

Investigating Pre-service Teachers' Mathematics Anxiety Using the Revised Mathematics Anxiety Scale (RMARS)

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Pre-service primary (elementary) teachers' mathematics anxiety affects their engagement with and future teaching of mathematics. The study measured the range of mathematics anxiety in 219 pre-service teachers starting a teacher education course in an Australian university. They responded to the Revised Mathematics Anxiety Scale (RMARS) and a set of demographic questions. Age differences in anxiety were found to be significant, and relationships were found between the RMARS scores and students' self-perceptions of their current mathematics anxiety levels.

Mathematics is essential for everyday life. Failure in mathematics can have a powerful emotional impact that may extend far beyond the mathematics classroom (Boaler, 1997), culminating for many in an ongoing state of mathematics anxiety.

Mathematics anxiety is an important research topic in the mathematics education community. Many students suffer from mathematics anxiety and this seems to be independent of whether they are good at mathematics or not (Furner, 1996).

Pre-service primary (elementary) teachers' mathematics anxiety has important impacts on their studies and on their future students. Previous research has investigated the use of bibliotherapy to address pre-service teacher mathematics anxiety (Wilson & Thornton, 2008; Wilson, 2007). This paper, part of a larger project to build on that research, examines the range of first year primary pre-service teachers' (PST) mathematics anxiety.

Theoretical Framework and Literature Review

This research is located at the intersection of the literature on the impacts of mathematics anxiety on primary teacher mathematics education, and bibliotherapy.

Mathematics Anxiety

Mathematics anxiety is more than a dislike for mathematics (Vinson, 2001). Among the early researchers of mathematics anxiety, Dreger and Atkin (1957, p. 344), identified "emotional reactions to arithmetic and mathematics". Richardson and Suinn, (1972, p. 551) elaborated "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". Smith (1997) characterises mathematics anxiety in a number of ways ranging from uneasiness when asked to perform mathematical task, to avoidance, feeling of physical illness, dread and panic, thus theoretical models of mathematics anxiety have multidimensional forms that incorporate attitudinal (dislike), cognitive (worry) and emotional (fear) aspects, (Hart, 1989; Wigfield & Meece, 1988).

Gender differences in mathematics anxiety have been extensively studied. The results are inconsistent, with a number of studies reporting that females have higher levels of mathematics anxiety than males (for example, Alexander & Martray, 1989) and others not confirming significant differences. Baloglu and Kocak (2006), controlling for mathematics experience, found that gender effects of mathematics anxiety varied with the context. Age is another factor where contradictory findings are reported in the literature. Hembree, (1990),

did not find any age-related differences, but Baloglu and Kocak (2006) found that older students exhibited more total mathematics anxiety than younger ones, particularly in mathematics testing and course situations.

Impact of Teaching

Mathematics anxiety has been associated with inappropriate teaching practices (Hasbee, Sam, Nur, & Tan, 2009, Uusimaki & Nason, 2004). The teacher's attitude has been identified as a major factor (Vinson, 2001). Teachers' beliefs about their own ability are significant in their approach to teaching mathematics and can produce unwillingness to teach upper primary classes (Wilson, 2009).

High mathematics anxiety impacts on performance and achievement in mathematics (Betz, 1978; Ma, 1999; Sheffield & Hunt, 2006). Mathematics anxiety is related to success in higher education (Stubblefield, 2006). Students with high mathematics anxiety avoid mathematics in their courses and careers (Scarpello, 2005). Researchers have found that high levels of teacher mathematics anxiety can be perpetuated in classrooms (for example, Martinez, 1987, Furner & Berman, 2005). Therefore, "preventing math anxiety begins by helping teachers confront and control their own fears of math" (Martinez, 1987, p. 117).

Many students come to tertiary teacher education with limited mathematics understandings, and a pattern of avoidance and anxiety. Researchers of primary PST report high levels of mathematics anxiety, low confidence levels to teach mathematics and low mathematics teacher efficacy. For a more detailed discussion of these issues see Wilson (2009). This affects not only their current study but also their future teaching of mathematics and hence the attitudes of their future students. Researchers have identified teacher preparation programs as sources of mathematics anxiety (Uusimaki & Nason, 2004, p. 370). Dunkle (2010) warns of the consequences of this:

A model of anxiety with regard to mathematical concepts can be passed on to the next generation of students by their teachers. Thus, there is an urgent need to overcome this anxiety in preservice teachers so that they may more appropriately model their skills to their students, and thus break the cycle of math anxiety that appears to be becoming generational in nature. (p. 14)

The way individuals perceive themselves as learners of mathematics is integral to their subsequent identity as teachers. In previous research (Wilson & Thornton, 2008; Wilson, 2007) many PST described an interaction during their schooling that led to them identifying themselves as persons who couldn't learn mathematics, and said that this still impacted on their self-images as future teachers of mathematics. Some of the consequences of these experiences can be seen in their levels of mathematics anxiety and self-perceptions as future teachers of mathematics. Identities remain open to revision during the time of their course. Hence, Walshaw (2004, p. 557) argues that "teacher education must engage the identities of pre-service students".

In summary, PST with mathematics anxiety are less likely to engage with mathematics, and have low confidence and low self-efficacy, impacting on their identity as teachers of mathematics. It is for these reasons that teacher education has become a crucial site for further research.

Mathematics Anxiety Scales

Researchers have sought way to assess levels of mathematics anxiety. Anxiety is a construct and not able to be measured directly. We have international units and standards for some measurements, but to attempt to quantify a construct such as anxiety is much more problematic. Observed or reported activities lead to inference of anxiety in anxiety scales.

Dreger and Atkin, (1957), developed the first standardised mathematics anxiety instrument, the Number Anxiety Scale. In 1972, the Mathematics Anxiety Rating Scale, (MARS), a major scale used in research and clinical studies, was developed by Richardson and Suinn. It has been widely used with high reliability and validity reported.

Alexander and Martray developed the Revised MARS in 1989, by reducing the original 98-item MARS (Richardson & Suinn, 1972), to 25 items. The original MARS was found to be time-consuming to administer because of its length. It also interpreted mathematics anxiety as one factor. The RMARS measures three factors - mathematics test anxiety, numerical task anxiety and mathematics course anxiety. The RMARS has been widely used in academic research, rigorously tested, and found to be psychometrically sound (Revak, 1996; Bowd & Brady, 2002; Haynes, 2003, Baloglu & Kocak, 2006). Baloglu and Zelhart (2007) reported that the RMARS “was found to be a valid and reliable measure of college students’ mathematics anxiety levels” (p, 608). They reported that, based on reliability investigations, the total scale and subscales were highly reliable, and they confirmed the three-factor structure. Recently, Dunkle (2010) used the RMARS to provide valid and reliable results for measuring PST math anxiety over time. A range of other instruments has been developed but their analysis is beyond the scope of this paper.

Bibliotherapy

Bibliotherapy is a technique that was developed in psychology (Shrodes, 1950), and library science. It involves guided reading of written materials used in gaining understanding or solving problems, followed by individual or group discussion in a non-threatening environment. Previous research used bibliotherapy during mathematics units for PST to examine their attitudes towards themselves as learners and teachers of mathematics (Wilson & Thornton, 2008; Wilson, 2007). Changes in response to the bibliotherapy process in previous research strongly suggest the importance of insight as a major factor in bringing about a positive projective identity. Identity brings together affective qualities and cognitive dimensions. Ricoeur (1994) suggests that people make sense of their own personal identities in a similar way to their understanding of the identity of characters in stories.

The Study

This paper reports the first stage of ongoing research investigating maths anxiety in PST in education courses in an Australian university. The project aims to investigate the range of anxiety that first year PST feel towards mathematics, and ways that they might change the way they approach their mathematics studies. The study will explore the use of bibliotherapy as a tool for reflecting on and changing affective responses to mathematics and enhancing primary PST engagement with mathematics in their university mathematics units.

Research Questions

In this mixed methods study, bibliotherapy will be used as a tool for addressing affective responses to mathematics. The goal is to understand what influences bibliotherapy has on PST in their engagement with mathematics units and their beliefs, and its impact on their developing professional identity. The following research questions will be investigated:

1. With what range and extent of mathematics anxiety do PST present?
2. What influenced the way PST think about themselves as a learner and potential teacher of mathematics?
3. What do PST identify as causes of their mathematics anxiety?

4. How do PST describe their mathematics anxiety experiences?
5. How do PST with high levels of mathematics anxiety respond to bibliotherapy readings?
6. How do PST describe their experiences of bibliotherapy that lead to reduced anxiety?
7. Does bibliotherapy lessen the level of PST maths anxiety as measured by the short MARS-R?

Four instruments will be used:

1. Participants will be surveyed at the start and the end of the year with an instrument to collect data on student mathematics anxiety. They will be asked to rank the extent to which they feel anxiety about activities involving maths, and to score their anxiety about mathematics.
2. PST who volunteer to take part in the extended project will complete a critical incident report, via email, on a past experience that contributed to their self-perceptions as a learner and teacher of mathematics.
3. PST on-line reflections and discussions will be stimulated by selected readings on mathematics anxiety, and will be posted in an on-line forum with access limited to the volunteer group.
4. Semi-structured interviews after the first mathematics unit, will focus on the insights that the PST developed as part of the bibliotherapy process. The reflections and interviews will be related to the outcomes of previous research using the bibliotherapy framework.

This paper reports the results of the first part of this project, which aimed to investigate the range of anxiety that first year PST feel towards mathematics, using the RMARS survey.

Methods

The Sample

Two cohorts of PST were the samples for the study. They comprised first year primary PST enrolled in the Bachelor of Education (Primary) degree course, from two campuses of an Australian university. Sample 1 came from a regional campus and Sample 2 from a metropolitan campus. Samples of 57 (98% response rate) and 162 (94% response rate) completed the survey instrument. They were surveyed in first few weeks of the first semester of their university course.

Instrument

A range of mathematics anxiety surveys was considered and RMARS (Alexander & Martray, 1989) was chosen because of its length, fit with the research question, appropriateness for group and strong psychometric information. The RMARS is a 25-item, five point (1 = not at all, to 5 = very much) Likert-type instrument. It has three sub-scales Mathematics Test Anxiety (items 1-15); Numerical Task anxiety (items 16-20); and Mathematics course anxiety (items 21-25). The original RMARS was used with minor modifications for the Australian context. The RMARS rating forms and a set of demographic questions were used in the study. These asked for information such as age and gender, and mathematics courses studied in high school, and the number of years/months since their last mathematics course.

Procedure

Ethics approval was obtained from the university ethics committee, and agreement to use the RMARS survey was received from the author. In addition to the survey the PST were asked to rate their general mathematics anxiety level, confidence and current mathematics anxiety level after completing the questions on a scale between 0 and 100, where higher scores related to higher levels. As current literature suggests that mathematics anxiety is a transitory-state construct (Baloglu & Zelhart, 2007), this question sought to obtain a measure of the mathematics anxiety that PST were currently experiencing when completing the survey.

Data were coded onto an excel spreadsheet and arranged so they could be analysed with the software program Statistical Package for Social Sciences (SPSS) 20.0.

Results and Discussion

Means and standard deviations for the total scale scores on the RMARS were computed. The PST exhibited a broad range of anxiety levels. Scores ranged from 31 - 116, with a mean score of 66.48 and a standard deviation of 16.74.

Comparing PST from the two campuses, Sample 1 had a mean score of 66.02 and a standard deviation of 19.19, and sample 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. Sample 1 and sample 2 were statistically equivalent on the total RMARS scores, ($p < 0.25$), as well as the three subscales (Mathematics Test Anxiety (MTA), $p < 0.33$; Numerical Task Anxiety (NTA), $p < 0.09$; and Mathematics Course Anxiety (MCA), $p < 0.73$). These results indicate that there is a wide range of mathematics anxiety within the cohorts, but that the cohorts as a whole are not significantly different.

Gender differences were examined for the total scale scores on the RMARS as well as the three subscales. 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, $p < 0.30$). The results for gender differences reported by researchers vary and this underlines the complexity of this issue.

Significant differences were identified between age cohorts. For the purpose of this study, and in line with published research, mature-age PST were defined as those 25 years and over. Age differences were examined for the total scale scores on the RMARS as well as for the three subscales. The older group demonstrated higher levels of mathematics anxiety than the younger group. Figure 1 shows the percentages of the younger (SL) and mature-age (Mature) cohort's anxiety scores at each level of anxiety.

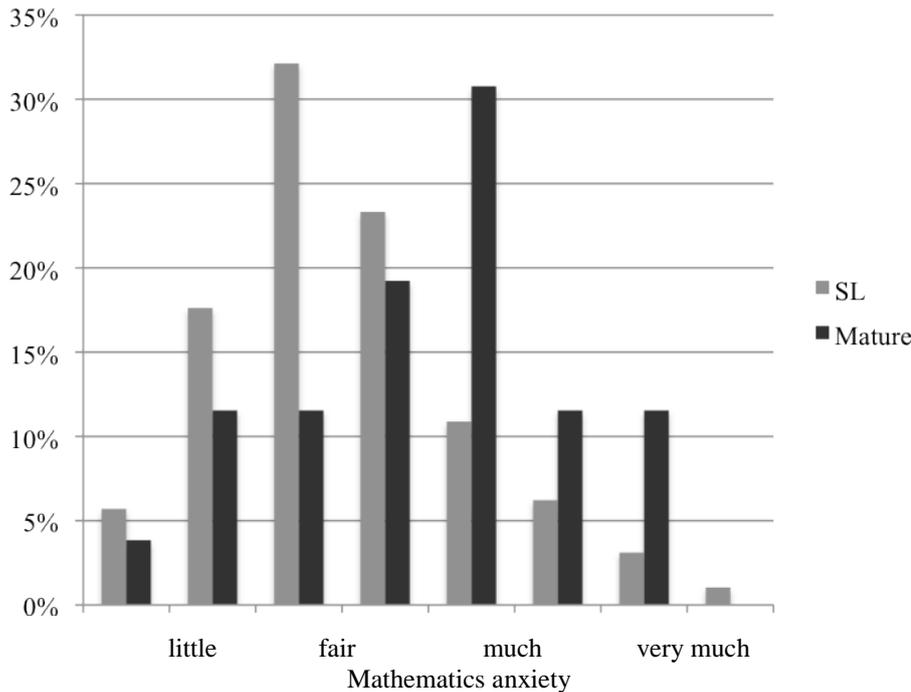


Figure 1. Percentages of mathematics anxiety scores of younger (SL) or mature age (Mature) PST.

Significant differences at the 95% level were found between the scores of the younger (mean 62.44, standard deviation 17.73) and mature-age (mean 73.58 standard deviation 19.75) on the total RMARS scores, ($p < 0.003$); and on the three subscales (MTA, $p < 0.035$; NTA, $p < 0.001$; and MCA, $p < 0.016$), with MTA and MCA significant at the 95% level and NTA significant at the 99.9% level. This supports the findings of Baloglu and Kocak (2006) that older college students show higher levels off mathematics anxiety than younger ones, however they reported that MTA and MCA contributed more to the anxiety of their older cohort than NTA.

Concurrent validity of the instrument was investigated by examining the relationships between the RMARS scores and students' self-perceptions of their general and current mathematics anxiety levels, using paired t-tests. The analysis showed that there was a correlation between the PST' estimates of their general levels of mathematics anxiety and their current level of mathematics anxiety. The RMARS scores were significantly different to the general mathematics anxiety level rating ($p < 0.009$), but not to their current level of mathematics anxiety. This indicates that the RMARS scores were a better indication of their perception of their current level of mathematics anxiety, than their general level.

Conclusions

This research reports on preliminary data on the range of mathematics anxiety experienced by PST in their first few weeks of their teacher education course at university, and shows that in some cases these anxieties may present differently when taking a mathematics test, doing mathematical computations, or undertaking a mathematics course. Teacher educators should be aware of the extent of range of anxiety that PST experience at the beginning of their teacher education course, and especially that mature-age PST experience anxiety differently in mathematics courses compared to younger PST, and hence

the needs of mature-age students coming in to teacher education may be different to those of younger students.

The next part of the study will involve the bibliotherapy approach, which is relatively unexplored in mathematics teacher education. The findings from this study will shed light on the extent to which bibliotherapy can foster a more positive orientation towards mathematics in pre-service teachers. As Wolodko, Willson and Johnson (2003) write “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).

Of particular interest to teacher educators will be the impact of the participation in writing about experiences and reflections on the development of PST evaluations of themselves as future teachers of mathematics, and sharing these with a supportive on-line community. The reflections produced during the project will be used, with permission, as tools for developing teacher educators and teachers’ personal and professional knowledge. This has the potential to transform learning and teaching beyond that of the PST to their future teaching of mathematics and hence the attitudes of their future students. It is also anticipated that examples related to reflective practice and developed during this project may be useful for a wider audience of teacher educators and PST, extending the strategies available in teacher education courses to address mathematics anxiety.

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