Teaching Math Effectively: Insights from LSAY and PISA on Primary Teacher Proficiency

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1 Abstract

This report investigates the mathematics performance of individuals who became primary school teachers in Australia, using the Longitudinal Surveys of Australian Youth (LSAY) and the Program For International Student Assessment (PISA) datasets. Results show that teachers consistently have a higher average math proficiency than non-teachers over time, with better performance across PISA testing years. However, they tend to score lower than professionals in fields like medicine, law, and engineering. Limitations include disproportionate teacher counts in some PISA years, potentional attrition bias, confounding variables such as socioeconomic status, and the evolving nature of math proficiency over time.

2 Background and motivation

Over the past two decades, Australian students' performance in the mathematics components of international assessments like PISA have shown significant declines. These declines persist even after adjusting for changes in family academic resources, affecting students across all states, social groups, and school types (albeit with variations).This trend has raised concerns among educators, researchers and policymakers as mathematics proficiency is not only foundational for broader academic success but crucial for Australia's future economic competitiveness.

Research indicates a positive correlation between teacher mathematics knowledge (as assessed through certification exams or subject-matter tests) and student achievement. This underscores the importance of qualified primary school teachers in improving children's math outcomes, supporting the notion that teachers with stronger mathematical knowledge are likely to teach it more effectively.

While research consistently suggests that a teacher's proficiency in mathematics is a crucial determinant of their effectiveness in the classroom, impacting student achievement directly (Tatto et al. 2008, p. 19) the relationship between a teacher's subject knowledge and student performance is complex, and extends beyond the teacher's own content mastery. It involves the ability to translate that knowledge into effective pedagogical practices, adapt to curriculum needs, engage in productive professional conversations and address student misconceptions. When students are taught by teachers who have little mathematical content *and* pedagogical content knowledge, learning suffers (Baumert et al., 2010; Hill et al., 2005).

Despite these nuances, the positive correlation between teachers' competence in mathematics and student achievement is clear (Hill, H. C., Rowan, B., & Ball, D. L. (2005)). While this correlation does not strictly imply causation, understanding the mathematics proficiency of primary school teachers remains a critical step in improving student outcomes.

This analysis seeks to deepen the understanding of the mathematics proficiency of individuals who eventually become primary school teachers in Australia by leveraging longitudinal data from PISA and LSAY. By examining trends over time and comparing the math performance of primary school teachers, the broader Australian population and other professionals, this study aims to provide insights into the readiness of teachers to deliver effective math instruction. Understanding these trend is crucial, as they provide insights into the mathematics performance of individuals who later became primary school teachers, and may assist in guiding professional development initiatives focused on targeting and strengthening the mathematics proficiency of primary school teachers, ultimately leading to improved student outcomes across Australia.

3 Objectives and significance

The primary objectives of this analysis was to utilise longitudinal survey data to understand the mathematics proficiency of students who eventually became primary school teachers in Australia. Using the LSAY and PISA datasets, the analysis seeks to address four main questions:

1. **Teacher performance over time:** How well did individuals who became primary school teachers perform in mathematics across the years?
2. **Comparison to other Professionals:** How are they performing in comparison to other 'professionals'?
3. **Comparison to the General Population:** How do teachers' math scores compare to the rest of the sample (non primary school teachers)?
4. **Proficiency standards:** How many teachers meet or exceed the mathematics proficiency standard in each year and over time?

This analysis is significant as it provides critical insights into the math skills of individuals who become primary school teachers, a factor that can directly impact student outcomes. By identifying trends and proficiency gaps, the analysis can allow for a deeper understanding of the performance of primary school teachers in Australia and inform potential

4 Methodology

The analysis focused on evaluating the mathematical performance of individuals who later became primary school teachers using (PISA) and (LSAY).

As the aim was to determine how individuals who became primary school teachers performed in mathematics, to be able to explore this the student ID was used to keep track of the observations. ANZSCO codes were then utilised to identify the primary school teachers in variables that related to the occupation of the individual. We filtered student ID's of those who responded to those variables (i.e. 'Kind of work') with the ANZSCO code, 2412. Additionally, to see the pathway of these individuals we looked for these students and their responses to 'Area of Study' variables.

4.0.1 The Data

The analysis required data which retained the demographic information from LSAY with the corresponding PISA scores for each observation. To achieve this, LSAY data post 2003 was used as participants were recruited from schools that also took part in the PISA. These years included: 2003, 2006, 2009 and 2015. It starts with a sample of 15-year-old students who repeatedly tested until they reach the age of 25 and as such, PISA utilises a complex survey design with sampling weights and plausible values.

4.1 Working with Sampling Weights and Plausible Values Accurately

To handle PISA's plausible values and sampling weights, the analysis utilised `intsvy` and `rrepest` R packages, which are designed to accurately estimate statistics under the complex survey design used by PISA.

These allowed for the calculation of mean scores, confidence intervals and standard errors while accounting for the inherent variability within the dataset.

But what are plausible values?

In the dataset each row represented a student, and each column had demographical data encoded into variable names, PISA scores and weights.

A dummy data frame was created for better understanding:

STIDSTD	SECTOR	SEX	PV1MATH	PV2MATH	ST38Q03	ST38Q04	ST38Q05	w__fstr1
1	2	2	478.0325	451.2464	2	1	1	1.4485556
1	1	1	595.8211	553.1254	5	1	2	0.6564361
5	1	1	469.0156	556.6674	4	5	2	1.3917214
5	2	1	462.5016	461.9213	2	1	1	0.9768890
2	1	1	590.5763	588.9628	3	1	4	0.9822531
2	2	2	424.0112	579.1393	4	4	5	0.9860410
5	2	1	526.6222	501.6526	3	3	4	0.6145305
3	2	1	571.5070	543.2421	1	2	1	0.8843982
5	1	1	482.8737	425.5916	1	3	5	1.4904997
4	2	2	592.6533	558.9235	5	1	4	1.0446148

5 Results

6 Discussion

7 Limitations

8 Conclusion