Foundation Content Knowledge: Pre-service Teachers' Attainment and Affect

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In this paper, three elements of primary pre-service teachers' relationships with mathematics are explored: mathematical achievement, feelings about the subject, and confidence to teach mathematics. At the beginning of their programme, under half of the pre-service teachers did not meet the numeracy requirements and took part in a support programme. By the end of their first year, 95% of the cohort had met the numeracy requirements of the course. Sixty-five percent of the pre-service teachers surveyed liked or felt neutral about the subject, and 38% felt confident to teach mathematics when they graduated.

Introduction

By the end of the 2013 academic year, 95% of the first year pre-service primary teachers at the University of Otago, College of Education had met the numeracy requirements of their programme and the Graduating Teacher Standards (New Zealand Teachers Council, 2010). The majority, therefore, had demonstrated that they had the foundation content knowledge (Linsell & Anakin, 2012) necessary to fully engage in their primary mathematics curriculum papers. Foundation content knowledge is specified as the mathematical knowledge at Level 5 of the New Zealand Curriculum, and is approximately that expected of a student in Year 9 in New Zealand or Year 8 in Australia.

This end of the year statistic of 95% does not adequately describe the different mathematical journeys of the pre-service teachers during the year, or their relationship with the subject. At the start of 2013, only 59% of the pre-service teachers were able to demonstrate foundation mathematical knowledge in their assessment. Those who did not were given the opportunity to take part in a support programme and had further attempts at the assessment (see Figure 1). The assessment and support programme are described by Linsell and Ingram (this issue).

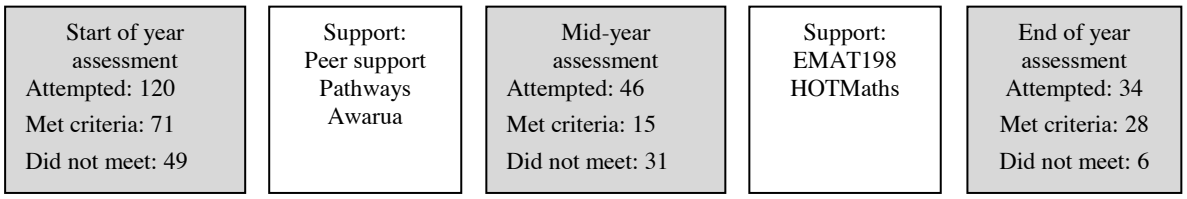

Figure 1. Assessment and support opportunities during 2013

The support programme was based on the principle of mathematical growth and its purpose was two-fold: to help the pre-service teachers to achieve the professional standard required, and to build positive relationships between pre-service teachers and mathematics. Ingram (2011) conceptualised a student's relationship with mathematics as comprising of five components: feelings about mathematics, views of the subject, mathematical knowledge, identities, and habits of engagement relating to the subject. These components

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interact to provide a context for learning and contribute to an individual's mathematical learning experiences and performances. Two affective components, related to this conceptualisation, are explored in this paper: the pre-service teachers' feelings about mathematics and their confidence to teach mathematics when they graduate. A student's confidence to teach mathematics is an aspect of their expectations or identities (Sfard & Prusak, 2005), which is part of a "teacher's ways of learning through experiencing, doing, being, and belonging" (Graven, 2004, p. 179). These components are explored with reference to the mathematical achievement of the first-year pre-service cohort.

Methods

Pre-service teachers' participation and results in the assessments were analysed using simple descriptive statistics, and the assessment results at different times of the year were compared using paired samples t-tests. 95% confidence intervals of the differences are given, and Cohen's d, a measure of effect size, stated in the results.

After the pre-service teachers met the requirements or they had reached the end of the year, the pre-service teachers were surveyed using an online survey tool. There were, therefore, four groups of pre-service teachers surveyed: those who met the requirements at the start of the year, those who met the requirements in the middle of the year, those who met the requirements at the end of the year, and those that did not meet the requirements. The surveys had Likert-like items and an overall return rate of 59%. Each group of pre-service teachers were asked the same questions: "How do you feel about mathematics?" where choices ranged from Strongly Dislike to Strongly Like, and "How confident are you in your ability to teach mathematics up to Year 8 when you graduate?" where choices ranged from No Confidence to Very Confident. This paper further explores the pre-service teachers' replies to these two affective questions using simple descriptive statistics.

Results

Start of Year - The results in the online assessment for whole cohort at the start of the year ranged from 456 to 881 with a mean score of 694 and standard deviation of 73. Seventy-one (59%) of the pre-service teachers met the requirement of 690 of a possible 1000 points. Forty-four of these responded to the survey. Fifteen (34%) of the pre-service teachers who met the requirements and responded to the survey felt positively about mathematics. Of these, 4 strongly liked mathematics. 22 felt neutral about the subject and 7 (16%) felt negative about mathematics. In terms of confidence to teach, 21 (47%) pre-service teachers felt confident to teach primary mathematics when they graduated, 17 (39%) had some concerns and 6 (14%) were lacking or had no confidence.

Mid-Year - The pre-service teachers who did not meet the numeracy requirement at the start of the year took part in the support programme. They engaged in peer tutoring to varying degrees and had access to Pathways Awarua (see Linsell & Ingram, this issue). Some took the opportunity to sit the online assessment again. Fifteen who met the numeracy requirement of 690 in the middle of the year, therefore, sat the assessment both at the start and in the middle of the year. A statistically significant difference was found in assessment results between the start of year and mid-year, $t(14) = -6.09$, $p < 0.001$. On average, the results went from 656 ± 31 to 702 ± 43, an improvement of 46 ± 29. The effect size was large (Cohen's $d = 1.6$). Their results therefore improved after engaging in Pathways Awarua and peer tutoring. The students who met the numeracy requirements in

the middle of the year had varying affective responses to mathematics. Nine of the pre-service teachers who met the numeracy requirements in the middle of the year responded to the survey. One felt positive about mathematics, two were neutral and six felt negative about mathematics. Two were confident in their ability to teach mathematics when they graduated and the others has some concerns or no confidence.

End of Year - In the second semester, the 34 pre-service teachers who had not met the requirements enrolled in the course Essential Mathematics and had access to the online resource, HOTmaths. They were then given a further opportunity to meet the numeracy requirements in the online assessment. These students therefore had the opportunity to sit the assessment three times (see Figure Two).

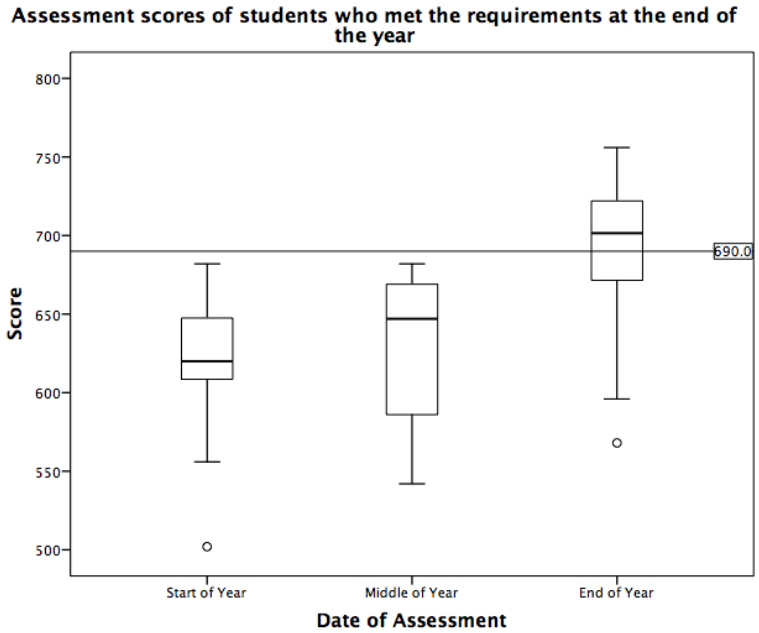

Figure 2. Boxplot of assessment scores for the students who met requirements at the end of the year

For the pre-service teachers who achieved the numeracy requirement at the end of the year, for those that sat the mid-year assessment, their results between the start and the middle of the year were significantly different: $t(25) = -2.48$, $p < 0.05$. On average, between the start of the year and the middle of the year, these pre-service teachers went from 619 ± 40 to 633 ± 41, an improvement of 13 ± 29. The effect size was moderate with Cohen's d = 0.49. Their results therefore improved after engagement in Pathways Awarua and peer tutoring though to a lesser extent than the group who achieved the standard in mid-year.

Their results improved at a greater rate between the middle and end of the year, and these means were also significantly different: $t(25) = -5.11$, $p < 0.001$. On average, these pre-service teachers went from 632 ± 41 to 687 ± 47, an improvement of 55 ± 55. This effect size was large (Cohen's d = 1) showing the results of students who engaged in HOTmaths and Essential Mathematics improved between the middle and end of the year. This group had a range of affective responses. Sixteen who achieved the numeracy requirement at the end of the year responded to the survey. Six disliked mathematics, and seven were neutral. Three liked the subject. Although 10 felt they had some concerns about

their ability to teach the subject when they graduated, only two of them were lacking in confidence. Three felt confident to teach the subject.

Six pre-service teachers did not meet the numeracy requirements by the end of their first year. Two of these pre-service teachers filled out the survey at the end of the year. Although their marks had improved steadily during the year, unsurprisingly, both of these pre-service teachers strongly disliked mathematics and did not have confidence to teach mathematics when they graduated.

Conclusions

At the start of the programme, only 59% of the cohort of first year primary pre-service teachers was able to demonstrate adequate mathematical knowledge at a Year 9 level in NZ. Without a support programme and further opportunities for assessment, a large proportion of the cohort would not have been able to engage in the primary curriculum courses or have been qualified to teach according to the Graduating Teaching Standards of New Zealand. By engaging in the support programme offered by the University of Otago, the year was a journey of mathematical growth for many of these pre-service teachers. In general, the different elements of the support programme met the individual needs of the pre-service teachers. A further 15 pre-service teachers (13% of the cohort) were able to demonstrate the required mathematical understanding by the middle of the year by engaging, to varying degrees, in the online support of Pathways Awarua and a peer tutoring programme. A further 28 pre-service teachers (23%) were able to demonstrate the required mathematical understanding by the end of the year after their further engagement in the course Essential Mathematics and access to the online resource HOTMaths.

For the 71 pre-service teachers who achieved the numeracy requirements of the course, and responded to the survey, 19 felt positively about mathematics, and 27 were confident to teach primary mathematics when they graduated. Of these 71, only four pre-service teachers strongly liked mathematics and only three were very confident in their ability to teach. It should be noted, it is difficult to comment generally on the pre-service teachers' affective factors at different times of the year because 41% did not respond to the survey.

From a cohort of 120 pre-service teachers, despite the relative success of the support programme and the growth of the pre-service teachers throughout the year, these statistics are sobering and demand our systematic support for their continued growth in the future years of their teacher education programme.

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