Mature Age Pre-Service Teachers' Mathematics Anxiety and Factors Impacting on University Retention

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The ability of primary (elementary) pre-service teachers to engage effectively in mathematics units in a rigorous program is vital to producing citizens who are able to use mathematics effectively in their lives. Mathematics anxiety affects pre-service primary teachers' engagement with and future teaching of mathematics. The study measured the range of mathematics anxiety in two hundred and nineteen pre-service teachers starting a teacher education course in an Australian university. They completed the Revised Mathematics Anxiety Scale (RMARS) and a set of demographic questions. Age differences in anxiety were found to be significant, and this has implications for university retention of mature age pre-service primary teachers.

Successfully engaging with mathematics has social, economic and political implications, as "… in this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures" (NCTM 2000, p. 5). Ensuring students develop productive relationships with mathematics is vital not only for making informed decisions in their daily lives, but for their future employment. As Minton notes: "Processing of information, problem solving, and using numbers and symbols to communicate are becoming routine job requirements" (2007, p. 4).

Anxiety towards mathematics has been identified as an issue nationally and internationally. Previous research on addressing pre-service teacher (PST) mathematics anxiety (maths anxiety) has been reported in national reviews of mathematics education research (Lomas, Grootenboer & Attard, 2012). High maths anxiety impacts on performance and achievement in mathematics (Betz, 1978; Sheffield & Hunt, 2006) and maths anxiety is related to success in higher education (Stubblefield 2006). This is an important issue for teacher educators. The Australian Institute for Teaching and School Leadership (AITSL) have stated that universities need to establish arrangements to ensure PSTs have the required standard of numeracy to engage effectively in mathematics units in a rigorous program, (AITSL, 2011).

This paper is part of a more extensive study that investigates how Australian PSTs' experiences of maths anxiety impact upon their orientations to and engagement with mathematics learning. Previous research has investigated the use of bibliotherapy to address pre-service teacher maths anxiety (Wilson & Thorton, 2008, Wilson, 2012a,b). This paper, reports the first part of part of a larger project to build on that research, examines the range of first year primary PST maths anxiety at the beginning of their course, and its impact on their engagement with their mathematics units.

Conceptual framework and literature review

This research is relevant to studies on student retention and the literature reporting the impacts of maths anxiety on mathematics education.

Student retention

Student retention 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). The investigation of factors impacting on mature age students connects with the current debate on attrition and retention. Krause (2005) investigated factors that identified first year students who were more likely to consider withdrawing. These were students who have money worries, have to spend more time in paid work, don't make a smooth adjustment to university and do not develop a sense of belonging by being involved in extra-curricular activities. In investigating mature age students, Crosling, Heagney and Thomas (2009) reported students 25 years and over are more likely to be the first in their family to have attended university, are more likely to be enrolled part-time (32% compared with 4%), and that 50% have dependants. James, Krause and Jennings (2010) found that although mature age students often express satisfaction with their courses, they are less likely to engage in collaborative study and are more likely to report that they keep to themselves at university (41% compared with 28%) and are uninterested in extracurricular activities. They are more likely to "have withdrawn from a subject", and to "experience money worries and find it stressful managing their study and other commitments" (p. 69).

The correlation between the profile of mature age students and the factors implicated in student withdrawals indicates the need for further investigation. The issue of mature age students and their persistence in tertiary studies has emerged, and Krause (2005) recommends that further research should investigate whether this issue is a possible variable that should be incorporated into the current debate on attrition and retention.

Maths anxiety

Failure can have an emotional impact far beyond the mathematics classroom (Boaler, 1997), culminating for many in maths anxiety. Many students suffer from maths anxiety and this seems to be independent of whether they are good at mathematics or not (Furner 1996). Students with high maths anxiety avoid mathematics in their courses and careers (Scarpello 2005). Maths anxiety is a complex phenomenon that has been studied by many researchers. It takes the form of more than just a dislike for mathematics (Vinson 2001). Among the early researchers of maths anxiety, Dreger and Atkin (1957, p. 344) identified "emotional reactions to arithmetic and mathematics", and 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". Theoretical models of maths anxiety have multidimensional forms that incorporate attitudinal (dislike), cognitive (worry) and emotional (fear) aspects, (Wigfield & Meece, 1988; Hart, 1989).

Maths 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), and teachers' maths anxiety can result in their being

unwilling to teach upper primary classes (Wilson, 2009). Jackson and Leffingwell (1999) found that the instructors' role is one of the most common factors affecting maths anxiety. Thus, "preventing math anxiety begins by helping teachers confront and control their own fears of math" (Martinez, 1987, p. 117), especially as high levels of teacher maths anxiety can be perpetuated in classrooms (Martinez, 1987, Furner & Berman, 2005). Hence, teacher education is a crucial site for research.

PSTs' maths anxiety has important impacts on their studies and on their future students. The way individuals perceive themselves as mathematical learners is important. In previous research (Wilson & Thornton, 2008) mature-age PSTs described an interaction during their primary schooling that caused them to think they couldn't learn mathematics, and said that, even thirty years later, this still affected their levels of maths anxiety and self-perceptions as future teachers of mathematics.

Many PSTs come to tertiary teacher education with limited mathematics understandings, and a pattern of avoidance and anxiety. In addition, researchers have identified teacher preparation programs as sources of maths anxiety (Uusimaki & Nason, 2004). Researchers of primary PSTs report high levels of maths anxiety, low confidence levels to teach mathematics and low mathematics teacher efficacy, (for a more detailed discussion see Wilson, 2009). PSTs with maths anxiety are less likely to engage with mathematics. This affects not only their current study but also their future teaching of mathematics and hence the attitudes of their future students. 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).

A range of instruments has been developed to assess levels of maths anxiety. Maths anxiety is operationalised by observed or reported activities, which lead to the inference of anxiety. In 1972, the Mathematics Anxiety Rating Scale, (MARS), a major scale used in research and clinical studies, was developed by Richardson and Suinn (1972) and validated with tertiary students. It has been widely used with high reliability and validity reported. Alexander and Martray developed the Revised Mathematics Anxiety Rating Scale (RMARS) in 1989 by reducing the original 98-item MARS to 25 items. Initial construct validity was obtained from a sample of undergraduate students. The RMARS has been widely used in academic research, rigorously tested, and found to be psychometrically sound (Bowd & Brady, 2002; Haynes, 2003, Baloglu & Kocak, 2006).

Unlike the MARS, which views the underlying construct of maths anxiety as unidimensional, the RMARS assumes the multidimensionality of the construct. It has three subscales for mathematics test anxiety (MTA), numerical task anxiety (NTA) and mathematics course anxiety (MCA), (Alexander & Martray, 1989, confirmed by Baloglu, 2002). Dunkle used the RMARS to provide valid and reliable results for measuring PST mathematics anxiety over time, and concluded: "Perhaps the single best overall tool for measuring math anxiety in the literature, after several confirmatory psyochometric studies, is the R-MARS total score." (2010, p. 113).

Studies on gender differences in maths anxiety have not produced consistent results, although a number of studies reported that females have higher levels than males. Alexander and Martray (1989) found female undergraduates have significantly higher levels of maths anxiety than male undergraduates, and Brady and Bowd (2005) reported that female final year education students scored significantly higher than males. Baloglu

and Kocak (2006), controlling for mathematics experience, found that gender effects of maths anxiety varied with the context. They reported multivariate differences between men and women, after adjusting for the differences in previous mathematics experiences. Female students showed significantly higher MTA, whereas male students were significantly higher in NTA.

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 maths anxiety than younger ones, particularly in mathematics testing and course situations. They reported that MTA and MCA contributed more to the anxiety of their older cohort than NTA did.

The study

As part of an ongoing research project investigating maths anxiety in PSTs in education courses, and ways that they might change the way they approach their mathematics studies, this paper reports the results of the first part of this project, which investigated the range of anxiety that first year PSTs feel towards mathematics, using the RMARS survey (see also Wilson, 2012a).

Research questions

The goal of this study was to investigate the level of maths anxiety PSTs bring to their teacher education courses. The following research questions were investigated:
1. With what range and extent of mathematics anxiety do first year PSTs come to university?
2. How does maths anxiety vary as a function of age?

Methods

The sample

The participants were two cohorts of primary PSTs in the first year of their Bachelor of Education (Primary) degree course, from two campuses of an Australian university. The PSTs were not studying any mathematics units in the first semester of their course. Sample 1 of 57 students (45 females: 12 males) came from a city in a regional area and Sample 2 of 162 students (140 females: 21 males: 1 not specified) was from a campus in a major metropolitan city. Response rates were 98% (Sample 1) and 70% (Sample 2). They were surveyed during the first few weeks of their university course. In the survey, PSTs were asked to rank the extent to which they felt anxiety about mathematics activities. In line with published research, mature-age PSTs were defined as those 25 years and over.

Instrument

The RMARS (Alexander & Martray, 1989) was chosen for the survey 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. Thus, potential Total Anxiety scores range from "not at all" = 25, to "very much" = 125. It has three sub-scales MTA, (items 1-15), NTA, (items 16-20), and MCA, (items 21-25). Possible scores for MTA could range from 5-45, and for NTA and MCA could range from 5-25. The RMARS was used with minor modifications for the Australian context. A set of demographic questions was also used in the study. These asked for

information such as age, gender, 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. Participants were surveyed at the start of the year. Data were coded onto an excel spreadsheet and analysed with the software program Statistical Package for Social Sciences (SPSS) version 20.0.

Results and discussion

Means and standard deviations for the total scale scores on the RMARS were computed, and are summarised in Table 1. Total Anxiety scores ranged from 31 - 116, with a mean score of 63.32 and a standard deviation of 16.74. The PSTs exhibited a broad range of anxiety levels, ranging from almost no maths anxiety to very high levels of anxiety.

Table 1
Total Anxiety Scores as measured by the RMARS

PST samples	range	mean	S. D.
Total PST	31-116	63.32	16.74
Campus 1	31-104	66.02	19.19
Campus 2	34-116	62.78	17.86
Females	31-116	64.01	18.44
Males	35-108	62.24	17.90
Less than 25 years	31-116	62.44	17.73
25 years and over	35-112	73.58	19.75

An independent-samples t-test was conducted to compare campus, gender and age differences in maths anxiety. Campus 1 had a mean score of 66.02 and campus 2 had a mean score of 62.78. There is a wide range of maths anxiety within the cohorts but no significant differences in Total Anxiety were found between the cohorts from the two campuses, which were statistically equivalent on the total RMARS scores, as well as the three subscales (MTA, NTA, and MCA). 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, nor on the three subscales. Previous findings of gender differences in the RMARS scores (Alexander & Martray, 1989; Brady and Bowd, 2005; Baloglu and Kocak, 2006) were not supported by these results.

The results of analysis of age differences in total and in the three factors are shown in Table 2. Significant differences were identified between age cohorts. The older group demonstrated higher levels of mathematics anxiety than the younger group. They also had larger standard deviations reflecting the greater spread in mature-age PST anxiety levels. Statistically significant differences were found between the scores of the younger and mature-age PSTs 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 PSTs receiving higher scores. This supports the findings of Baloglu and Kocak (2006) that older college students show higher levels of mathematics

anxiety than younger ones, although they reported that MTA and MCA were more instrumental in the anxiety of their older cohort than NTA.

Table 2

Means and Standard Deviations* of the Revised Mathematics Rating Scale and its Subscales

Factors	Groups	
	Younger than 25 years (n=193)	25 years and older (n=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.

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Conclusion

This research reports on preliminary data on the range of mathematics anxiety experienced by PSTs 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 PSTs experience at the beginning of their teacher education course, and especially that mature-age PSTs experience anxiety differently in mathematics courses compared to younger PSTs, and hence the needs of mature-age students coming in to teacher education may be different to those of younger students. This is important in considering factors that can increase the retention of mature age students. It is recommended that further research should investigate how the level of maths anxiety in mature-age students might contribute to the factors that impact on attrition and retention discussed by Krause (2005).

This has the potential to make an important contribution to the strategies available in teacher education courses to address maths anxiety. Of particular interest to teacher educators will be further research on the impact of levels of maths anxiety on engagement of PSTs in their mathematics units, and their participation in writing about their experiences and reflections on the development of themselves as future teachers of

mathematics, potentially transforming learning and teaching beyond that of the PST to their future teaching of mathematics and hence the attitudes of their future students.

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