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Addressing Preservice Teacher's Reasons for Mathematics and Test Anxiety

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Abstract: Mathematics anxiety in initial teacher education is a growing issue that reflects on teacher quality and their student's maths anxiety and abilities. Previous studies have presented a range of different perspectives to mathematics anxiety. We aimed to explore further the reasons of mathematics anxiety in preservice teachers and suggest some intervention strategies in reducing maths anxiety for initial teacher education systems. We used a mixed methodology in this research analysing both qualitative data along with some quantified data derived from qualitative data sources. The findings provide insights to causes of maths and test anxiety along with some intervention strategies that teacher educators can use in their future teaching.

Keywords: *Intervention strategies for maths anxiety, LANTITE, maths anxiety, teacher preparation quality, test anxiety.*

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Introduction

Improving initial teacher education to better prepare quality teachers is the ultimate goal of teacher education systems. In Australia, assessing the quality of preservice teachers (PSTs) before they enter the profession is a high priority. Like many other countries aligning with global policy trends (Australian Government Department of Education and Training (AGDET), 2015; Rowe & Skourdoumbis, 2017), there are stringent teacher accreditation requirements in place (Australian Institute for Teaching and School Leadership [AITSL], 2019a, 2019b). In the case of mathematics education, teacher educators must make sure that PSTs have a good level of mathematics understanding and practice during their education in both primary and secondary mathematics. PSTs need to pass a series of mathematics teaching unit assignments, a comprehensive Teacher Performance Assessment (TPA), and finally, literacy and numeracy tests for initial teacher education (LANTITE) before teacher graduation. During the first year of teaching, Graduate Teachers undertake a rigorous teacher registration process to show they meet the teacher standards as mandated by the AITSL and each state's teaching profession body. In the state of Victoria, this is the Victorian Institute of Teaching (VIT).

Teacher education systems have been impacted by the high level of requirements which are expected from PSTs in terms of understanding and using mathematics accurately and confidently during their education journey as well as in their teaching practice (Wilson & Goff, 2019). However, many international studies have shown that a significant number of PSTs harbour anxieties about their maths knowledge and ability to teach mathematical concepts. Many are also impacted negatively by having to complete tests relating to numeracy. Because maths anxiety can be transferred from teachers to their students easily (Beilock et al., 2010), PSTs need to less reflect, or ideally not reflect their anxiety, during their teaching practice so their students are not affected by any negative feelings towards mathematics around them. PSTs need to be confident in their ability to teach mathematics. In this sense, understanding the sources of PSTs' maths anxiety, and the allied concept of test anxiety, gains importance in planning and implementing maths anxiety reducing interventions by teacher educators.

Hadfield and McNeil (1994) proposed a theoretical model for the causes of mathematics anxiety that is "negative classroom experiences in mathematics and lack of support at home combined with an anxiety toward testing produces a mathematically anxious individual". With this current study, we would like to further extend the reasons and causes of mathematics anxiety model to improve Hadfield and McNeil's (1994) model. Therefore, we aim to explore what are the main sources of PSTs' mathematics anxiety in general and whether the sources are different based on their gender.

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We also aim to suggest some intervention strategies in reducing maths anxiety for initial teacher education systems. We expect this study will be a valuable add on the existing literature around the reasons for maths anxiety and test anxiety around the world (Ashcraft, 2002; Hembree, 1988; von der Embse et al., 2018) and in Australia where it is rarely studied (Boyd et al., 2014; Uusimaki & Nason, 2004). Under this main purpose, we investigate responses to below questions:

1. How do the levels of perceived maths anxiety change across the levels of perceived maths content knowledge?
2. How do the levels of perceived maths anxiety and the content knowledge change by gender?
3. What are the main themes that emerge as the sources of PSTs' mathematics and test anxiety?
4. How the main themes change across females and males.
5. What can be some interventions in reducing the maths anxiety of PSTs?

Literature Review

Mathematics anxiety and test anxiety

Ashcraft (2002) defines mathematics anxiety as "a feeling of tension, apprehension, or fear" toward math-related activities (p. 181). Further, Buckley et al. (2016) state that mathematics anxiety is manifested by 'feelings of unease and worry experienced when thinking about mathematics or completing mathematical tasks' (p. 158), leads to avoidance of mathematics, and is a major barrier to effective mathematics learning in the classroom.

According to Dowker et al. (2016), 'the construct of mathematics anxiety has been an important topic of study at least since the concept of "number anxiety" was introduced by Dreger and Aiken in 1957 and has received increasing attention in recent years' (as cited in Dowker et al., 2016, p. 1). Hadfield and McNeil (1994) posit that there are three categories of causes of mathematics anxiety - *Environmental factors* - negative experiences in the classroom, traditional teaching methods restricting participation, strict rules and insensitive teachers, and high cultural and parental expectations; *Intellectual factors* – being taught with mismatched learning styles, lack of self-confidence, self-efficacy and lack of perceived usefulness of mathematics, and little belief in the usefulness of mathematics; *Personal factors* – shyness, low self-esteem, viewing mathematics as a male domain.

Dowker et al. (2016), also provide a comprehensive overview of what is known about mathematics anxiety: what it is, how it is manifested, its negative impact on working memory, what a wide range of studies say about mathematics anxiety, how it is measured using a variety of measures and scales, and physiological measures including brain functions tests. They provide a comparison of mathematics anxiety in different cultures citing some findings from different countries, especially between eastern and western cultures. Genetics, age, and gender are also considered as factors impacting mathematics anxiety. Therefore, the topic is very complex, and much is still to be learned (Dowker et al., 2016). Martinez and Martinez (1996) reinforce this idea of complexity and no easy fixes by stating that mathematics anxiety is a 'construct with multiple causes and multiple effects interacting in a tangle that defies simple diagnosis and simplistic remedies' (p. 2 – cited in Uusimaki & Nason, 2004 p. 369).

Mathematics test anxiety is a concept that is closely related to the overarching idea of mathematics anxiety. 'Feeling anxious about mathematics has been linked to avoidant behaviour, poor performance and test anxiety' (Buckley et al., 2016, p. 158). Test anxiety has been defined as 'the emotional, physiological, and behavioural responses surrounding the potential consequences of negative evaluation on an upcoming test or exam' (Zeidner, 2007). For a range of reasons, some people undertaking tests suffer from stress and anxiety, resulting in both negative emotional, behavioural, and physical symptoms, and under-perform in test situations (Hembree, 1988; von der Embse et al., 2018). Both mathematics anxiety and test anxiety present in a significant percentage of PSTs (Boyd et al., 2014; Wilson & Goff, 2019).

Sources of maths anxiety in PSTs

Anecdotally, through the authors' own experiences of working with PSTs to help develop their mathematics teaching and Pedagogical Content Knowledge (PCK) in mathematics (Shulman, 1986), it is very clear that there is a substantial level of existing mathematics anxiety in some of these students. Gresham (2007) established this in her seminal paper, 'A study of mathematics anxiety in pre-service teachers.' To add to this research and a number of other older research papers, relatively recent international studies support the notion (Ersozlu et al., 2022; Finlayson, 2014; Mizala et al., 2015; Peker & Ulu, 2018; Sloan, 2010; Soysal et al., 2022; Wilson, 2018). These studies from a range of countries have uncovered a range of reasons for this phenomenon. These include negative mathematics experiences at primary school (Uusimaki & Nason, 2004) and PSTs defining themselves as persons who had difficulty learning mathematics (Wilson, 2018). Finlayson (2014) identifies 'lack of self-confidence, fear of failure; teaching styles; ineffective learning practices, and non-engagement of students.' Dowker et al. (2016) question whether an increasing over emphasis on mathematical achievement is causing problems with mathematical anxiety in PSTs. Interestingly, several researchers have found that

teacher education students are more likely to present with mathematics anxiety than students from other fields. (Kelly & Tomhave, 1985; Mizala et al., 2015; Watson, 1987).

Worryingly, it is also clear, that without some form of intervention from teacher educators that these PSTs enter the profession carrying their anxieties into their classrooms, impacting students (Beilock et al., 2010). They also questioned their effectiveness in teaching mathematics (Hadfield & McNeil, 1994; Lu & Setayesh, 2022).

Sloan (2010) found that some researchers have presented information indicating that teachers with mathematics anxiety teach differently than teachers who are less anxious about mathematics. These teachers have a tendency to teach more traditionally. Teachers who do not enjoy mathematics spend 50 percent less time teaching this subject than teachers who feel comfortable. 'Teachers with negative attitudes towards mathematics frequently rely on teaching algorithms while neglecting cognitive thought processes and mathematical reasoning' (p. 242). This then can foster feelings of dependency and anxiety in their students. Research suggests that teacher education programs should improve preservice teachers' ability to teach their content by addressing knowledge, attitudes, and beliefs besides content knowledge (Ball, 1991; Brown et al., 2012; Wilkins, 2008).

Test anxiety and LANTITE

LANTITE was made compulsory for PSTs in 2016. This was a response to falling TIMMS and PISA test scores by Australian students (Wilson & Goff, 2019) and was an effort to increase the capabilities of teachers and logically, by extension, students. The tests were developed by the Australian Council for Educational Research. They are high-stakes tests (Hilton et al., 2020). PSTs can have three attempts (a further two can be negotiated by the higher education institution) at passing the mathematics test in which they display their practical knowledge and application of everyday mathematics. If they don't pass, they can't graduate or be eligible to work as a classroom teacher (Department of Education, Skills & Employment (DESE), 2021). There are some doubts to the validity of the tests (Barnes & Cross, 2020), and whether they measure what they are purported to measure (Hall & Zmood, 2019).

Further to the well-researched existence of mathematics anxiety in PSTs, from our own experience conversationally and experientially, it is evident that there is also quite a lot of angst amongst PSTs about sitting the Mathematics LANTITE test. Recent research has also confirmed this (Barnes & Cross, 2020; Hall & Zmood, 2019; Hilton et al., 2020; Wilson & Goff, 2019). Despite the fact that over 90% of students pass the LANTITE on the first try, and most of those that fail the first time eventually pass (Barnes & Cross, 2020), it is clear that extra stress is put on students through the testing process. The titles of the research papers "In LANTITE, no one can hear you scream!": student voices of high stakes testing in teacher education (Hilton et al., 2020), and "Hopefully, I Will Gain Confidence": hope in Pre-Service Teachers' Mathematics and Numeracy Testing (Wilson & Goff, 2019) suggest that something is awry. Zuccarelli's (2020) research based on Australian PSTs wrote about the effects of the LANTITE, based on a survey of 213 students and discussions with forty students. Some interesting data was produced –

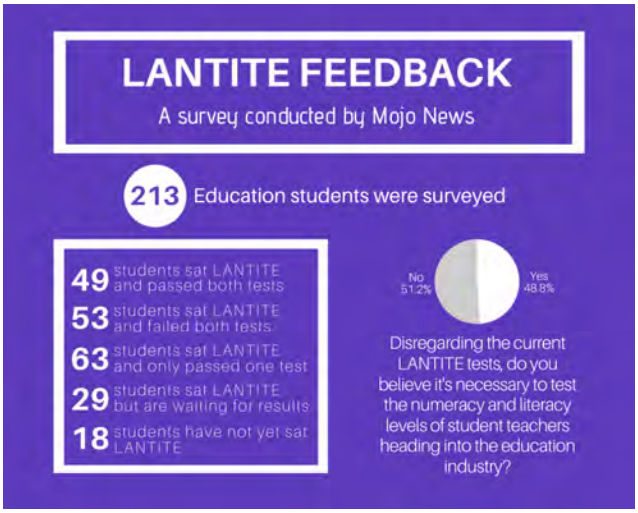

Figure 1. LANTITE Survey data (Zuccarelli, 2020)

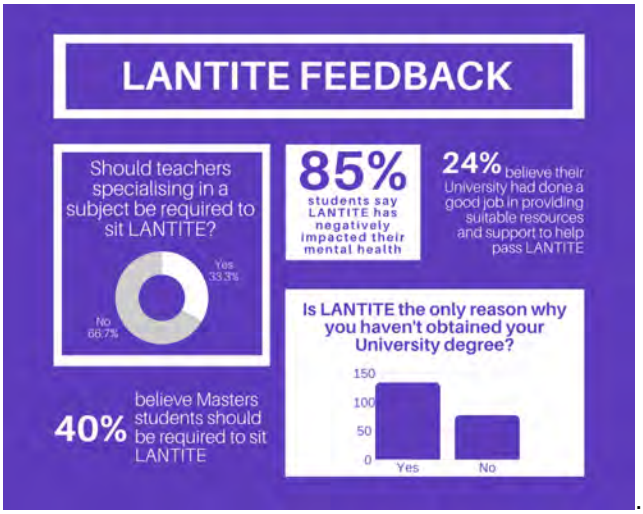

Figure 2. LANTITE Survey data (Zuccarelli, 2020)

Gender differences in maths and test anxiety

Particularly disturbing in the 85% of participants indicating that the LANTITE negatively impacted their mental health, and the very large number who indicate that the LANTITE is the only factor preventing them from completing their degree. These are educated people who should have little problem completing the test. What is stopping them? Perhaps statements like the following are an indicator. A mature age student who has failed both tests for the second time –

"*Getting the results for the second time has completely flattened me in every aspect. My whole demeanour, my confidence, my everything. It made me feel like a failure, like a dummy, despite I've almost finished my second degree. It is absolutely shattering, that I have got severe anxiety because of it. I just think of it and I start to cry."* (Zuccarelli, 2020)

As an undergraduate student studying Early Childhood Education (teaching children up to 6 years old) –"*LANTITE has put so much pressure on me. So, this [degree] is obviously something that I've wanted to do forever and having that kind of pressure and anxiety put on you to not even being able to pass and do what you want for a career is really stressful."* (Zuccarelli, 2020).

The results of the recent research and negative media attention indicate that some interventions need to be made to ease the stress of the LANTITE burden on students.

Gender difference in Mathematics and Test Anxiety.

'Research findings suggest that the relationship between gender, mathematics, and MA (mathematics anxiety) is not straightforward' (Buckley et al., 2016). They go on to cite a variety of different research studies which have mixed findings of gender impact, from none to significant. In terms of mathematics anxiety in PSTs, Peker and Ertekin's (2011) study of 316 primary school PSTs in Turkey found no significant gender differences in pre-service teachers' mathematics teaching anxiety and mathematics anxiety. On the other hand, Bowd and Brady (2003) and Boyd et al. (2014) found that females were far more anxious about teaching mathematics than male PSTs. Other studies into mathematics anxiety in PSTs did not enter the gender debate as the research participants were overwhelmingly female, e.g., Gresham (2007) and Sloan (2010). Hembree (1990) also suggests that females are far more likely to suffer test anxiety than males. It is clear that gender has an influence on mathematics anxiety and test anxiety in PSTs needs further examination.

What the literature says about interventions for PSTs suffering from mathematics and test anxiety.

Given the negative nature of the points raised earlier about mathematics anxiety in PSTs, and the anxiety driven by having to sit the LANTITE tests, particularly in mathematics, it is clear that as teacher educators, we must be cognisant of these facts and be proactive in finding ways to help our PSTs overcome any difficulties they might have. Most papers on the subject propose some form of intervention after acknowledging the presence of mathematics anxiety in the PSTs. It is a phenomenon we can't afford to ignore if we want 'good' teachers of mathematics in our schools. Uusimaki and Nason (2004) suggest that 'participants (PSTs in mathematics) workshops need to be provided with learning environments where they are able to 1) freely explore and communicate about mathematics in a supportive group environment 2) explore and relearn basic mathematical concepts, and 3), apply this re-learnt knowledge in real-life and authentic situations. They develop a positive mathematics learning community. Gresham (2007) advocates the employment of constructivist pedagogies citing Bruner's modes of learning, along with the use of manipulatives and a range of group-based learning experiences, to assist PSTs get over their anxieties about mathematics and teaching it.

Engagement with the literature and reflective journaling are also useful strategies. Buckley et al. (2016) promote the use of relaxation techniques such as mindfulness and the use of clinical psychology techniques such as 'cognitive reappraisal'. Leading scholar in mathematics education, Professor Jo Boaler, advocates the development of positive mindset (Dweck, 2008) with school students (Youcubed, 2021). This could also be a good strategy for teacher educators too.

The few research papers on LANTITE related anxiety suggest a range of interventions to assist PSTs with the test, including ' offering different preparation programs for PSTs undertaking standardised testing' and peer support networks (Hilton et al., 2020) early detection of issues surrounding PSTs' issues with mathematics, 'teaching for the test,' directing resources to better support PSTs' mathematical efficacy, and goal setting strategies (Wilson & Goff, 2019), and diagnostic testing and practice tests (Thai et al., 2021). Similarly, Hall and Zmood (2019) suggest 'refreshing test-taking skills, especially time management and exposure to online tests… reinforcing literacy skills, developing strategies to decode numeracy contexts and questions, and strengthening fluency with computations (p. 14).

Our research delves into the topics of mathematical and test anxieties in PSTs in the state of Victoria, Australia, and also contemplates some interventions that might help to alleviate this widespread problem.

Methodology

Research Design

We have adopted a mixed method approach to the analysis of the data collected via semi-structured questions linked with two ranking scales. In the analysis we considered a combined (qualitative data into quantitate scales) approach along with a series of illustrations via a visualisation tool, Voyant (URL: https://voyant-tools.org/). We used mostly descriptive and relational analysis as well as triangulation of data analyses across diverse groups, which addresses the gender differences in the current study. Participation was voluntarily based, and the ethics process had been completed before the data collection.

Participants

Participants were preservice teachers (N=39) who enrolled in a Victoria-based state university from various teacher education programs in the school or faculty of education. 20.5% of them males and 79.5 % females and the age range was wide such as 28 % of the participants were between 24-29 and 13 % of them were between 18-23, 30-35, 36-40, 41-46 years old and 20 % of them were over 46 years old. 80% of PSTs have stated their intention to teach after graduation while 12% of them undecided and 2% was not interested in teaching at all.

Data tools and analysis procedures

There was a semi-structured question following two ranking scales.

"Perceived level of mathematics anxiety scale" asks PSTs to point their level of mathematics anxiety using a 0 to 10 scale where 0 means "no anxiety at all" and 10 means "high level of anxiety following the question "Could you please give an example when you recently experienced anxiety? What do you think the reasons are for your mathematics anxiety? Please write down your reasons of mathematics anxiety".

"Perceived mathematics ability scale" asks PSTs to score their perceived level of mathematics content knowledge on a scale from 0 to 10 scale where 0 means "no content knowledge at all" and 10 means "*high level of content knowledge*".

To analyse the semi-structured question in attach to anxiety scale, we have used two different analysis methods. Initially, we used the content analysis techniques to find the emergent themes then re-analyse the data via Voyant tool which is a free text mining tool to bring more visual perspective to the data. We created a corpus which refers to a qualitative data console in the analysis where we also used cirrus (visualisation of the most frequently used words) and links (shows the relationships and links among the words).

Considering the gender differences, we created two different data sets in the analysis as well as whole group analysis. We combined the emergent themes for the whole group and for gender groups with the quant result using descriptive statistics which is resulting from the ranking scales. We used triangulation of results while interpreting the results for whole and for specific to gender groups.

We also grouped the level of maths anxiety and the perceived content knowledge scales to make the analysis more meaningful and understandable as follows: on both scales, zero has been labelled as "None", the range between 3 and below labelled as "Below", 4 labelled as "Close to middle", 5 labelled as "Middle", 6 labelled as "slightly high" and 7 and above labelled as "high".

Reliability for the qualitative analysis part is accomplished by using Miles and Huberman's (1994) formula. The themes in the written comments were categorised by two educational scientists and based on this formula, Reliability

level=Agreement/Agreement+Disagreement, the differences and similarities between the categorizations were calculated using to determine inter-rater reliability. A high level of agreement ensured a high level of reliability (0.98).

Findings / Results

The levels of perceived maths anxiety change across the levels of perceived maths content knowledge

Table 1. Crosstabulation of perceived mathematics anxiety by perceived content knowledge

Perceived Mathematics Anxiety (PMA)	Perceived Content Knowledge (PCK)					
	Low	Close to Middle	Middle	Slightly High	High	Total
None	1	0	1	0	3	5
Low	0	1	0	4	12	17
Close to middle	0	0	0	0	2	2
Middle	0	0	2	1	0	3
Slightly high	0	1	0	0	0	1
High	2	1	3	4	1	11
Total	3	3	6	9	18	39

Correlation between PMA and PCK, r=-.467**, p <.001

There is a significant negative correlation (close to middle level) between perceived mathematics anxiety and perceived mathematical content knowledge suing Pearson Correlation (r=-.467**, p <.001) showing that while the mathematics anxiety lowers the mathematical content knowledge increases and vice versa.

17 students indicated that low (below 4) mathematics anxiety matches perceived close to middle (at 4), slightly high (at 6) to high (above 6) content knowledge for mathematics teaching. 11 students indicated high anxiety issues with slightly high to low content knowledge for teaching and only 1 student indicated high level anxiety with high level content knowledge.

There are some students who have indicated mid-range responses for both questions and also indicate that they are unsure of how they might go about their maths teaching in the written responses.

The levels of perceived maths anxiety and the content knowledge changes by gender

Table 2. Crosstabulation of perceived content knowledge and maths anxiety by gender

Level	PCK			PMA		
	Male (N)	Female (N)	Total	Male (N)	Female (N)	Total
None	-	-	-	2	3	5
Low	0	3	3	4	13	17
Close to Middle	0	2	3	0	2	2
Middle	2	5	6	0	3	3
Slightly High	2	7	9	0	1	1
High	4	14	18	2	9	11
Total	8	31	39	8	31	39
	$X^2(4) = 1.170$, $p = .881$			$X^2(5) = 2.884$, $p = .724$		

5 students reported none (2 males and 3 females) anxiety while 22 students reported low to middle anxiety (4 males and 18 females). Interestingly there were only 12 students reported slightly high to high level of anxiety (2 males and 10 females). In terms of PCKs, 2 males and 10 females reported low to middle level of content knowledge while 6 males indicated that they have slightly high to high level of content knowledge whereas 21 females indicated that they have slightly high to high level of content knowledge. The comparison of PCKs versus PMAs is summarised in table 2.

The Chi-Square test results revealed that there is no statistically significant difference between genders by both maths anxiety ($X^2(5) = 2.884$, $p = .724$) and mathematical content knowledge ($X^2(4) = 1.170$, $p = .881$). This finding suggests that there is no meaningful association between gender and neither perceived maths anxiety or perceived mathematical ability; that is both Males and Females similarly perceive their maths anxiety and maths ability.

The main themes emerged as the sources of PSTs' mathematics and test anxiety

24 students reported close to middle or low to no anxiety based on the ranking scales. Of the other 12 respondents, the maths anxiety was slightly high to high.

In terms of their written responses, significantly, of the other 25 respondents there were reports of varying degrees of mathematics anxiety surrounding the following themes. We looked for some links in the comments to find themes and were able to identify 6 clear themes. Some comments crossed over more than one theme. We have indicated the number of responses related to each theme.

1. Bad mathematics experience at school/university/workplace that induced anxiety (12 comments)
2. Not wanting to be wrong/fear of failure in front of peers or teachers (4 comments)
3. Fear of tests and exams - pressure of the LANTITE (6 comments)
4. Wondering about how to teach the subject in contemporary classrooms (7 comments)
5. Nervous about revising /refreshing skills and knowledge - no recent engagement in mathematics (4 comments)
6. Time pressures to complete a problem task (4 comments)

Based on the results of Voyant analysis we have also found that the most frequently used words were “anxiety (17); feel (7); problem (6); school (6); test (6)”. The below figures show how they are linked to each other over other concepts in the written responses. We have used the stop word list function to exclude some common words, such as “mathematics, maths, the” since those words do not contribute to the results besides, they might take the reader away from the main information conveyed by the analysis.

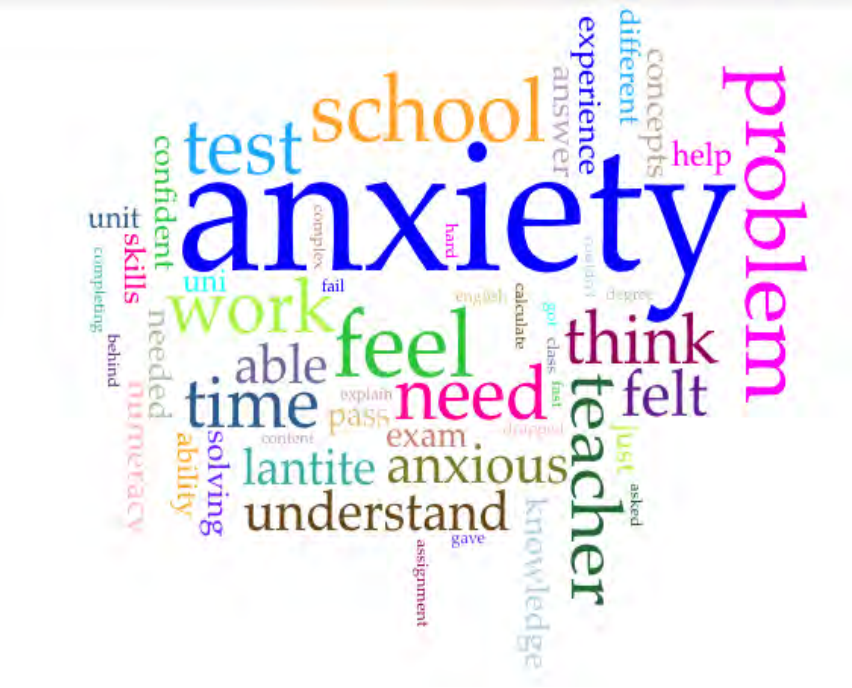

Figure 3. Cirrus of the Most Frequently Used Words in Written Responses

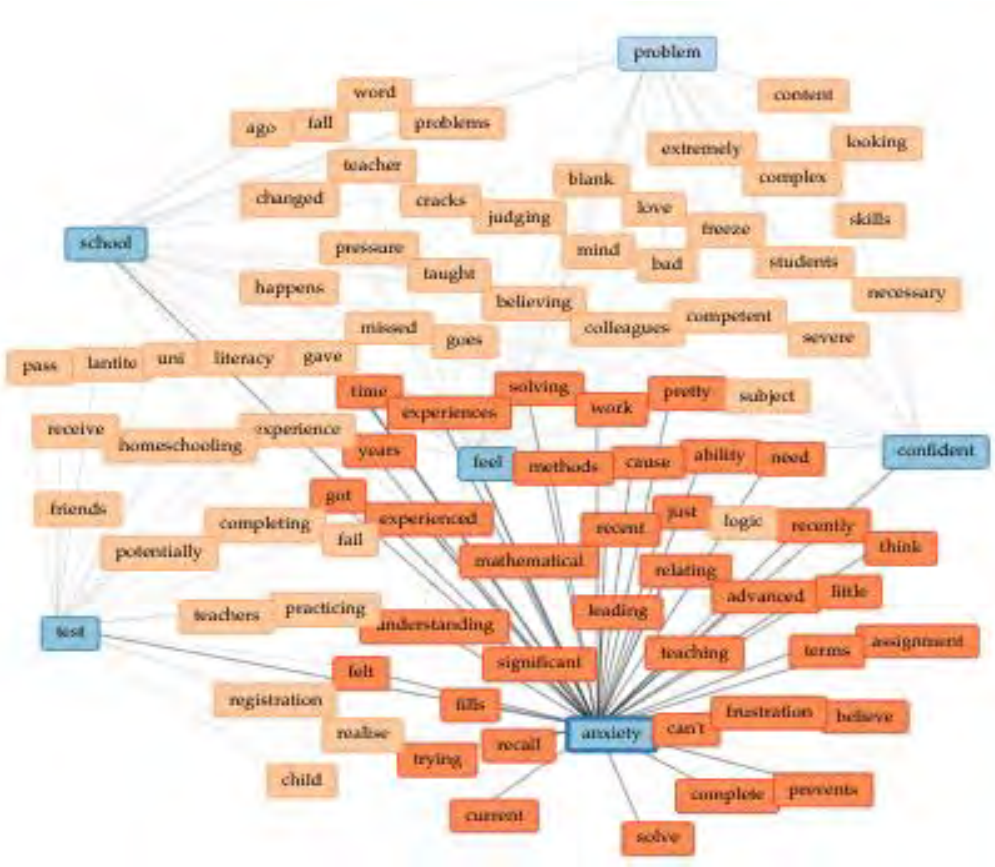

Figure 4. Links Among the Most Frequent Concepts

Based on these two figures, the words "school", "feel" and "test" were among the most frequently used words which were connected to word "anxiety". Analysing these relationships closely among the main and sub wordings used by PSTs while describing the reasons of their maths anxiety, it was clear that "testing" was closely related to words such as "friends, teachers, registration, university, Lantite, home-schooling, experience and practice" as well as "anxiety" itself. The word "anxiety" had shared words with the main words such as "feel" and "confident" while "school" has shared connections with "school" and "problem". The words "test", "school", "problem", "feel", "teacher", "work" "time", "need", "lantite", "think" and "understand" were the most important ones that were stated by PSTs.

The main themes change across females and males

Females have used the words "anxiety (16); feel (7); school (6); need (5); problem (5) in their written responses, the cirrus below summarises their responses.

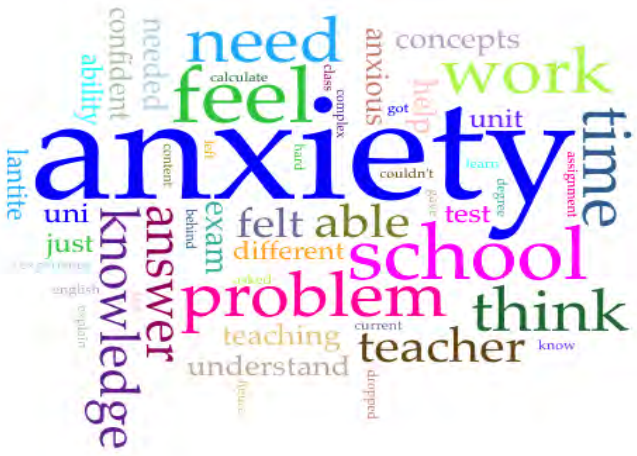

Figure 5. Cirrus of the Most Frequently Used Words by Females

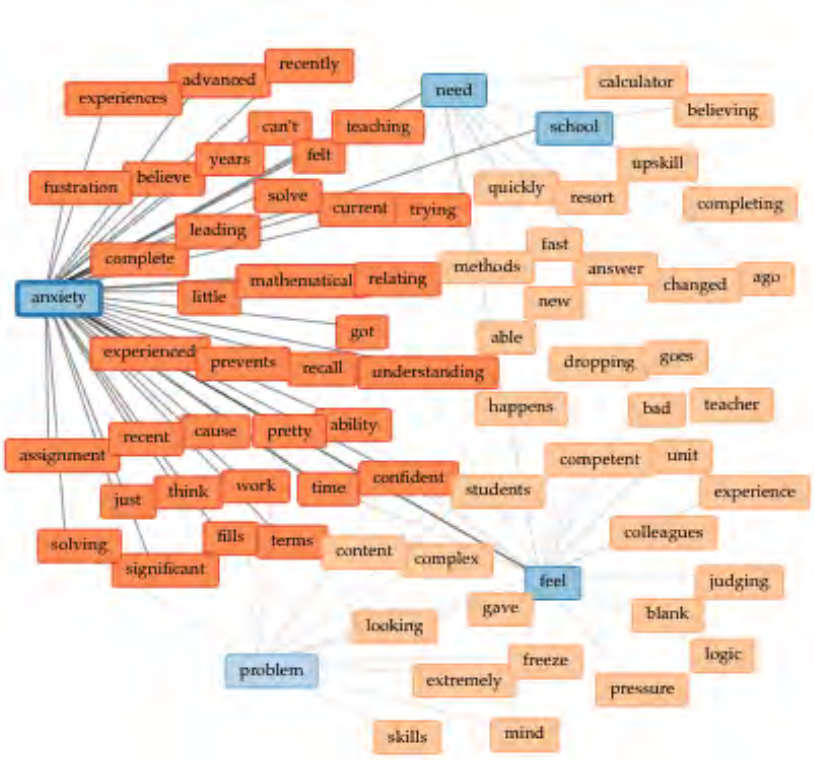

Figure 6. Links Among the Most Frequent Concepts Used by Females

The most frequent words in the corpus by males were “test (3); fail (2); numeracy (2); teachers (2); afraid (1)”.

Figure 7. Cirrus of the Most Frequently Used Words by Males

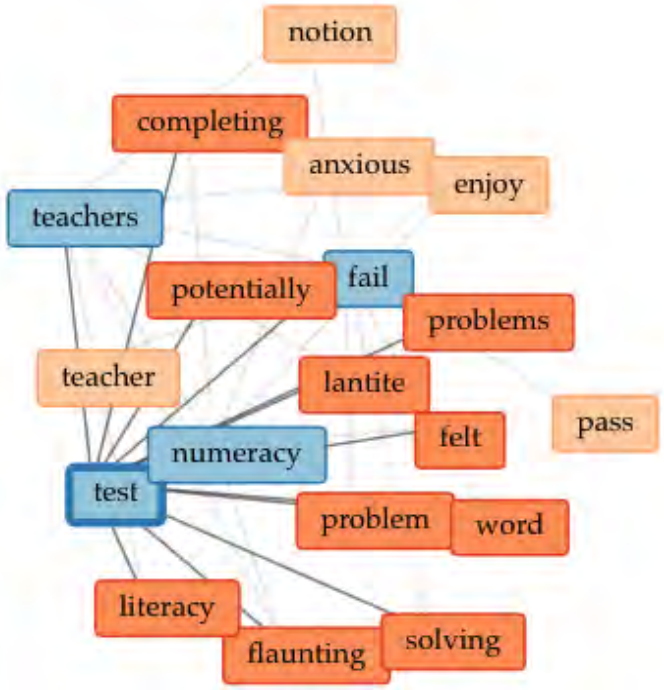

Figure 8. Links Among the Most Frequent Concepts Used by Males

When we compare the males and females' sources of mathematics anxiety, we found out that their sources vary. Females' maths anxiety was mostly focused on the words "need", "feel", "work", "school", "knowledge", "problem", "teacher" and "able" which can be an indication of general maths anxiety. Opposite to females, males' anxiety sources were mostly focused on the words "test", "teachers", "fail". Given the fact that there were only 8 males involved in this study, it is interesting to see how they all focused on tests anxiety rather than general maths anxiety.

Discussion

The main purpose of this study was to explore and understand the causes and resources of maths anxiety among preservice teachers. Not surprisingly we found that there is a negative correlation between mathematics anxiety and perceived mathematical content knowledge level meaning that low level of maths content knowledge causes high level of mathematics anxiety in PSTs which is parallel with some research findings in the literature (Geary et al., 2019; Wang et al., 2020). Our finding for the first research question aligns with existing literature suggesting that high maths anxiety associated with insufficient understanding of mathematics content knowledge (Kelly & Tomhave, 1985), there is a negative correlation between maths anxiety and maths performance in both Hembree's (1990) and Ma's (1999) meta-analysis. There are many factors affecting maths anxiety both cognitively and psychologically, however some studies also took attention to the quality of teacher education mathematics courses taught procedurally and lack of conceptual support (Bowd & Brady, 2003; Harper & Daane, 1998; Trujillo & Hadfield, 1999).

Mathematical content knowledge is also positively correlated with personal teaching efficacy (Newton et al., 2012). Gresham (2007) investigated the changes in levels of mathematics anxiety among pre-service teachers who took a mathematics method course that emphasized Bruner's model of concept development in early childhood/elementary education. The results from Gresham's (2007) study which posits that some students attributed their mathematics anxiety reduction to the methodology and the use of concrete manipulatives, some attributed this reduction to the enthusiasm of the professor and the inviting atmosphere of the class created by the professor and some others attributed their anxiety reduction to both.

Even though the majority of research on mathematics anxiety has been done in the USA more than everywhere in the world (Omitted for peer-review), there is a growing recognition in research regarding mathematics anxiety in Australia, but most of them are focused on how to teach mathematics rather than on teachers' mathematical content knowledge (Lowrie & Jorgensen, 2015. The quality of learning mathematics content knowledge impacts the quality of teaching mathematics (Hill et al., 2008). Not only the number of mathematics content courses are important but also the content of mathematics content courses taken has a stronger effect on preservice teacher's mathematical content knowledge (Qian & Youngs, 2016).

In response to the second research question, based on our PSTs' comments, we can conclude that majority of our PSTs (N=27) have low to middle level of anxiety while there are some (N=12) have high level anxiety regardless of their

gender. In terms of the mathematical content knowledge, majority of them (N=27) have perceived their maths ability at a high level whilst some of them (N=12) have seen their maths content knowledge at low to middle level regardless of their gender.

Although there was no statistical difference in terms of male and female PSTs perceptions regarding their anxiety and mathematics ability, their choice of wording to describe their resources of mathematics anxiety varied. While females mostly used the wordings associated with maths knowledge and school/social related mathematics anxiety, males mostly used the wording associated with test anxiety. In this current study, gender has found to be no impact on PSTs perceptions of mathematics anxiety and mathematics content knowledge, however it is clear that some students have put more emphasis on test anxiety than others which is consistent with previous research has been made on an Australian sample suggesting that Australian PSTs' situational anxiety during a test-taking is high (Review for peer-review).

In more detail, to respond third and fourth research questions, the emerged themes addressed this finding as well in a way that while two of these themes referred to LANTITE along with fear of tests and exams and time pressures to complete a problem task. In addition to these themes, it was not surprising to see PSTs reasons for their anxiety similar to the previous research such as school related bad experiences, worry about teaching mathematics in a real classroom, fear of failure in front of peers or teachers (Hadfield & McNeil, 1994) and learning/refreshing mathematics knowledge (Bursal & Paznokas, 2006; Gresham, 2007; Rayner et al., 2009).

Conclusion

It is important for teacher educators to understand the mechanism of maths anxiety to reduce it by noticing their student's individual circumstances. The fifth research question in this study is related to maths anxiety intervention strategies. Aligning with existing research, we believe putting more emphasis on understanding aspect of mathematics (conceptual) rather than using procedural and time limited tasks as well as using concrete manipulatives can significantly reduce PSTs' mathematics anxiety (Bursal & Paznokas, 2006; Hembree, 1990; Thompson, 1992). Mathematics anxiety can cause PSTs to avoid mathematics thus this can limit their future career options (Lefevre et al., 1992). It is not unfamiliar to see secondary mathematics teachers changing career to primary teachers because of their mathematics anxiety levels and even preferring to teach lower primary years than upper years. We also suggest that differentiating maths teaching according to needs of PSTs aligning with multiple intelligences (Gardner, 1983) can be a helpful tool along with using Bruner's model (Gresham, 2007). Teacher educators must adopt any models that have been suggested by research into their individual and unique teaching considering the diversity of students that they have at hand. Mentoring can be another useful strategy that teacher educators use to partner PSTs with supervising teachers who have the capacity to reduce their anxiety by engaging them into creative and differentiated lessons in confidence (Perkins, 2016). Group mentoring through a range of social media tools can also reduce PSTs mathematics anxiety, especially regarding test anxiety.

Our study adds to the existing literature regarding causes of mathematics anxiety in preservice teachers (Hadfield & McNeil, 1994) by revealing and extending the reasons of maths anxiety in more detail ("Bad mathematics experience at school/university/workplace that induced anxiety"; "Not wanting to be wrong/fear of failure in front of peers or teachers"; "Fear of tests and exams - pressure of the LANTITE"; "Wondering about how to teach the subject in contemporary classrooms"; "Nervous about revising /refreshing skills and knowledge - no recent engagement in mathematics"; "Time pressures to complete a problem task") as well as showing that there were no gender differences in PSTs' perceptions of maths anxiety and mathematics ability.

Recommendations

The following recommendations are offered to mathematics teachers considering the findings of this study:

- Anxiety can be reduced by being positive but not overly demanding, therefore, one-to-one communication can be provided to help reduce anxiety. There is still a gap in the existing literature around the effect of using anxiety reducing intervention strategies. More research is needed to be conducted to help reduce anxiety in all schooling levels and tertiary education.
- Given that anxiety begins in childhood and continues throughout people's lives, more studies can be conducted to emphasize the importance of mathematics teachers' attitudes toward learners and the subject.

Limitations

There are limitations to this study (considering the results are based on an Australian sample), this study informs theory and models regarding the reasons of mathematics anxiety of preservice teachers hence it provides a good learning opportunity for us as teacher educators to improve teacher preparation aspects to reduce PSTs' mathematics anxiety levels whilst increasing their mathematical content knowledge along with their pedagogical content knowledge. We would like to further research on the intervention strategies to reduce maths and test anxiety among preservice

and newly graduated teachers. Future studies also should focus large cross-cultural samples to understand how mathematics anxiety functions in teacher education programs and add on the existing literature further.

Author Contributions

All authors listed, have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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