way you have been treated during the study, or you have a query that the Investigator has not been able to satisfy, you may write to:

Chair, Human Research Ethics Committee
C/- Research Services
Australian Catholic University
Brisbane Campus
PO Box 456
VIRGINIA QLD 4101
Tel: 07 3623 7429 Fax: 07 3623 7328

Any complaint will be treated in confidence and will be fully investigated. The participant will be informed of the outcome.

If you are willing to participate, please provide your name and email address below. Your participation in the research project will be most appreciated.

.....

Sue Wilson

Student Researcher

.....

Ass. Prof. Paul White
Principal Supervisor

By nominating for Part 2, I acknowledge that my name will be associated with my survey results for purpose of the research, but that I will be given a pseudonym in any reports and I give the following details so that you are able to contact me.

Name:

Email:

Appendix C: Written permission to use the RMARS survey

From: Alexander, Livingston [lalexand@pitt.edu]
Sent: Wednesday, February 01, 2012 1:17 AM
To: Sue Wilson
Subject: RE: using the RMARS

Dear Ms. Wilson,

Thanks for contacting me about the RMARS. You most definitely have my approval to use the RMARS for your research. If it's no trouble, I'd appreciate any reference information you might be able to share about the research conducted by Mustafa Baloglu; and I would welcome the opportunity to see your results as well.

Cheers,

Livingston alexander

Livingston Alexander
President
University of Pittsburgh at Bradford
300 Campus Drive
Bradford, PA 16701
814-362-7501
814-362-7690 (Fax)
lalexand@pitt.edu<<mailto:lalexand@pitt.edu>>
From: Sue Wilson [<mailto:Sue.Wilson@acu.edu.au>]
Sent: Tuesday, January 31, 2012 2:37 AM
To: Alexander, Livingston
Subject: using the RMARS
Dr Livingston Alexander
President, University of Pittsburgh-Bradford

Appendix D: Tutorial 2 views and CIT



(The code is the first letter of your mother's first name + last three digits of your mobile phone number)

Code

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Paul White

At the start of the year, level 1 pre-service teachers completed a survey, and we are now asking you to describe your previous experiences in maths. Participation is voluntary, and your responses will not be seen by your lecturer/tutor nor linked to your results in any unit. By completing this activity, you agree that your responses may be published in reports of this research, but you will not be identified. Thank you for contributing to this research about improving maths experiences for students.

As part of the project, we are setting up a separate online forum for level one pre-service teachers from Canberra and Strathfield to share reflections on their maths experiences and on some readings about learning maths. If you would like to contribute please print your name and email, so that Sue can contact you and add you to the forum.

How do you see/feel about yourself as a learner of maths?

How do you see/feel about yourself as a future teacher of maths?

Describe an incident in your own maths education that impacted on your image of yourself as a learner and/or potential teacher of maths. What class/year were you in? What happened and how did it make you feel? How does it make you feel now, looking back? (Please continue writing over the page if needed)

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Appendix E: Tutorial 4 Bibliotherapy



Name

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Paul White

We are asking you to read an extract from an article and complete a reflection. Participation is voluntary, and not linked to your results in any unit. By completing this activity, you agree that your responses may be published in reports of this research, but you will not be identified. Thank you for contributing to this research about improving maths experiences for students.

Read the extracts from the article by Dossel on Mathematics anxiety

When I read this article, my response to it was:

Appendix F: Tutorial 12 – final reflection



Code

(The code is the first letter of your mother's first name + last three digits of your mobile phone number)

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Paul White

This week we are asking you to reflect on the three tutorial reflections that you did at the start of the semester. Participation is voluntary, and not linked to your results in any unit. Names will not be collected. Your code will be used only to match to other reflections. By completing this activity, you agree that your responses may be published in reports of this research, but you will not be identified. Thank you for contributing to this research about improving maths experiences for students.

If you would be prepared to share more reflections on your experiences in an interview, please print your name, email, and mobile number so that Sue can contact you.

?

1. When do you feel most anxious about maths?

.....?

How anxious do you feel? (not at all) 1 2 3 4 5 (extremely)

What do you do to overcome this?

?

.....?

?

.....?

?

2. In week 1 we asked you to write about an incident in your maths schooling that impacted on you.

Do you feel this helped you:

☐ Understand more about yourself as a maths learner yes/no

If so, how.....

?

.....?

?

☐ Engage more with maths in your maths unit? yes/no

If so, how.....

?

.....?

?

Please continue on the next page

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Appendix G: Workshop – recording permission



PERMISSION LETTER FOR AUDIO RECORDING

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF RESEARCHER: Sue Wilson

NAME OF SUPERVISOR: Ass. Gloria Stillman

Dear student

Thank you for participating. This project is part of ongoing research investigating maths anxiety in pre-service teachers in education courses in Australian universities.

- ☐ **Background information for the survey:** This will ask for background information including your age and gender.
- ☐ **Survey:** Students will be asked to rank the extent to which they feel anxiety about activities involving maths, and to score their anxiety about mathematics. **Please label your surveys with your name and code (Mother's initial and last 3 digits of mobile number).**
- ☐ **Workshop:** You will be invited to review your previous experiences in mathematics, engage with materials about learning mathematics and share your reflections in a group of your peers.
- ☐ **Interviews:** You will be invited to take part in an interview in second semester.

Participants in the workshop reflections and interviews will not be identified to any other person, and will be given a pseudonym in any reports or publications. The workshop and interviews will be audio recorded so they can be transcribed, and then the audio files will be erased.

Participation in this research project is voluntary. Participation in this study is for the purposes of data collection and this study will not contribute to the participant's academic progress. Participants can withdraw from the study at any stage without giving a reason.

Confidentiality will be maintained throughout the study and in any report of the study. Participants in the survey will not be able to be identified in any reports, as only the aggregated data will be reported.

Workshops and Interviews will be audio taped, to facilitate transcription, after which audio files will be erased.

Please sign to acknowledge your consent to these procedures

Name (please print)

.....

Signature & date

.....

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Appendix H: Workshop survey

Code

(Please enter a code made up of the first letter of your mother's first name + last three digits of your mobile phone number)

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF PRINCIPAL INVESTIGATOR: Sue Wilson

Primary Pre-service teacher survey

By completing this survey, I acknowledge that I understand that this research is not related to the course I am studying and agree for this data to be used in a form that does not identify me.

Demographic questions

9. Age:

10. Gender ___F ___M

11. Aboriginal or TSI yes _____ no _____

12. Did you complete year 12 in the

ACT _____

NSW _____

other _____ (please tick one)

13. Please name the mathematics course you completed in year 12: -

OR tick: I did not complete a mathematics course in year 12

14. Indicate the number of months _____ or years _____ since you completed your last mathematics course.

15. Postcode (or location) of your home address in your last year of school

16. Postcode (or location) of the school you attended in your last year of school

Indicate your GENERAL level of mathematics anxiety by entering a percentage, where 0 is: "no maths anxiety at all" and 100 is: "the severest maths anxiety possible". _____

In GENERAL how confident are you in your ability to do mathematics? Enter a percentage where 0 is: "no confidence at all" and 100 is: "the highest possible level of confidence". _____

Mathematics scale

Read each statement carefully and use the following scale to indicate the amount of anxiety that you would experience in each of the situations listed

	1 (none at all)	2	3	4	5 (very anxious)
	situation				Level of anxiety
1:	Studying for a maths test				1 2 3 4 5
2:	Taking the mathematics section of a scholarship exam				1 2 3 4 5
3:	Taking an in-class test in a maths course				1 2 3 4 5
4:	Taking an exam (final) in a maths course				1 2 3 4 5
5:	Picking up maths textbook to begin working on a homework assignment				1 2 3 4 5
6:	Being given homework assignments of many difficult problems that are due the next class				1 2 3 4 5
7:	Thinking about an upcoming maths test 1 week before				1 2 3 4 5
8:	Thinking about an upcoming maths test 1 day before				1 2 3 4 5
9:	Thinking about an upcoming maths test 1 hour before				1 2 3 4 5
10:	Realizing you have to take a certain number of maths units to fulfill requirements in your course				1 2 3 4 5
11:	Picking up a maths textbook to begin a difficult assignment				1 2 3 4 5
12:	Receiving your final maths grade in the mail				1 2 3 4 5
13:	Opening a maths book and seeing a page full of problems				1 2 3 4 5
14:	Getting ready to study for a maths test				1 2 3 4 5
15:	Being give a surprise test in a math class				1 2 3 4 5
16:	Reading a cash register receipt after your purchase				1 2 3 4 5
17:	Being given a set of numerical problems involving addition to solve on paper				1 2 3 4 5
18:	Being given a set of subtraction problems to solve				1 2 3 4 5
19:	Being given a set of multiplication problems to solve				1 2 3 4 5
20:	Being given a set of division problems to solve				1 2 3 4 5
21:	Buying a maths textbook				1 2 3 4 5
22:	Watching a teacher work on an algebraic equation on the blackboard				1 2 3 4 5
23:	Signing up for a maths course				1 2 3 4 5
24:	Listening to another student explain a maths formula				1 2 3 4 5
25:	Walking into a maths class				1 2 3 4 5

Indicate your CURRENT level of mathematics anxiety by entering a number between 0 and 100, where 0 is “no maths anxiety at all” and 100 is “the severest maths anxiety possible”. _____

End of Survey

Appendix I: Workshop CIT



Name

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Gloria Stillman

As part of this research you filled in a survey, and we are now asking you to complete some activities to help us learn about improving students' experiences in maths. Participation is voluntary, and not linked to your results in any unit. The study is confidential.

Describe an incident in your own maths education that impacted on your image of yourself as a learner and/or potential teacher of maths.

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Appendix J: Workshop bibliotherapy



Name

TITLE OF PROJECT: Addressing mathematics anxiety in Pre-Service Primary Teachers

NAME OF STUDENT RESEARCHER: Sue Wilson

NAME OF PRINCIPAL SUPERVISOR: Ass. Prof. Gloria Stillman

We are asking you to read an extract from an article and complete a reflection. Participation is voluntary, and not linked to your results in any unit. By completing this activity, you agree that your responses may be published in reports of this research, but you will not be identified. Thank you for contributing to this research about improving maths experiences for students.

Read the extracts from the article by Dossel on Mathematics anxiety

When I read this article, my response to it was:

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Appendix K: Semi-structured interview invitation

9th December, 2013

Addressing mathematics anxiety in Pre-service Primary Teachers

Dear

Thank you for accepting the invitation to participate in the extended part of the research project and take part in an interview with me for about 30 minutes. The interviews will help us understand more about students' responses to their mathematics learning, and you may gain greater insights about your attitudes towards and feelings about mathematics.

Could you please sign below that you give your agreement to be interviewed and give permission for your responses to be recorded.

I acknowledge that my interview responses may be published, but that I will not be identified.

Signed _____ Date _____

Thank you again

Sue Wilson
Student Investigator
Australian Catholic University

Appendix L: Semi-structured interview protocol

What I want to talk to you about today was the impact of the workshops and how you felt about it.

What is your view of mathematics?

What are your feelings now about maths?

Why do you think it is important to teach maths?

What knowledge do you think primary school teachers need to know to be able to teach maths?

What sort of qualities do you think primary teachers need?

Are there particular mathematical concepts that cause you anxiety? Did the workshop help you address your maths anxiety?

Can you tell me any strategies from completing the workshop that help you to overcome your maths anxiety?

Can you identify any impacts of the workshop, or differences it had on how you approached your next maths unit/practicum?

How confident are you about your teaching of mathematics after your participation in the workshop?

How do you plan to help your future students to overcome/not develop maths anxiety?

Was there anything else you want to tell me that you think is important?

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