Investigating Secondary Mathematics Teachers' Confidence Levels after Attending Voluntary Professional Learning

Gregory Hine[1], Chris Forlin[2], Paola Chivers[3]

[1, 2] University of Notre Dame Australia, Australia
[3] Institute for Health Research, University of Notre Dame Australia, Australia
[3] School of Medical and Health Sciences, Edith Cowan University, Australia
[3] Research Department, Child and Adolescent Health Services, Australia

Abstract

The supply of secondary school mathematics teachers (SSMTs) in Australian schools is a problematic issue [1]. To address this issue, one effort conducted at scale involves providing professional learning (PL) for teachers of Years 7-10 mathematics, so that they are competent and qualified to teach mathematics courses to Year 11 and 12 students. PL is viewed as the processes by which teachers acquire new knowledge, skills, affects, and/or develop behaviors [2], which ultimately lead to improved student outcomes [3]. Presented at the conference are the findings of a survey where 73 SSMTs completed immediately before and again, immediately after, they participated in an intensive PL course. The survey interrogated the extent to which SSMTs felt confident to teach mathematical content following their PL course participation. For one survey question with six items, mean confidence scores were calculated, and pre-post PL changes in confidence levels were assessed across mathematics courses and year levels using a linear mixed model [4]. Results indicated SSMTs' confidence levels improved after completion of all PL courses, with teachers in the Year 11 courses having higher confidence levels than those attending the Year 12 courses. No significant difference was detected for Mathematics Methods versus Specialist Mathematics courses.

Keywords: *Secondary mathematics teachers; Professional learning; Confidence*

1. Introduction

Australia has experienced problems with the supply of secondary mathematics teachers for several decades, evidenced in out-of-field (OOF) teacher rates and increasing student enrolments in secondary schools [1]. Efforts to ameliorate this issue have included pre-service mathematics teacher training [5], the provision of professional development (PD) for in-service teachers, and professional learning (PL) for OOF [6]. According to some authors [1], one suggestion is that teachers of Years 7-10 be encouraged to progress to Years 11 and 12, through collaboration across discipline and education professionals. Within this paper, the confidence levels of secondary school mathematics teachers (SSMTs) participating in voluntary PL will be outlined. PL is viewed as the processes by which teachers acquire new knowledge, skills, affects, and/or develop behaviours [2], which ultimately lead to improved student outcomes [3]. The significance of this study is underpinned chiefly by the premise that quality teaching impacts student learning positively [7]. Accordingly, school leaders and systems have focused on implementing quality teaching practices and accessing PL which supports these practices [8].

1.1 Research Question

The main research question addressed in this paper is: To what extent does SSMTs' participation in voluntary PL courses affect their confidence to teach mathematical content?

2. Research Design

2.1 Context

In response to the need for secondary mathematics PL, the Department of Education Western Australian (DoE) offers PL courses in senior secondary mathematics to SSMTs. The lead author has delivered perennially the following intensive, short PL courses to current DoE SSMTs from 2020-2022; Year 11 Mathematics Methods [11MAM], Year 11 Mathematics Specialist, Year 12 Mathematics

Methods, and Year 12 Mathematics Specialist [see School Curriculum & Standards Authority (SCSA)], [9]. Over the 3-year period, 73 SSMTs participated in pre-course surveys, post-course surveys, and individual interviews. Reported in this paper are the analysed confidence results from the pre- and post-course surveys (see Instrument).

2.2 Instrument

SSMTs were invited to complete a pre-and post-course survey for every PL course they participated in. The survey items for each PL course were identical except for Question 3. All PL surveys listed six course topics at Question 3 which were developed according to the content for respective courses [9]. Respondents rated their confidence to teach mathematics topics according to a 5-point Likert scale. To illustrate, Question 3 of the pre-course survey for 11MAM is presented below.

3. Currently, how confident are to you feeling to competently teach the following Year 11 Mathematics Methods course topics (1 = Not Confident at all, 2 = Slightly Confident, 3 = Somewhat Confident, 4 = Fairly Confident, 5 = Completely Confident):

• Functions and graphs	1	2	3	4	5
• Trigonometric functions	1	2	3	4	5
• Counting and probability	1	2	3	4	5
• Exponential functions	1	2	3	4	5
• Arithmetic and geometric sequences and series	1	2	3	4	5
• Applications to differential calculus	1	2	3	4	5

3. Statistical Analysis

A total confidence score was calculated by summing the six Likert scale items at Question 3 for each PL course. Scores could range from a minimum of six to a maximum of 30. A mean item score was calculated (total score/6). Cohen's d effect sizes were computed for individual items, and magnitude was interpreted as no effect (0.0-0.1), small effect (0.2-0.4), intermediate effect (0.5-0.7), and large effect (≥0.8). A linear mixed model was used to investigate the change in confidence levels (mean item score, dependent variable) across mathematics course (Methods/Specialist), year level (11/12) and course evaluations (pre-/post-PL course), treated as fixed factors, and anonymous identifier treated as a random effect. Tests of fixed effects (F and p-value) are reported. Residuals were assessed and assumptions met with a normal distribution (Shapiro-Wilk=1.0, p=.166). IBM Statistical Package for the Social Sciences Statistics Version 29.0 was used for the data analysis [10].

4. Results

Over a period of 3 years, 167 SSMTs attended one of four PL courses. A total of 133 pre- and post-responses were collected from participants across that period, with a response rate of 39.8%. For each professional learning course, SSMTs' reported confidence levels increased (Fig. 1). Across course topics, all but three course topics reported intermediate or large effect sizes (Fig. 2).

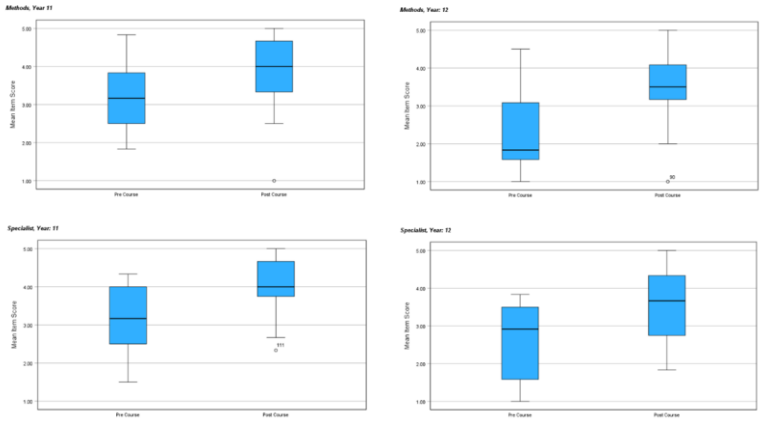

Fig. 1. Confidence levels (mean item score) to competently teach mathematics course topics, separated across course, year level and pre- and post- professional learning course attendance.

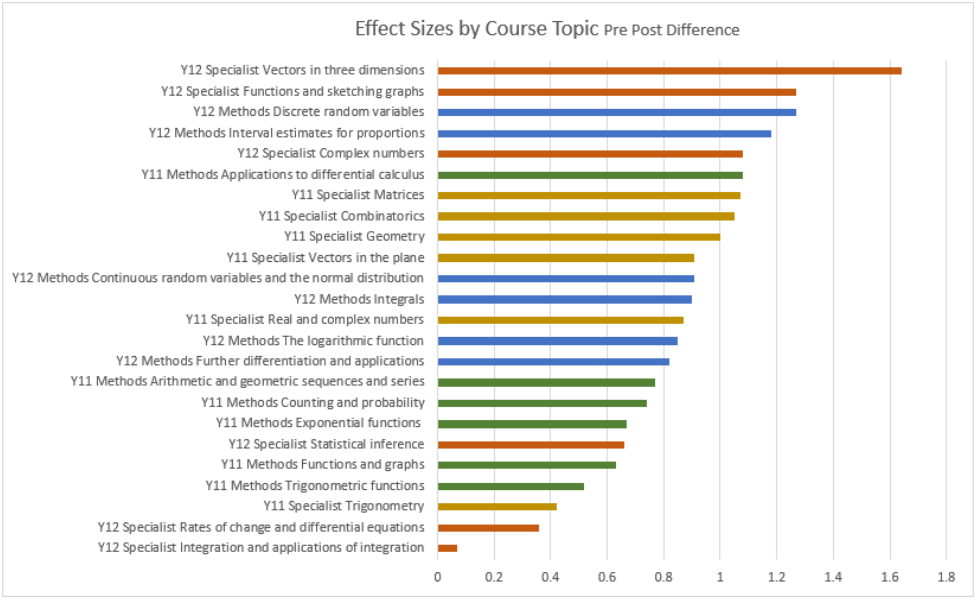

Fig. 2. Pre- and post- effect size differences by professional learning course topic.

Linear mixed modelling [4, 11] found SSMTs' confidence levels improved after completion of the PL program ($F=32.2$, $p<.001$), with teachers in the Year 11 programs having higher confidence levels than those attending the Year 12 courses ($F=10.6$, $p=.001$). No significant difference was detected for Methods versus Specialist courses ($F=0.4$, $p=.553$). Mean differences are summarised in Table 1.

Calculation	MD	SE	p-value	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Specialist-Methods	0.1	0.2	.553	-0.3	0.5
Year 12-Year 11	-0.6*	0.2	.001*	-0.9	-0.2
Post-/Pre-Course	1.0*	0.2	<.001*	0.6	1.3

Table 1. Linear mixed model mean confidence level differences for pairwise comparisons of mathematics unit, year level and pre and post course.

N.B. Based on linear mixed model with the dependent outcome mean item score, degrees of freedom =122.
bolded statistical significance at $p<.05^{a}$ Bonferroni adjustment for multiple comparisons [MD Mean difference, SE standard error].

5. Conclusion

This survey reported a positive effect where SSMTs felt confident to teach mathematical content following their PL course participation. Teachers participating in the Year 11 courses had higher confidence levels than those attending the Year 12 courses, which likely represents the level of mathematical difficulty involved. No significant differences were detected for Methods versus Specialist courses, which probably indicates that the affordances of PL are similar for both mathematics courses. Effect sizes suggest that SSMTs may benefit from PL focused on certain mathematics topics more than others. This study supports the value of PL for improving quality teacher practice which should translate into quality learning outcomes for students.

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