Examining Non-Traditional Pathway Preservice Teachers' Attitudes Towards Mathematics

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In this study, we examined non-traditional pathway preservice teachers' attitudes towards mathematics to inform decision-making on designing the course and the units related to mathematics and how to support the teachers in transitioning smoothly into higher education programs. We adopted a mixed design approach to document teachers' attitudes towards mathematics. Results show that the teachers revealed positive attitudes towards their mathematical self-ability of the subject, the enjoyment of mathematics, and the utility of the subject.

Introduction and Research Questions

As a way of increasing the quality of teacher education courses, the Australian Institute for Teaching and School Leadership (AITSL, 2014) has recently called for only the top 30% of school applicants to be admitted. For students who do not meet the Australian Tertiary Admission Rank (ATAR) score requirements, their chances of entering the teaching profession are consequently limited. Nevertheless, Australian researchers/educators have argued that the success of non-traditional students at university is related as much to how the institution engages, supports and challenges the students in constructive relationships as to student pre-entry scores (Funston, Gil, & Gilmore, 2014). To address this, Victoria University offers a one-year intensive program of supported study developed in a unique collaboration between Arts and Education in 2011. The Diploma in Education Studies (EDES) was designed for students who do not meet the entry requirements for selection for the Bachelor of Education (BEd P-12) through the Victorian Tertiary Admission Centre (VTAC) selection process, and provided a pathway that offered extensive and supported study to build capacity in literacy and numeracy appropriate for a career in teaching. These students are able to transition into the second year of the BEd program via an internal course transfer process conditioned on completing requirements of the EDES. In order to prepare students for successful transfer into the second year of the BEd, the EDES curriculum included a significant focus on increasing the literacy and numeracy of students, with a quarter of the course credit points (24 out of a total of 96) devoted to developing these skills. The length of individual units is also unusually long (16 weeks as opposed to 12), with an explicit focus on learning support and retention.

Attitudes towards mathematics appear to be an important variable in teaching and learning, and in predicting students' mathematical performance (e.g., Sakiz, Pape, & Hoy, 2012). Positive attitudes towards mathematics help reduce anxiety (Akin & Kurbanoglu, 2011), and students with more positive attitudes towards mathematics have higher perceptions of the utility of mathematics that motivate them intrinsically towards their study (Perry, 2011). The students have a better mathematical self-concept (Hidalgo, Maroto, & Palacios, 2005), and are more confident that they can learn mathematics (McLeod, 1992). As these students, hereafter called non-traditional pathway preservice teachers, are perceived to accrue low academic ability (low ATAR), gauging their affective factors is critical to help address the challenges the students might have, and determine

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how to move the students towards the academic standards of higher education. In the current study, we address the research question: What are the attitudes of non-traditional pathway preservice teachers towards mathematics in the first year of study?

Literature

Increasing attention is being paid to the role of affective factors in mathematics education as "students who have positive emotions towards mathematics are in a position to learn mathematics better than students who feel anxiety towards that subject." (Organisation for Economic Co-Operation and Development, 2013, p. 42). In a recent review of research into the affective domain in mathematics education, Attard, Ingram, Forgasz, Leder, and Grootenboer (2016) summarise six prominent constructs, including identify, beliefs, attitudes, engagement, motivation, and anxiety. McLeod (1992) argued that beliefs, attitudes, emotions (anxiety could be grouped here), differ in stability and intensity. He stated that, "beliefs are largely cognitive in nature, and are developed over a relatively long period of time. Emotions, on the other hand, may involve little cognitive appraisal and may appear or disappear rather quickly" (p. 579). Importantly for this study, significant attention from the research community is recently focusing on attitudes (Palacios et al., 2014).

In regard to research about attitudes, consistent findings show that negative attitudes towards mathematics persist across primary and secondary students (Larkin & Jorgensen, 2014), and preservice teachers (e.g., Afamasaga-Fuata'i & Sooaemalelagi, 2014). Winheller, Hattie, and Brown (2013) found that for secondary students, self-efficacy in mathematics was primarily related to their outcomes, and confidence in and liking mathematics influence their perception of quality of learning. However, research shows that their attitudes towards mathematics could be changed. For example, primary pre-service teachers' positive mathematical attitudes increase during their initial teacher education program (Bailey, 2014) through the use of open-ended investigations in their program. The scarcity of research related to non-traditional pathways pre-service teachers' attitudes towards mathematics necessitate the current study. It is essential to know where these teachers come from and what beliefs they bring with them into the course that might help or hinder their learning. Affective factors could inform educators in designing learning opportunities to meet their need as well as to help them transition smoothly into higher education programs.

Methodology

We adopted a mixed design approach to document teachers' attitudes towards mathematics. Data include digital reflective journals collected in the first semester and a survey about attitudes towards mathematics administered in the second semester.

Participants

This paper focused on the 2016 cohort of 163 full-time students, of whom two are international students. The students ranged in age from 18 years to 32 years. Most were young adults (median age = 18), with nearly 67% of the cohort was 19 years old or younger, and 25% of the cohort aged between 20 and24. Most were female (65.6%). All did not have an ATAR score. For 77.6% of the cohort, English was the only language spoken at home. The demographic information indicates that the course was meeting the

institutional goals of widening participation and enabling new cohorts of students to enter this course.

Data Collection

Data were collected in two units related to mathematics (numeracy), EDC1002, Semester 1 2016 and EDC1003 Semester 2 2016 when students were in their first year of study. In the first semester, as part of reflective journals, students were asked to write a response to the following prompt: "Describe your self reflection as a mathematics learner and teacher. What are your goals for this unit?" Data from 70 students' responses were used for data analysis. In the second semester, towards the end of the Unit EDC1003, students were asked to fill out a paper-and-pencil survey including 32 items to measure attitudes towards mathematics (Palacios, Arias, & Arias, 2014). This scale categorises attitudes into four factors: *perception about mathematical incompetence* (12 items), *enjoyment of mathematics* (12 items), *perception about utility* (4 items), and *mathematical self-concept* (four items). This is a five-point Likert scale ranging from strongly-disagree to strongly-agree. 58 students filled out the survey and 12 of those did not leave their identity in their response. This scale, Attitudes towards mathematics, was validated and checked for reliability using a sample of 4,807 students at the school levels building on previous efforts to measure attitudes (e.g., Aiken, 1979; Fennema & Sherman, 1976; Tapia & Marsh, 2004). Across the two data points collected, only 26 students finished both. As the data were collected from a voluntary sample, caution is also needed when making generalisations from the data to the whole cohort.

Data Analysis

The digital reflective journals were coded through two phases: open coding and a priori coding. For the first phase, an emergent coding was applied to describe what the students alluded to in their reflection, such as their perception of self-ability in mathematics, enjoyment/dis-enjoyment of mathematics, and their attitudes towards improving their mathematical knowledge. After this, the second phase built on the emergent coding, using an a priori coding scheme related to attitudes towards mathematics adopted from Palacios et al. (2014). The scheme includes four factors: perception of mathematical incompetence, enjoyment of mathematics, perception of utility, and mathematical self-concept. Students' responses were coded for the four factors if evident. When it was evident, the direction of the factors was also noted as positive or negative. For example, in responding to the prompt, Malinda indicated: "My reflection from my past high school and college mathematics experience has given me some passion and opportunity to enjoy and achieve well with results. I'm very interested and willing to learn more about primary mathematics." This was coded as *enjoyment of mathematics* (positive) and *mathematical self-conception* (positive). It was also coded for *looking forward* in addition to the four factors specified. Then, counting and percentages were processed to quantify reflection of the group. For the survey, students' responses were entered into a spreadsheet as a numerical scale from 0-4. Questions with negative wording were recorded to reflect the scale. Then the items in the survey were regrouped based on the four factors and summary statistics (mean and standard deviation) of each of the factors were developed. Percentages were also reported for each of the items.

Results

Reflective Journals

Among 70 responses, 35 commented on their perception about their mathematical ability. Of the 35 responses, 23 teachers perceived that they felt incompetence about mathematics whereas 12 teachers perceived that they were able to learn mathematics. These 12 teachers saw themselves as mathematically capable and felt self-confident about the subject and that they could do well if they were trying hard enough. For examples, Kat responded "I have always struggled with mathematics, believing it to be a rigid and formulaic discipline that my artistic brain is not suited for. This is untrue though, as I have the potential to study maths further and to explore how I can use my other learning strengths to overcome the challenge." This teacher perceived herself to have an artistic brain, which was not appropriate for learning mathematics. Teachers with responses of incompetence in mathematics described it as either stressful, difficult, a weak subject, fixed mindset (giving up easily when frustrated), insecure, or having gaps in knowledge. Interestingly, one student saw herself better in mathematics than in English.

Only seven teachers mentioned about enjoyment/dis-enjoyment of the subject. Three teachers said they enjoyed mathematics, such as Tom, "Personally in early years of high school, I loved maths and I loved getting tests back and seeing what you answered right and wrong but as I got older I got lazy when I probably needed to work my hardest and my results reflected that." One teacher, Sam said she did not like it, "I had 'fixed' (Dweck, 2014) ideas about mathematics some of which being; thinking I didn't like anything about math." Among the teachers, three commented on the love-hate relationship, depending on their performance on and understanding of the subject, Mel said: "I as a mathematics learner have a love hate relationship with maths as I hate it when I do not understand it and absolutely love it when I understand it."

Only one teacher commented on the utility of mathematics, and the comment was positive:

> In mathematics, there are many challenges one faces as a student, but without these challenges in the subject, would the world be where it is today? With all the addition, subtraction, multiplication, division and even the long equations that may take hours to complete are all worth it.

The vast majority of the teachers (65) aimed to improve their knowledge during the unit; 55 of those aimed to improve their mathematics content knowledge, and 24 focused on developing their knowledge for teaching mathematics including how to teach, teach in a fun way, and understand their students. For example, Tayla responded:

> A personal goal for me in this unit is to get a better understanding of maths in a different perspective, throughout our lives we have been told to do the work but not actually teach it. So, I would like to learn how to actually teach maths than actually doing it. I would also just like to make sure I understand all the content that maths has to offer.

Thirty-two teachers explicitly set the goals to improve their attitudes towards mathematics, to develop grow mindset, to perceive them as capable if trying hard, and to put more efforts into improving their knowledge. For example, Sarah after realising her own mindset stated that: "I'm now going to make a conscious effort to turn my fixed mindset into a growth mindset by learning to appreciate challenge and grow from my mistakes."

Survey of Attitudes Towards Mathematics

The teachers tended to disagree or feel neutral about perception of mathematical incompetence, and feel neutral or agree that they had a positive mathematical self-concept.

Likewise, these teachers tended to feel neutral or agree that mathematics was enjoyable, and especially agree or strongly agree that mathematics was useful (Table 1). These results are elaborated more next.

Table 1
A Summary of Mean and Standard Deviation Obtained for Each Factor

Factors	*N*	Mean	*SD*
Perception of Mathematical Incompetence	58	1.61	1.26
Enjoyment of Mathematics	58	2.21	1.26
Perception of Utility	58	3.03	1.00
Mathematical self-concept	58	2.61	0.98

More than 50% of the teachers disagreed with the notion of their mathematical incompetence as stated in six of the 12 items related to perception of mathematical incompetence (see Figure 1). For example, in response to Item 11 - "Except for a few cases, no matter how much effort I put, I cannot understand mathematics", 34% of the students strongly disagreed and 29% disagreed.

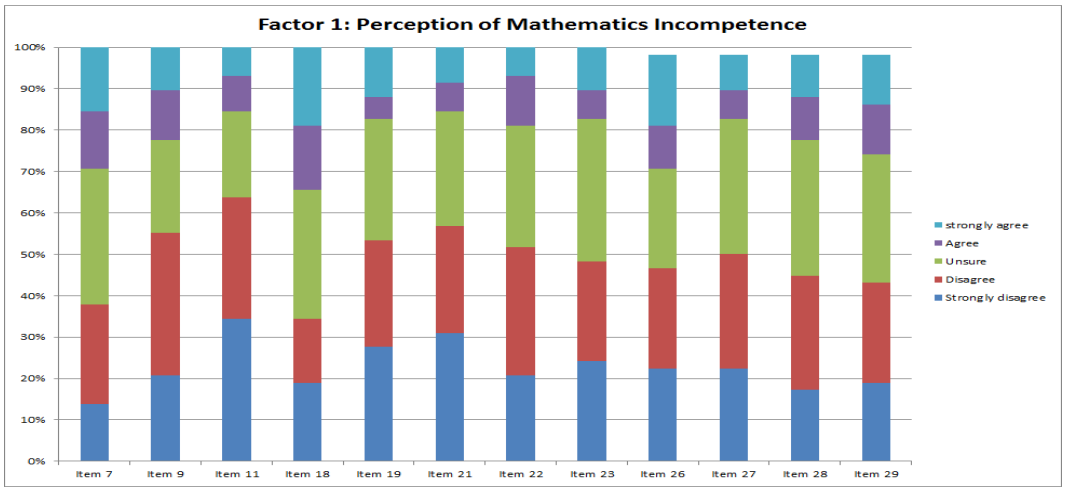

Figure 1. Teachers' responses about perception of mathematics incompetence.

Note that for Items 26 to 29, one student did not put any response. Four items (8, 14, 15, and 25) in this factor included negative statements, such as Item 8: "It's time for maths, how awful". Respectively, 53%, 60%, 50%, and 52% respondents disagreed or strongly disagreed with these negative statements. However, for positive statements such as in response to Item 1: "I like mathematics" and Item 2: " I feel comfortable doing maths problems", 58% and 64% respondents recorded a strongly agree or agree response.

Overall, more than 50% of the teachers agreed that mathematics was enjoyable in 6 of the 12 items.

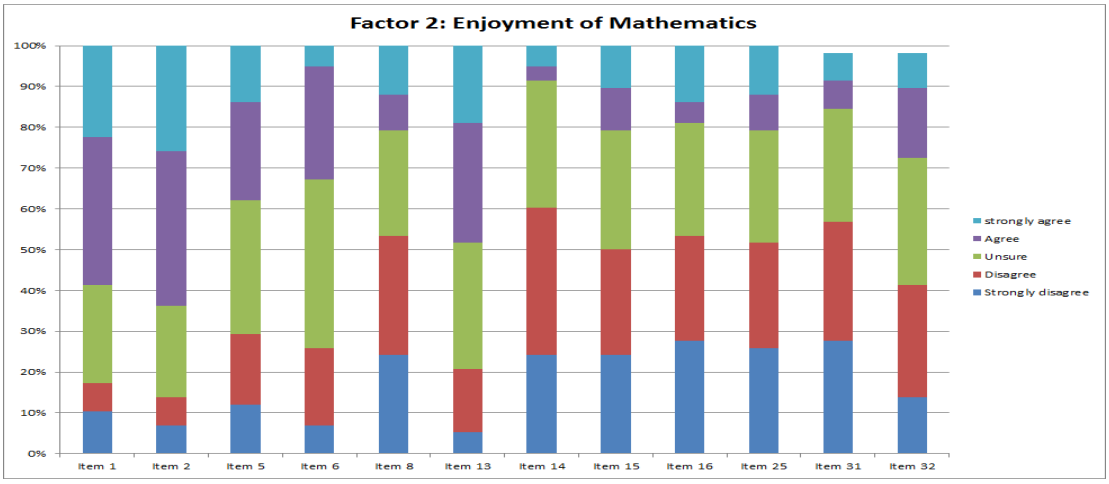

Figure 2. Teachers' responses about enjoyment of mathematics.

Note that for Items 31 and 32 one student did not put any response. Two items (3 and 4) in this factor also included negative statements. For example, Item 3: "Mathematics is useless" and Item 4: "mathematics should be present only in science careers", respectively 83% and 81% students disagreed or strongly disagreed with the statements. Similarly, for Item 17: "Learning maths is a matter for only few" scored a 53% strongly disagree or disagree response. (Figure 3, left graph)

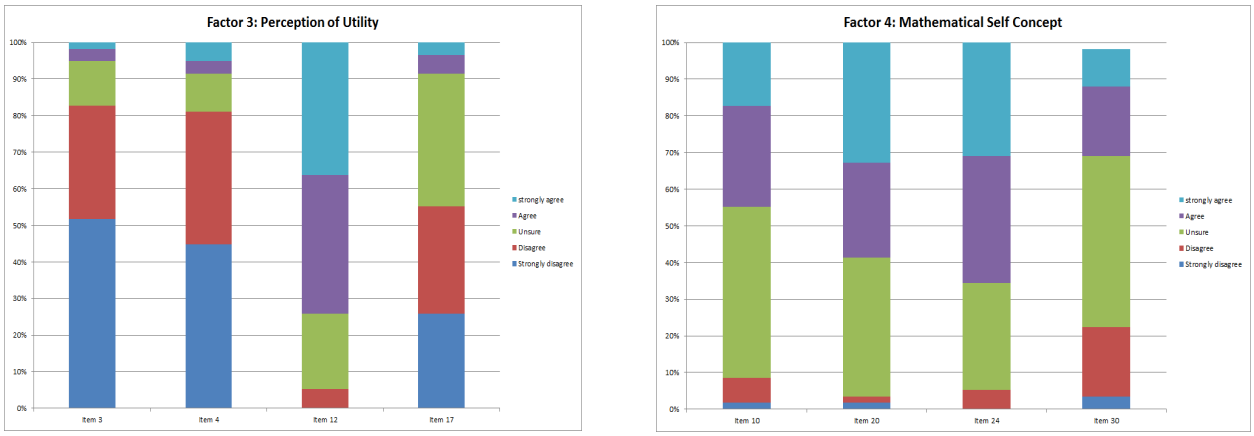

Figure 3. Teachers' responses about perception of utility and self-concept.

For Item 20 and Item 24 students showed 59% and 65% agree or strongly agree response. These items included statements, "For my math teachers and lecturers I am a good student" and "I can become a good student of mathematics" respectively. (Figure 3, right)

Discussion

This study examined non-traditional pathway preservice teachers' attitudes towards mathematics to inform decision-making on designing the course and the units related to mathematics and how to support the teachers in transitioning smoothly into higher education programs. In the first semester, only 23 of 70 teachers expressed they felt incompetence in mathematics whereas 12 students self-perceived their capability in doing mathematics. The vast majority of students were looking forward to improving their knowledge and attitudes towards the subject, thinking they could do mathematics if they try hard. Likewise, in the second semester, there were positive attitudes towards the subject (mean for perception of mathematical incompetence was less than 1.7 and mean for mathematical self-concept was more than 2.6). The results do not corroborate previous finding that pre-service teachers tend to show negative attitudes towards mathematics (e.g., Afamasaga-Fuata'i & Sooaemalelagi, 2014). This could be for several reasons. First, the reflection journal was finished after Week 3 of the semester when students had been challenged about their own attitudes towards mathematics and encouraged to develop a growth mindset by watching a video about growth-fixed mindset. It seemed that this brief intervention had a positive impact in shifting the teachers' thinking. Furthermore, the supporting structures put into the units, such as regular and frequent feedback to students, and their ability to do well in their first semester maths unit, might help explain the result. Likewise, the scale was administered towards the end of the second unit after they had experienced support in developing growth mindset during the first year of study.

Overall, the experience in the first year was helpful in changing teachers' perception about the subject, which apparently encouraged them to keep challenging their self-beliefs and attitudes and improve their academic standards. However, how such experience in their first year could be followed in other years of the teacher education program still remains unclear. Furthermore, in what ways these experiences serve as a trigger for the teachers to develop their academic knowledge, and to reach the top 30% as required to registered as a teacher, is yet to be investigated. Future study could further track the students and use appropriate measure to link between cognitive and affective domains for the students. It is challenging to help teachers create a balance between perceiving the good in their ability, and continuing to improve their academic standards. Preliminary findings suggest that attending to helping teachers' change of their attitudes seems to be a first step.

The philosophy of this sub-degree is reflected in the overall university commitment to enable entry to university degrees via alternative entry courses, increase the diversity in teacher education, and widen participation of non-traditional groups in higher education. In general, the course appeals to a recent call by Sahlberg to rethink government approaches to selecting teacher educators on the basis of elite performance at school but rather to select wider socio-economic and diverse cohorts who represent school populations (Shaw, 2015). The staff in the course sought to "find ways to enable non-traditional students to draw on the rich cultural resources, alternative knowledge and ways of knowing that brought them to the course" (Hallpike, 2014, p. 107). Non-pathway students would not traditionally be offered the opportunity to enter initial teacher education programs, and it is argued they need significant support to become qualified teachers.

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