

# Feeling Good about Teaching Mathematics: Addressing Anxiety amongst Pre-Service Teachers

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## Abstract

Research regarding pre-service teachers' attitudes towards teaching mathematics has revealed that many pre-service teachers experience high levels of mathematics anxiety about both the learning of mathematics and the teaching of the mathematics curriculum. Little is known about the particular characteristics of pre-service teachers that make them more likely to experience anxiety about mathematics in the early years. Addressing anxiety towards mathematics and the teaching of mathematics could effectively eliminate later problems in teaching. Teaching mathematics confidently is associated with teachers' beliefs about their mathematical ability, which is their mathematical self-efficacy. This paper reports on an investigation into the anxiety of first-year pre-service teachers towards their future teaching of mathematics. 223 students enrolled in a first-year mathematics unit for birth to eight years, in the Bachelor of Education of Early Childhood and Primary Education Courses attributed their beliefs about mathematics to external—their past teachers—or internal factors: that one is either good at mathematics or not. The findings highlight the need for pre-service teacher's anxiety about mathematics to be addressed within the university education classroom context so that pre-service teachers become capable and competent teachers of mathematics.

## Keywords

Mathematics Anxiety; Teacher Education; Mathematical Self-Efficacy

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## 1. Introduction

Understanding mathematics is recognised as being important in everyday life, and cuts across many professional

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occupations including engineering, medicine, science and education. There is a strong societal expectation that teachers themselves will be competent at mathematical skills, have a deep understanding of mathematics, and be able to teach effectively so that their students are successful in mathematics. Furthermore, it is widely accepted that having good understanding and knowledge of mathematics, and confidence in one's ability to learn mathematics, are of prime importance for teachers (Wilson, 2009). Results from the Programme for International Student Assessment, Pisa (OECD, 2010) indicate that Australia ranked significantly above the OECD average for mathematics for 65 countries, but did not score as well as Singapore, Korea, Finland and New Zealand. Mathematics is a priority area for the national curriculum in Australia and viewed as essential for providing a solid foundation in education (knowledge, skills and values) and life-long learning (ACARA, 2011). There is concern, however, that standards need to lift in mathematics education. Nobel Laureate Brian Schmidt has warned that it was important to "make sure the skill set of teachers ... is there and, if not, we need to train them up" (Schmidt, 2012).

Children need to be exposed to mathematical concepts prior to formal schooling (Lago & DiPerna, 2010), and the Early Years Learning Framework (EYLF) (DEEWR, 2009) identifies that early childhood educators need to have "a rich mathematical vocabulary to accurately describe and explain children's mathematical ideas and to support numeracy development" including "spatial sense, patterning, number, measurement, data argumentation, connections and exploring the world mathematically" (p. 38). Educators thus need to be fluent in mathematical concepts, and this should be addressed in early childhood educators' preparation in mathematics teaching needs to improve (Gülteke, Tomul, & Korur, 2013; Lee & Ginsburg, 2009).

## 2. Theoretical Background

Students' beliefs and attitudes to mathematics, that is their self-efficacy (Bandura, 1997), affects one's teaching of mathematics, and many people suffer from anxiety about mathematics (Goos, Smith, & Thornton, 2008). Self-efficacy influences one's personal approach to mathematics. Based on Bandura's theory (1997), Warwick (2008: pp. 31-32) asserts there are four main areas of mathematical self-efficacy comprised of:

1) Performance experience derived from the level of success in mathematics where successful achievement strengthens self-efficacy, and repeated failures weakens it.

2) Vicarious experience obtained when students compare themselves with others on maths scores which affects self-efficacy negatively or positively.

3) Verbal persuasion which relates to feedback from others on one's mathematical ability

4) 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.

Much of the discussion regarding pre-service teachers and mathematics is centred on mathematics anxiety, and if not addressed in the teacher, is thought to be transferred from teacher to student with immediate and long term educational implications (Sloan, Daane, & Giesen, 2002; Vinson, 2001; Warwick, 2008). The most often used definition of mathematics anxiety is that of Richardson and Suinn's (1972), who describe mathematics anxiety as "feelings of tension ... that interfere with the manipulation of numbers and solving mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). These authors devised a tool to measure mathematics anxiety, called the Mathematics Anxiety Rating Scale (MARS). Numerous studies have investigated anxiety and negative attitudes to mathematics (Bekdemir, 2010; Uusimaki & Kidman, 2004; Uusimaki & Nason, 2004; Wilson, 2009), some finding that these negative attitudes were found to affect a high proportion of students preparing to be teachers (Trujillo & Hadfield, 1999 in Townsend et al., 1999). Some studies suggest that having some anxiety, that is low level anxiety, about teaching mathematics is beneficial in that it is a motivator to engage more deeply in the course of the unit to reach an understanding of the discipline and be a better teacher than they had experienced (Young-Leveridge, 2010).

Pre-service teachers in the USA and Australia experience higher levels of mathematics anxiety than other university undergraduate students (Gresham, 2007), with the incidence of mathematics anxiety significantly higher among elementary (early years) education students (Swars, Hart, Smith, Smith, & Tolar, 2007). Research has identified reasons for pre-service teachers experiencing mathematics anxiety: past experiences of failing mathematics (Bekdemir, 2010); the pedagogical approach to the teaching of mathematics (Gresham, 2007); classroom instruction techniques (Hawera, 2004); teaching practices associated with negative attitudes towards mathematics (Swan, 2004) and students' experiences during their own primary school education (Uusimaki &

Nason, 2004). Research has also shown that females have greater anxiety compared to male counterparts (Bowd & Brady, 2003).

Anxiety associated with mathematical tasks has been observed via neuroimaging. Lyons and Beilock (2012) identified that when a person is anxious about mathematics and is confronted with a mathematics task, then more activity in the visceral threat detection area of the brain is recorded, which is associated with pain. They also found that when the person was engaged in the actual mathematics task then this activity was absent. Therefore the engagement in the task reduced the anxiety levels. The implications are that raising awareness that anxiety will subside once the task is may be beneficial for pre-service teachers and contribute to their self-efficacy in the teaching of mathematics.

### The Study's Focus

Anxiety about mathematics, and the teaching of mathematics, is of concern for educators training future early years' teachers. However, feeling incompetent and anxious about teaching has often gone unacknowledged and where it is acknowledged, it has been shown to be effective in helping students start to address their anxiety (Boyd et al., 1998; Zimmerman, 1998a,b). In this study we examined students' awareness of their own individual performance at mathematics, and what reasons they give for their mathematical self-efficacy. It is argued that if students feel that anxiety towards mathematics is common amongst their student population then this will raise awareness enabling reflection on learning and motivation for addressing this anxiety.

This study was initiated by educators who teach primary school and early childhood pre-service teachers. Feedback from the 2010 student cohort after completion of the foundational mathematics course, which focused on teaching mathematics to children aged six weeks to eight years, had indicated that students experienced low levels of mathematical self-efficacy and did not feel capable with their skills in mathematics. In order to address students' self-efficacy regarding the teaching of mathematics this study investigated

- 1) pre-service teacher's anxiety towards mathematics at the beginning and the end of the session,
- 2) pre-service teacher's memories of mathematics' experiences
- 3) pre-service teacher's views of teaching mathematics at the beginning and end of the teaching session.

### 3. Method

*The questionnaire and associated analysis:* This study involved a questionnaire at the beginning and end of the teaching session in mathematics. The questionnaire was developed to measure students' anxiety towards the learning and teaching of mathematics, and was comprised of three parts:

- Part 1 was the demographic data of the students including age, gender, course, and educational background.
- Part 2 of the questionnaire included short answer open-ended questions about their attitudes and beliefs regarding mathematics, and to identify reasons for their beliefs. The analysis of short answer open-ended questions identified themes to understand attitudes to the learning and teaching of mathematics, and reasons students cited for attitudes towards mathematics. Participants' responses were read, and re-read as part of the analysis. This systematic analysis of the textual data, via content analysis, revealed that key themes were common across the cohort (Krippendorff, 2012). Open-ended responses to the questions were read and re-read and categories were developed. Flick, Von Kardoff and Steinke (2004) stress the importance of re-reading data so that the researchers' theoretical prior knowledge and the research questions can guide the reading of the transcript.
- Part 3 was designed to measure students' attitudes to mathematics. Eight items presented on a 5-point scale rated from 1 = strongly disagree to 5 = strongly agree. Items designed to measure the key construct of Attitudes towards Mathematics. Negatively worded items (Items 5 and 6) were reverse scored before analysis. The scale had acceptable internal reliability (Cronbach's alpha = 0.73). The items were:
  - 1) I feel confident about teaching mathematics;
  - 2) I expected to study mathematics in my course;
  - 3) Studying mathematics will be useful to my training;
  - 4) I understand mathematical concepts well;
  - 5) I struggled with mathematics at primary school;
  - 6) I feel anxious about teaching mathematics;
  - 7) I am keen to learn how to teach mathematics well;

8) It is important that I teach mathematics well.

Analysis of this scale of items was conducted by the following procedure: Numeric data were entered into the SPSS statistical package to generate descriptive statistics. Scores for the 8 items were summed, and a new variable was formed: Attitude towards Mathematics. The maximum score possible was 32.

### 3.1. Participants

The participants were 223 pre-service teachers studying a foundation (first year) unit of mathematics in the Bachelor of Education Early Childhood Education ( $n = 73$ ; 34%) and Primary Education Degrees ( $n = 155$ ; 66%). The student cohort was predominately women ( $n = 180$ ; 80%); the age range was 17 to 42 years old (mean  $22.3 \pm 5.1\sigma$ ). Approximately 38% had finished school the previous year, and just over half had finished school within the past two years. Eight students held a previous degree, 88 had a Technical and Further Education (TAFE) qualification, and 35 had completed the university's Preparing for Success course.

### 3.2. Procedure

In this teaching unit students had a one hour weekly lecture, followed by a two hour face to face tutorial. The lecturer prepared the unit material for all tutors of the content and learning activities for each week's tutorial. The content of the mathematics unit focused on the teaching mathematics in the early years that is for children aged from six weeks to eight years old. Each week the tutorials included discussions addressing anxiety towards mathematics so that it was embedded within the unit.

Participants were recruited during the first tutorial for the session following the lecture that had introduced the topic regarding attitudes and anxiety towards mathematics. This is known in this study as Time 1. The students were informed that research indicated that attitudes and beliefs about one's ability in mathematics, and affects a teacher's own ability to teach in these areas (Sloan, Daane, & Giesen, 2002; Vinson, 2001). The topic also included a discussion of how feeling anxious in mathematics can be transferred to teachers' students. The students were invited to participate in the study and advised that there were no negative consequences for those not participating. The University's Human Research Ethics Committee approval had been obtained, and participants had the option of completing the survey, or opting out.

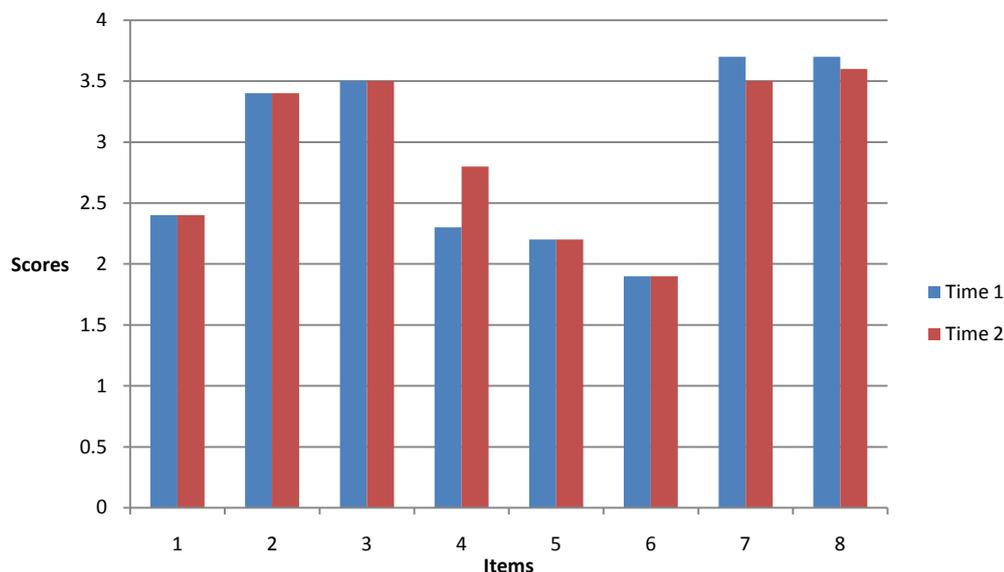
The students were informed that the study was investigating changes of attitude towards mathematics over the course of the teaching of the unit, and would be re-surveyed at the end of the teaching session. To ensure that analysis was of the same students each student's identity number was recorded, and matched when entering the data from the beginning of the session to the end of the session. The second questionnaire was handed out and completed at the end of the teaching session (nine weeks later) by these participants, following class discussions of anxiety regarding mathematics and strategies to approach anxiety throughout the session. This is known as Time 2 in this study. This paper reports on the results from the questionnaires from Time 1 and Time 2. Participants' response rates were 81% ( $n = 223$ ) of the cohort. The questionnaire took approximately 20 minutes to complete during the tutorials.

## 4. Results

### 4.1. Pre-Service Teacher's Anxiety

There was considerable anxiety towards teaching mathematics amongst this student cohort. The mean scores for anxiety at the commencement and end of the session were compared to obtain a difference of mean scores. The range of possible scores resulting from the 8 items was 0 to 32, with the actual range for this cohort of students being from 1 - 32. The mean score for Time 1 was  $23.2 \pm 4.6\sigma$ , and for Time 2 was  $23.4 \pm 4.6\sigma$ . Mean scores were not significantly different at Time 1 to Time 2 with paired sample t tests being  $t(210) = -1.1$ ,  $p = 0.27$ . This indicated that students' attitudes to mathematics did not change significantly on these eight items.

Figure 1 shows the mean scores on each item. Feeling anxious about teaching mathematics was the lowest scored item (Item 6,  $M = 1.9$ ) and was identical at both time points. The data verified that 40% of students ( $n = 88$ ) were anxious about teaching mathematics. The highest scored items at Time 1 were that students were keen to teach mathematics well (item 7,  $M = 3.7$ ), and that it was important to teach maths well (Item 8,  $M = 3.7$ ). Of interest is the change in attitude to understanding mathematical concepts which on paired sample t tests was significantly different  $t(210) = -6.2$ ,  $p = 0.000$ . So while anxiety about teaching mathematics remained constant



**Figure 1.** Mean scores for the 8 items for attitude to mathematics at time 1 and time 2 (n = 211).

throughout the session students reported that they understood mathematical concepts better at the end of the teaching session than at the commencement.

To identify the characteristics of the students who felt anxious about teaching mathematics, correlational analysis indicated a weak correlation that female students were significantly more anxious about teaching mathematics than male students ( $r = 0.2$ ,  $n = 223$ ,  $p = 0.004$ ). Gender was the only demographic item that presented significant associations with the items in the scale.

To examine the reasons for students' anxiety a correlational analysis was conducted on the Item 5: I struggling with maths at primary school and Item 6: I feel anxious about teaching mathematics. This showed a moderate correlation ( $r = 0.4$ ,  $n = 223$ ,  $p = 0.000$ ) at both time points indicating that students remembered finding maths at primary school difficult. The idea that they were training to be a primary school teacher may have elevated their anxiety.

## 4.2. Pre-Service Teacher's Memories of Mathematics' Experiences

There were 183 responses (87%) to this question: Please describe your memories of your mathematics experiences prior to this course at Time 1. Participants' memories of mathematics were either overwhelmingly positive or negative and the participants' judged their memories on the reasons why they felt that way. The analysis of memories students reported were categorised into: (1) external reasons with negative or positive attitudes to mathematics; and (2) internal reasons with their negative or positive attitudes to mathematics. These were then counted and results are reported in [Table 1](#).

### 4.2.1. External Reasons Associated with Mathematics Ability

The main external reason given for students' attitudes to mathematics ( $n = 77$ ; 47%) was the teaching approaches they had been exposed to as students in schools. The following quotes were chosen to highlight this theme from the pre-service teachers' comments. Student is identified as S.

#### 1) Positive Attitudes

The participants identified that having a teacher who was passionate about teaching mathematics, provided hands on activities, made it fun and consequently engaged the students contributed to positive learning of mathematics. Examples of the teaching approaches that influenced students' attitudes to mathematics positively are given in the following quotes:

*Thanks to my teacher who had a passion for mathematics and made it fun, enjoyable, and gave us activities to do outside which made the class interesting (S16).*

*My mathematics classes were always fun in primary school. The teachers made sure we had different ways of*

**Table 1.** Students' memories of their mathematics experiences (n = 183<sup>\*</sup>).

	Attitude to mathematics		
	Positive	Negative	Total
External reasons	27 (16%)	50 (30%)	77 (47%)
Internal reasons	38 (23%)	49 (30%)	87 (53%)
Total	65 (40%)	99 (60%)	164 <sup>*</sup> (100%)

Note: <sup>\*</sup>Note that 19 participants' responses could not be coded according to this matrix owing to insufficient information—for example: a response that said "Bad" with no explanation was omitted from analysis.

*explaining situations and numbers. For example, through songs, books, pictures, etc. (S25).*

*Had primary school teachers who were passionate about mathematics and it rubbed off (S100).*

The participants' also recalled their teachers took time to ensure the students understood the mathematics concepts:

*Not great until year 11 when I had the privilege of a wonderful math teacher who loved teaching math and took the time to make sure we all understand all formulas (S115).*

*I enjoyed mathematics at school. If I had trouble understanding something, the teacher would take the time to explain it to me and give me extra practice, specifically for what I was finding difficult, until I understood it. I enjoyed working towards understanding of mathematics concepts (S130).*

Three participants recognised that the quality of the teaching influenced their memories and subsequent learning, and intended to apply this concept in their future teaching. The following quote is an example of these three responses:

*I have had some bad memories and some good memories. Throughout high school it depended on the teacher and their teaching skills. Therefore, I would like to become a success teacher so I bring a quality learning experience to all children (S3).*

## 2) Negative attitudes

Fifty participants (27%) cited external reasons for their negative attitudes to mathematics. They recalled teaching approaches, use of resources and the teacher' classroom management style as contributing to negative attitudes to mathematics. Teaching approaches included poor explanations, teaching as too fast a pace and could not keep up, a lack of hands on experiences, and teaching directed approaches that did not support the students' learning. Examples of quotes from these participants follow:

*Not very positive memories. Teachers did not provide the help I needed in high school and I would fall behind, thus losing interest in the subject (S194).*

*My mathematics experiences are all horrible; I've never known mathematics or how to do mathematics. Every mathematics teacher I've never had, always worked through the mathematics too fast, so I was never able to keep up, so I got left behind and I've been scared of it ever since (S68).*

*At school mathematics wasn't my strongest subject and the teachers just stood out the front of the class and told us how they wanted it done, they didn't really help when it was needed (S195).*

Of this group of 50 participants 20 of them said that they had negative memories of mathematics because of the resources used. The use of work books, work sheets and text books were cited by 20 participants as being poor teaching practices that did not support their learning, and participants felt that these resources were often boring, as the following two quotes indicate:

*I enjoyed math in Primary school, I enjoyed reasoning and questioning. When I got to high school I found it difficult to learn straight from the textbook and could not make meaning or connections with what I was learning about (S67).*

*I strongly disliked mathematics in primary school and high school. The teaching was boring and mostly taken from a textbook and the teachers did not take time to help individual students (S126).*

*Boring same old same old, worksheets—no hands on (S81).*

The teacher's classroom management styles were reasons students cited for their negative attitude to mathematics. Being embarrassed by the teacher for not knowing the answer when asked was cited by four participants:

*I had a mean teacher in year 6 who laughed at me because I did not know something, and now I hate offering answers in case they're wrong (S27).*

*Horrifying. Made to feel inadequate and like an idiot (S56).*

*I strongly dislike mathematics. In school I struggled with mathematics and never received any help. I was often embarrassed in front of the class due to my low knowledge of mathematics (S48).*

*Not very enjoyable. Mathematics teacher made me feel anxious and was not supportive, made me feel stupid for not understanding (S91).*

#### 4.2.2. Internal Reasons

Analysis of the students' memories of mathematics revealed that 87 ( $n = 53\%$ ) of the students believed that an ability to be good at mathematics is internally determined. You are either a mathematics person or you are not. The following examples indicate how students viewed their memories of maths and the causes of these memories.

##### 1) Positive attitudes

Thirty-eight students (23%) recorded that mathematics was easy for them; some of their quotes include: (maths) *comes easy* (S 98), (I am) *good at it* (S41), (I am) *capable* (S196), and (I am) *successful* (109). For these students it was the nature of mathematics being logical with problems to solve with one answer that they found easy.

*I loved mathematics; I was always quite good at mathematics. It's just logical which makes sense to me (S42).*

*I enjoyed mathematics. It is interesting and I learnt there is many ways to solve mathematics problems, and I like that there is only one answer to a question (S62).*

*Very positive, easy to learn, got lots of success in mathematics (S109).*

*I enjoyed problem solving, however disliked working out of textbooks in high school where we just did a chapter per week (S192).*

The notion that mathematics comes easy to some people, and not to others, is evident in these quotes and the following quotes also support this theme. However these quotes indicate that these students believe themselves not to be a maths person.

##### 2) Negative attitudes

Thirty percent of participants ( $n = 49$ ) felt that their inability to do mathematics was a personal internal characteristic that could not be altered. A list of words that were used to describe their memories of their mathematics included (Maths is) *hard*, *it didn't gel*, (I) *couldn't understand it*, (I) *don't get it*, (maths is) *frustrating*, *scary*, *horrible*, *terrible*, *horrifying* and even (I have) *a hatred of mathematics*. The notion that people are born a mathematics person, or not, was a common theme in these comments as the following quotes indicate.

*I was never an "A+" student in mathematics. I tried my hardest at primary high school but was never able to really understand the concepts of mathematics. Even today I still struggle! (S10)*

*Negative attitude towards mathematics in K-12 (didn't do mathematics in year 11 and 12) I was convinced that I was bad at it and not a mathematics person and I never had a teacher that reassured me (S121).*

Of particular interest in this quote is that this student identified that perhaps a teacher could have changed his/her self-perception. This gives hope to those students who sense that their negative experiences that derived from internal qualities may be able to be changed by a supportive teacher, and this is valuable learning for these pre-service teachers who will be teaching mathematics to children in the classrooms. Two students who felt that they were not particularly scholarly in mathematics were motivated and willing to learn what they could to be good teachers for their future children as the following quotes indicate.

*Not great, I studied mathematics throughout school and my HSC. I wasn't great at it and didn't enjoy it very much but I think that will help me now, in making me a better and more engaged teacher (S72).*

*Wasn't my most enjoyable subject at school. However I find learning how to teach mathematics is enjoyable (S146).*

What is clear from these comments is the way maths has aroused student emotions. Students did not just like or dislike mathematics they loved it or hated it. Maths seems to have the power to rouse extreme emotions in their memory, and now they were to learn how to teach it.

#### 4.3. Views of Teaching Mathematics

The 23 participants' responses who rated their anxiety towards teaching mathematics at 5 (the highest level) on the Likert-type scale at Time 1 to the question "Please describe your views to teaching mathematics" were chosen

for analysis. This group were chosen to see first see how these student's viewed their teaching of mathematics, and then to see if these views had changed by the end of the teaching session. Only 12 of the 23 students completed this part of the questionnaire so the nine responses below demonstrate the three categories of responses. The students fell into three categories: they still felt the same about teaching mathematics; they felt slightly more confident, or they viewed teaching mathematics as a responsibility they had to conquer. T1 is at Time 1, and T2 is Time 2.

#### 4.3.1. The Same: Still Quite Anxious

*T1: I am hoping that I can be confident in teaching maths by improving my understanding of maths. T2: I would like to teach maths in a fun way that allows children to be involved confident learners (S2).*

*T1: That I wish to become a lot more confident in my abilities to teach maths well and that my "maths anxiety" will slowly disappear. T2: Still the same as the start of this unit. Nervous, not confident, scared and very unsure about my abilities to become a great mathematics teacher (S5).*

*T1: I need to become confident in my own abilities in order to teach math well. T2: I still need to learn A LOT (S36).*

#### 4.3.2. Slightly More Confident

*T1: I do not enjoy math as I have never understood it but children need to be taught mathematics. So I will teach it to the best of my abilities. T2: I am more confident to teach math now but I still have some anxiety. I do not fully understand all concepts though (S5).*

*T1: I don't feel that at this stage I am confident to teach maths but I understand that it is really important to teach it well. I hope that I succeed. T2: I feel slightly more confident and look forward to my future studies in maths (S8).*

*T1: At present I am very nervous about teaching maths. However I am looking forward to making maths enjoyable to making maths enjoyable for the children I teach and giving them fun, memorable learning experiences. I want to support the children and make them feel safe about giving maths a go. T2: I feel a little more confident with teaching maths, but will not feel totally ready until I am putting my knowledge into practice (S151).*

#### 4.3.3. Taking Responsibility for Teaching and Learning

*T1: I want to give students the best possible start to maths because I know how important it is to succeed in schooling and life. Mostly, I want them to enjoy maths. T2: I am a bit nervous about teaching the later stages as the work gets more complex. However, I feel confident in that I could teach the students different techniques (S79).*

*T1: Making it fun and hands on and making children feel safe, supported and like they can have a go. Children are valued in the classroom. T2: (Maths) can be enjoyable. It is up to me as the educator to motivate students and get them excited about maths by fun, authentic, hands on experiences that children can use in real life (S91).*

*T1: I realise how important math is! Seeing children in early childhood experiment and early concepts is exciting and I want to learn how to extend this exploration and knowledge in later years!! Maths is a lifelong skill and essential to functioning in our modern world. T2: I still have some anxiety about how to make concepts clear and concise and catering for such a diversity of ability. I know how important math is and it feels like a big responsibility—this is part of my journey as I become a teacher I suppose (S112).*

## 5. Discussion

This study sought to understand pre-service teachers' attitudes towards teaching mathematics, the prevalence of anxiety about teaching mathematics, and pre-service teacher's understanding of the sources of their attitudes to mathematics. Students reported being anxious about teaching mathematics and this score did not change from the beginning to the end of the session. It is likely that this feeling will remain until students have the opportunity to "put my knowledge into practice", as Student 151 stated. That is their self-efficacy towards teaching mathematics will change once they have mastered the first part of self-efficacy—what Bandura terms "performance experience". They were viewed as taking responsibility for their learning how to teach mathematics, even

though many of them had negative past experiences of being taught mathematics.

Overall the students were positive about studying mathematics, based on the score of Attitude to Mathematics. This result is reassuring, as past research indicates that a positive attitude to teaching mathematics influences learning, even without the knowledge about the subject (Lazarus, 1974). While a significant number of students were anxious about teaching mathematics, students viewed the teaching of mathematics to be important and were positive about learning how to teach mathematics. Indeed, students self-rated scores for understanding mathematical concepts increased significantly throughout the course of the session indicating that students felt more capable mathematically.

The results indicated that students who were positive about mathematics recalled quality teaching practices of mathematics such as engaging the students, student centred learning, supporting the students' learning by giving time, assistance and assurance about mathematics skills. This points to the power the teacher has in supporting children to learn mathematics. Choosing a teacher-centred approach, especially in the early years of learning mathematics has been found to be far more effective than a child-centred approach where children "discover" knowledge by interacting with concrete materials. Children's learning has been found to be optimised by having an effective pedagogue working alongside and supporting children's learning (Polly, Margerison, & Piel, 2014).

Unfortunately, the results also indicated that students who had struggled with mathematics identified that their teachers had used poor teaching practices, such as inadequate explanation of concepts, working from the text-book, worksheets, and poor teaching management practices. What can be learned from this is that the resources and pedagogical approaches used by teachers in classrooms need to be appropriate and respectful: teachers need to have a range of strategies to engage students in learning about mathematics in an enjoyable manner.

The cited practice of "naming and shaming" students in front of their class by asking students answers that they could not work out nor understand is likely to weaken a student's mathematical self-efficacy. Such practices constructed barriers to learning for these students, and were associated with negative attitudes to mathematics. While the study of mathematics for these students elicited strong emotional arousal, including anxiety, as a result of these practices, this study has enhanced these pre-service teacher's awareness of such practices, and the influence upon their own learning. It is hoped that by reflecting on such practices they will take this understanding with them into their own professional practices.

The results from the qualitative data identify significant issues that need to be addressed in the teaching of mathematics in undergraduate teacher education mathematics courses. Past experiences of teaching were closely linked to current perceptions, and many students had identified teaching practices that they themselves would, or would not, take into their own classroom when they taught. Even the students who identified high levels of anxiety about teaching mathematics recognised that they need to develop confidence about teaching mathematics.

## 6. Conclusion

The results from this study provide an insight into societal views about mathematical ability: that we are either good or bad at mathematics, and this is a result of how we were taught. That said, many of the students in this study who linked their poor mathematical ability to "I am not a maths person" labelling, recognised that they could change their ability in mathematics and wanted to learn how to teach it well. It also needs to be stated that female students were more anxious about teaching mathematics than male, and this finding supports previous research by Bowd and Brady (2003).

University teachers of mathematics can raise pre-service teacher's awareness regarding these issues identified in this study to improve student's mathematical self-efficacy. For students, to know that they are not alone in feeling like this about mathematics may enhance their self-efficacy. This second part of self-efficacy identified by Bandura (1997), that is vicarious experience, may be enhanced.

While this study focused on mathematics anxiety, this is just one part of mathematical self-efficacy. The results indicate that anxiety has the power to influence other aspects of self-efficacy—participants made strong links between their mathematics anxiety to their personal experiences of mathematics. It would be useful to survey pre-service students as they progress through their four-year teaching degree to see if anxiety towards mathematics lessens as they prepare to embark on their career as a teacher. If the anxiety did not diminish it would be recommended that pre-service teachers with low mathematical self-efficacy seek support from a mentor. In conclusion the study found that pre-service teacher's anxiety did not significantly diminish throughout the teaching session, however there was no doubt that there was heightened awareness regarding addressing one's

self-efficacy about the teaching of mathematics.

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